# SHEPHERDING KNOWLEDGE: A CASE STUDY OF SOCIAL INTERACTIONS THAT SUPPORT KNOWLEDGE MOBILISATION FOR SEPSIS CARE IN SCOTLAND

Tricia Ray Tooman

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at the
University of St Andrews

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# Shepherding knowledge: a case study of social interactions that support knowledge mobilisation for sepsis care in Scotland

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This thesis is submitted in partial fulfilment for the degree of
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# Abstract

**Shepherding knowledge: a case study of social interactions that support knowledge mobilisation for sepsis care in Scotland**

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This thesis is about knowledge that interconnects across different domains, and the social interactions that support the mobilisation of such knowledge for clinical practice. These issues are explored in the context of sepsis care in Scotland.

Sepsis claims the lives of at least 52,000 people in the UK each year, more than breast, bowel and prostate cancer combined. While Hippocrates observed the dangers of sepsis well over two thousand years ago, only in the last 25 years has a coordinated research strategy been established to guide modern therapeutic efforts. Yet despite a mounting clinical evidence base, the cause(s), progression, treatment and even the very *definition* of sepsis remain often unclear and sometimes contested. In care settings, the clinical manifestations of sepsis are frequently subtle and difficult to distinguish from other common conditions, and the lack of a definitive diagnostic test heightens the range of knowledge clinicians depend upon in order to recognise and treat potentially septic patients.

Within this context of uncertainty, connecting the domains of research, policy and practice remains an enduring concern in sepsis care, as with many other clinical issues. In particular, there are significant challenges in ensuring that knowledge (and knowing) in each of these domains better connect for continued improvements in patient care.

This thesis then contributes to improved understanding of the persistent ‘knowing in practice’ problem: using a knowledge mobilisation framing to capture the development, sharing, and use of knowledge, where these processes are conceptualised as multifaceted and intertwined rather than segmented and detached. With a dual focus on both knowers and their knowledge, this work seeks a closer understanding of the social interactions that contribute to an interconnected ‘knowledge network’, a network that can, in turn, underpin better, safer patient care.

Using a qualitative case study design, this study provides a detailed exploration of an interconnected knowledge network (on sepsis care in Scotland) that successfully drew together the research, policy, and practice communities and resulted in improved patient outcomes. Drawing on documentary, observational, and interview data, this work found that knowledge is carefully curated (through social interactions) in order to connect knowledge from the different domains and to support the mobilisation of new actionable understandings for care. Tensions within both what knowledge ‘is’, as well as the social system in which knowledge is employed, are negotiated and nurtured by social practices that have been termed ‘shepherding’. Shepherding practices are those that tend to the social interactions that support the mobilisation of knowledge, and they are in evidence throughout the distributed areas of research, policy and practice. In concluding, this thesis argues that – because knowledge is complex and emergent, and because mobilising knowledge is an ongoing social process – a developmental perspective needs to be taken as the normative frame for the ‘knowing in practice’ problem.

The thesis makes two main contributions:

- *empirically* it provides a rich and detailed account of interconnected knowledge and the social interactions that contribute to the mobilisation of that knowledge in sepsis care in Scotland;
- *theoretically*, this work extends the academic literature that explores the diversity, complexity, and interconnectivity of knowledge for practice by emphasising the role of social interactions in supporting knowledge networks; and the study demonstrates the successful use of Soft Knowledge Systems (SKS) and Clinical Mindlines (CM) as a combined ‘relational knowledge systems’ lens to better understand knowledge mobilisation processes.

## Candidate's declaration

I, Tricia Ray Tooman, do hereby certify that this thesis, submitted for the degree of PhD, which is approximately 80,000 words in length, has been written by me, and that it is the record of work carried out by me, or principally by myself in collaboration with others as acknowledged, and that it has not been submitted in any previous application for any degree.

I was admitted as a research student at the University of St Andrews in September 2013.

I received funding from an organisation or institution and have acknowledged the funder(s) in the full text of my thesis.

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For Bill.

# Table of Contents

# List of Boxes, Figures and Tables

## List of Boxes

## List of Figures

## List of Tables

# List of Abbreviations

| | |
|---|---|
| ACCP | American College of Chest Physicians |
| A&E | Accident & Emergency |
| CCM | Critical Care Medicine journal |
| CCOT | Critical Care Outreach Team |
| CLAHRC | Collaborations for Leadership in Applied Health Research and Care |
| EBM | Evidence-based Medicine |
| ESICM | European Society of Intensive Care Medicine |
| GRADE | Grading of Recommendations Assessment Development and Evaluation |
| ICM | Intensive Care Medicine journal |
| ICU | Intensive Care Unit |
| IDSA | Infectious Diseases Society of America |
| IHI | Institute for Healthcare Improvement |
| ISF | International Sepsis Forum |
| MDT | Multidisciplinary Team |
| NEWS | National Early Warning System |
| JAMA | Journal of the American Medical Association |
| PARIHS | Promoting Action on Research Implementation in Health Services |
| RCT | Randomised Controlled Trial |
| RRT | Rapid Response Team |
| SCCM | Society of Critical Care Medicine |
| SIRS | Systemic Inflammatory Response Syndrome |
| SKS | Soft Knowledge Systems |
| SOFA | Sepsis-related Organ Failure Assessment |
| SPSP | Scottish Patient Safety Programme |
| SSC | Surviving Sepsis Campaign |
| SSM | Soft Systems Methodology |

# 1. Chapter 1—Introduction

This thesis is about developing and connecting knowledge within and across the research, policy and practice communities and the social interactions that support the mobilisation of such knowledge for clinical practice. The broad research question that the thesis addresses is: how is knowledge mobilised within and between the research, policy and practice communities for clinical practice?

This introductory chapter first explains the research problem and outlines some of the main ways this knowledge-in-practice problem has been understood with particular attention to the knowledge mobilisation way of framing the problem. Next the chapter overviews the research approach and setting, explaining why sepsis care is a relevant and fertile empirical area in which to set the study. The final section sketches an outline of the remaining chapters in the thesis.

## 1.1. The Research Problem

There is a seemingly intractable knowledge problem within health services. Despite the proliferation of evidentiary sources and substantial dedication of public resources, the utilisation of research findings within policy and practice contexts remains inconsistent. Expediting and enhancing the use of research-based knowledge in clinical practice has been given many names, including research utilisation, evidence based practice, knowledge translation, and, more recently, knowledge mobilisation. Knowledge mobilisation addresses the problem of contested forms of knowledge and the amount of time knowledge takes to reach across different domains in order to improve health policy and practice for the wellbeing of patients.

Connecting knowledge between the research, policy and practice communities can take time and often does not happen. Relatedly, some practices spread quickly with little basis, whilst others spread slowly despite having strong evidentiary support (Ferlie et al., 2005). The underuse, overuse, and misuse of research-informed evidence is a challenge that includes both learning and unlearning by individuals, teams, organisations, and systems (Institute of Medicine, 2001; Rushmer & Davies, 2004). It appears that “knowledge obstinately refuses to be driven unproblematically into practice” (Greenhalgh & Wieringa, 2011, p. 501).

The discrepancy between actual care and evidence-informed care has been described as a “quality chasm” (Institute of Medicine, 2001). Furthermore, the chasm has often been understood as a deficit in clinician knowledge resulting from a ‘knowledge translation’ or flow problem (Haynes et al., 1986; Laine & Weinberg, 1999; Cooksey, 2006). Thus, strategies have emerged to assist health professionals with the consolidation and prioritisation of ever more data and information. These strategies include the development of systematic reviews and practice guidelines, as well as the establishment of compulsory continuing education. However, despite considerable effort and allocation of public resources, these strategies alone have not proven sufficient to bridge the chasm (Cabana et al., 1999; Cochrane et al., 2007; Gabbay & le May, 2011; Oborn et al., 2013).

The inconsistent percolation of evidence to practice has proven alarming for health systems across the world (Cooksey, 2006; Institute of Medicine, 2001). Seminal reports by David Cooksey in the United Kingdom (2006) and the Institute of Medicine (2001) in the United States depict the problem as a breakdown between the creators and users of scientific knowledge, representing the knowledge flow problem as a series of pipeline stoppages. In other words, the knowledge boundaries between research, policy and practice contexts are of significant concern.

The reason this problem has garnered so much attention is because the stakes are high. The processes of developing, sharing and applying professional knowledge for patient benefit touch every part of society. Healthcare funders have finite resources. They are pressured to fund “what works” (Davies et al., 1999, 2000; Boaz et al., 2019). Policymakers are judged according to health outcomes. Researchers are increasingly held accountable for the usefulness of their work. Healthcare recipients place their trust in a profession that requires a balancing act to attain and maintain competence.

All the while, the task has grown ever more daunting. In the knowledge-intensive context of healthcare, the proliferation of evidence holds promise for clinical improvements that can result in better health outcomes. However, this is coupled with the formidable task of remaining up to date with the latest research findings as health providers balance the responsibilities of professional practice in complex social contexts (Gabbay & le May, 2011; Smith et al., 2012). The result has been described as an ‘information paradox’ whereby clinicians are overwhelmed with information, and yet are unable to locate relevant material when they need it (Nicolini et al., 2008). As a result, a clearer understanding of what forms of knowledge are useful and how such knowledge is mobilised within practice takes on increased importance.

To address the challenge, some scholars have called for the consideration of a wider range of metaphors and models beyond ‘knowledge translation’ that would contribute to a richer understanding of the link between knowledge and practice (Davies et al., 2008; Greenhalgh & Wieringa, 2011). Often ‘knowledge translation’ connotes an individualistic view of knowledge and a purely rational activity. Moreover, the burden of responsibility for the knowledge deficit is placed solely on an individual practitioner’s shoulders (Davies et al., 2008; Gabbay & le May, 2011; Rycroft-Malone, 2007).

Specifically, these scholars call for the consideration of relational and systems-based models to better understand the issues (Best & Holmes, 2010; Nutley et al., 2007; Olson et al., 2010). This involves looking to fields other than health care that envisage ‘knowledge’ and ‘knowledge flow’ in different ways. There one finds terms such as ‘co-constructed’ and ‘collectively negotiated’, which implies that the social context of human interactions plays a significant role in how, when, and often whether or not knowledge is utilised in practice (Brown & Duguid, 2000). And yet, as will be shown in more detail in Chapters 2 and 3, while a portion of the existing literature stresses the importance of social processes for knowledge and knowledge flow, there is little about the qualities of these interactions that supports the social processes.

## 1.2. Using a Knowledge Mobilisation Perspective

Knowledge mobilisation has surfaced as a useful way to frame the process of developing and shifting multifaceted forms of knowledge (Holmes et al., 2017; Swan et al., 2016; Ward, 2017). Knowledge mobilisation is broadly concerned with the processes and activities that encourage the development, sharing and application of knowledge between communities (Nutley & Davies, 2016). Knowledge mobilisation moves away from instrumental and linear understandings of knowledge. And, increasingly, this literature embraces a complex adaptive systems way of understanding the world and how actors have to overcome social and epistemic boundaries in order to helpfully facilitate knowledge processes (Beckett et al., 2018; Greenhalgh & Papoutsi, 2018; Reed et al., 2018). In other words, knowledge mobilisation is about identifying and addressing boundaries between epistemic communities in order to help them develop, spread, and use their knowledge within the milieu of complex social settings (Swan et al., 2016).

In this way knowledge mobilisation seeks to address the tensions between disconnected communities that sometimes place them at odds with one another. The divisions cast researchers as out of touch with the needs of the user communities, and practitioners as resistant and even delinquent (Locock & Boaz, 2004). Furthermore, these detachments result in a continuous redirection of blame where mobilising knowledge is “in everyone’s interests and no one’s job description” (Boaz et al., 2015, p. 147).

## 1.3. Research Approach and Setting

Rather than expand the already sizeable ‘barriers to knowledge use’ literature, this study instead uses an appreciative approach to learn from a series of interconnected knowledge networks. This qualitative case study explores interrelated and, to a degree, nested research, policy and hospital networks (also referred to as ‘communities’, which is explored more fully in Chapter 3) that have overlapping responsibilities for sepsis. (See Box 1-1 for the networks of interest.)

**Interconnected Networks**

**Surviving Sepsis Campaign** – A international research-based network that develops and distributes materials for use in policy and practice contexts. Chaired by two professional specialist societies: the Society for Critical Care Medicine and the European Society of Intensive Care Medicine. Discussed in Chapter 5.

**NHS Scotland Sepsis Collaborative** – A national policy-oriented network that includes policy leaders and clinicians from every regional health board in Scotland. Discussed in Chapter 5.

**Aurora General Hospital** – A local Scottish practice-based network of people providing sepsis-related care. Discussed in Chapter 6.

*Box 1-1 Three Interconnected Networks*

Sepsis is the result of a body’s maladapted response to an infection and can injure essential organs, in particular the heart, kidneys and brain. While those with weakened immune systems are at higher risk, it is a condition to which every person is susceptible, young and old, healthy and frail (see Box 1-2, Sepsis Description). Sepsis is the leading cause of death from infection and one of the costliest to treat (Gary et al., 2016; Levy et al., 2010). Each year sepsis kills more people than bowel, breast and prostate cancer combined. Furthermore, the lingering consequences for patients who survive include irreversible cognitive impairment and serious physical disabilities (Angus, 2010; Iwashyna et al., 2010).

**What is Sepsis?**

1) The body’s potentially life-threatening response to infection
2) Sepsis leads to septic shock, multiple organ failure, and, sometimes, death
3) There are 150,000 cases of sepsis in the UK each year
4) Septic shock is sometimes preventable if recognised early and treated promptly
5) High mortality rate when not identified and treated early

(Source: UK Sepsis Trust)

*Box 1-2 Sepsis Description*

Sepsis is a particularly difficult condition to identify because it has no distinctive features and early symptoms are masked within normal and even expected markers for hospitalised patients (Marshall, 2014). Adding to the difficulty, the very definition of sepsis remains highly contested (Angus, 2016; Angus et al., 2016). And lacking a biomedical understanding of what causes this maladapted response to infection means there is no definitive test available for clinicians to depend upon for the diagnosis of sepsis. For this tricky condition, bedside practitioners must rely upon a combination of the best available, yet still insufficient, evidence, their experience and judgement in order to identify and treat this potentially deadly and damaging disorder.

However, there are hospitals that have found ways to address sepsis and have a far lower mortality rate than their peers. For this reason, data collection for this study began at Aurora General Hospital. Aurora had been identified by multiple people at the NHS Scotland policy level as a high-performing hospital in respect to sepsis care. The interrelated research and policy networks, the Surviving Sepsis Campaign and NHS Scotland's Sepsis Collaborative respectively, arose from these data as the key interrelated bodies that shaped Aurora's sepsis work.

Sepsis is a highly relevant clinical area for studying the research problem because the evidence base for defining, diagnosing and treating sepsis is dispersed amongst many stakeholders with different forms of specialist knowledge. The sepsis knowledge base is unsettled and at times heavily contested, which brings to the fore the social processes needed to develop consensus. As a result, the sepsis research community that many participants at Aurora repeatedly named, the Surviving Sepsis Campaign, brings a lively example of an emergent and messy social process underpinning knowledge mobilisation.

Also, within Scotland the Scottish Patient Safety Programme (SPSP) focused on improving sepsis care throughout the nation. The SPSP established a Sepsis Collaborative drawing together multidisciplinary stakeholders from every health board, which officially lasted from 2012-2014. These gatherings provided the opportunity to witness how the policy community structured the arrangement of actors, processes, and materials in order to reduce the burden of sepsis in Scotland.

Finally, although sepsis is challenging, the disease's knowledge problems are not unique in the health field (Angus et al., 2016). The scientific basis for understanding diseases are inevitably incomplete and thus continually revised, updated, and reversed (Angus & van der Poll, 2013; Prasad et al., 2013). The long list of reasons for a delayed or missed sepsis diagnosis recorded by an Australian public campaign to eradicate sepsis can be thematised into three areas: a lack of knowledge, structural deficiencies with health systems, and poor interpersonal communication between system actors (Clinical Excellence Commission, 2009). This thesis seeks to address these areas by focusing on how one hospital was able to draw on research and policy communities to mobilise knowledge and improve outcomes for their patients.

## 1.4. Structure of Thesis

The purpose of this thesis is to contribute to a richer understanding of professional knowledge and how such knowledge is mobilised within and between the research, policy and practice communities. To do so, the remainder of the thesis will unfold in six further chapters.

The relevant literature is covered in two chapters. First, Chapter 2 appraises the knowledge and knowing literature to reveal varying epistemic assumptions that divide actors and communities. In particular, this chapter foregrounds existing tensions around knowledge in the health professions linked to the evidence based medicine agenda. The chapter also introduces Clinical Mindlines (Gabbay & le May, 2011) as a useful theory for conceptualising knowledge and how knowledge is acquired and developed for practice. Chapter 3 then moves to explore the ways actors are organised to mobilise their knowledge. The chapter focuses on teams and networks as they are two key structures that health systems have used to address social boundaries between actors. This chapter explores the assumptions about knowledge mobilisation upon which these structures are set. Next, the chapter presents Soft Knowledge Systems theory (Engel, 1997). Soft Knowledge Systems is useful because it is a knowledge network lens to understand how actors band together and overcome boundaries to accomplish their shared knowledge-orientated goals. Chapter 3 concludes by focusing on the what is seen in these literatures that sheds light on interactions that address social boundaries in order to help facilitate knowledge mobilisation.

Chapter 4 reviews the research goals and questions and then discusses the qualitative methodology, case study design and methods used in this study. Furthermore, this chapter explains why and how Clinical Mindlines and Soft Knowledge Systems theories were used to design the project, focus data collection, and analyse these data.

The findings of this study are presented and analysed over two chapters. Chapter 5 details the sepsis research and policy networks. The purpose of the chapter is to describe the relevant background actors and sources that contributed to the evolution of ideas, evidence and initiatives at Aurora General Hospital, the practice network. Chapter 5 is divided into two parts. The first covers the emergence of sepsis and the sepsis care field found in the research literature with particular focus on the development and work of the Surviving Sepsis Campaign. The second part turns to explore the policy setting, with an emphasis on the Sepsis Collaborative as a subset of the Scottish Patient Safety Programme. Here patterns of connection and interaction emerge that foreshadow what is seen more clearly within Aurora in Chapter 6. These groups provide a glimpse of how knowledge is formed, agreed and shared for use. In this way we also begin to see how knowledge is shepherded within and across network boundaries.

Chapter 6 provides a detailed empirical account of Aurora General Hospital that shows the dynamic, evolving and interaction-based knowledge system for sepsis practice. These data substantiate the claims of this thesis, which are that in this case knowledge and knowledge mobilisation are interconnected social processes. Furthermore, particular interaction-based practices help nurture the social engagement between actors that in turn support the development, sharing, and use of knowledge.

Lastly, Chapter 7 reviews the overall findings of this thesis and explains how these data answer the core research question. (Box 1-3 provides a preview of the thesis claims.) The chapter then examines how these findings and insights provide an empirical, theoretical, and methodological contribution within the knowledge and knowledge mobilisation literatures. Finally, the study's implications, limitations, and potential avenues for further research are outlined.

In summary, this introductory chapter explains the rationale for and importance of this study. Furthermore, the chapter proposes that another look at the knowledge in practice problem is warranted. Specifically, a study is needed that considers the complex forms of knowledge, the ways knowledge develops, disperses, and is utilised within and between groups of actors, and the interactions that bind knowledge and knowers together. Next, Chapters 2 and 3 delve into the literature on knowledge and ways of organising for knowledge mobilisation.

**RQ: How is knowledge mobilised within and between the research, policy and practice communities for clinical practice?**

Thesis claims: Knowledge and knowledge mobilisation are regularly referred to as social processes. Drawing on a case of successful knowledge mobilisation within and between interrelated sepsis practice, policy and research communities, this thesis shows that both knowledge and knowledge mobilisation were shepherded processes. This thesis contends that these social processes involve both binding together different forms of knowing (tending knowledge) as well as relevant actors and communities (tending the knowers). Shepherding practices nurture the social aspects of developing, sharing, and using knowledge, which are often harmonised (or damaged) at the micro-interaction level. How knowledge is mobilised involves both the structural organisation of knowledge systems and the relational activities between actors. In other words, knowledge is mobilised within systems-based structures (arrangement of actors, the processes and the materials they use). But to understand how knowledge is mobilised within these structures we must look to the muddle of human interactions.

*Box 1-3 Thesis RQ & Claims*

# 2. Chapter 2—Knowledge and Knowledge Use

*If only knowledge could be picked up like shells from the seashore or pulled from bushes and trees like fruit or netted like butterflies.*
*(Peter Burke)*

## 2.1. Introduction

At the heart of the knowledge in practice problem are differing viewpoints on the construct, or nature, of knowledge. Some view knowledge as explicit and codifiable, a *thing* that is portable and transmissible from person to person and across contexts. Others assert that knowledge is better captured in terms of a *process of knowing* that is not readily separable from the knower and is embedded within specific contexts (Cook & Brown, 1999; Tooman et al., 2016). It is essential to delineate our views, for how we conceptualise knowledge shapes our understanding of not just knowledge itself, but also the ways we mobilise our knowledge in practice.

The last chapter established the research problem and context of study. This chapter reviews the relevant concepts and research that provide a basis for this thesis. We step through this complex literature in two primary parts. The first part sets out key understandings around what knowledge and knowing are, and is organised in four parts. It begins with a description of key conceptualisations and debates about knowledge and knowing primarily from the management and organisation studies literatures, and then turns to focus on related evidence-based medicine debates set within the medical and health services literatures. It then provides an explanation of Clinical Mindlines (Gabbay & le May, 2004, 2011), one of the two theoretical frameworks used to examine the knowledge mobilisation problem in the present study. The section concludes with a consideration of the implications these conceptualisations have about ways we use our knowledge to facilitate practice improvement.

The second part outlines and critiques the conceptual and empirical research on knowledge use and the major ways we have responded to the knowledge and practice divide in healthcare. To do so, the chapter draws on Best and Holmes' (2010) segmentation of knowledge use approaches and assesses the *linear*-based transfer and translation, *relationally*-based linkage and exchange, and *systems*-based knowledge mobilisation frames for facilitating knowledge use in professional practice. The chapter concludes emphasising the importance of understanding knowledge and related knowledge concepts of creation, diffusion and use as interconnected, social processes that are based upon the social interactions between individuals, within and between teams, and across networks.

## 2.2. Understanding Knowledge and Knowing

Knowledge is a diffuse and ambiguous concept that defies simplistic categories (Easterby-Smith & Lyles, 2011; Tooman et al., 2016). A wide array of terms, types, and descriptors are found within academic discourse. Knowledge-related terms can be used in incongruent and incompatible ways. The lack of agreement on terminology reveals the discontinuity between philosophical frames (Nutley et al., 2007). It is not uncommon to see terms like 'knowledge' and 'information' used interchangeably (as well as labels such as 'data', 'research' or 'evidence'). The seeming alignment between these terms gestures to a view of the nature of knowledge as an object that is readily detachable from a knower; something that can be de-contextualised, that is generalisable, and thus transmissible intact from one context to another. Instead, some propose a progression of terms beginning with data, information, knowledge, and onward to wisdom, based on the increasing role of human intervention and judgement (Tsoukas & Vladimirou, 2001; Greenhalgh, 2010), or, as Burke (2000) puts it, from 'raw' to 'cooked'. These scholars hold that knowledge is not a variant of information but rather involves the ability to make judgements, draw distinctions, and imbue information with meaning based upon a particular time and place. Crucially, a distinction is made between whether one sees that knowledge can be separated from the knower, or is inseparable and 'sticky' (Brown & Duguid, 2001; von Hippel, 1994). In the 'sticky' view knowledge is anchored, or situated, and tightly dependent on both the knowers and the context (Lave & Wenger, 1991). What is known, the one who knows it, and the context of action are bound together, and, as a result, knowledge is far more than an object and is more aptly recognised as a process of *knowing* (Gourlay, 2006).

## 2.3. Key Conceptualisations and Debates

To build a case for interconnected conceptualisations of knowledge a closer examination of the complex character of knowledge is needed. Indeed, many forms and dimensions of knowledge are portrayed in the literature. An Aristotelian understanding of knowledge is often taken as a useful place to begin (Abbasi, 2011; Greenhalgh & Wieringa, 2011; Montgomery, 2009; Nonaka et al., 2008; Van de Ven & Johnson, 2006). Aristotle viewed knowledge as a nexus of three interdependent parts: *episteme* (i.e. systematic, often scientific, research-informed knowledge, or information), *techne* (i.e. skilful craftsmanship, artistry, stemming from experience), and *phronesis* (i.e. wisdom or judgement). In this conceptualisation, no one strand constitutes knowledge on its own, but rather 'knowledge' is a fusion of these forms, and each form plays an essential role within knowing, doing, and context-based understanding.

Gilbert Ryle's (1949) demarcation between knowing *that* and knowing *how* set forth an important distinction between content-based subject matter and skills-based capability. Knowing *that* is to know about some*thing*, to accumulate abstract or explicit forms of knowledge (Blackler, 1995). And yet, knowing *how* is an embodied process of using explicit forms of knowledge (Brown & Duguid, 2000). Knowing *that* and knowing *how* are interconnected. Ryle used the game of chess to demonstrate the interconnection of these forms. He observed that to know the rules of chess (know *that*) is connected to, but not the same thing as, knowing *how* to play chess (Brown & Duguid, 2001). Knowing *how* is personal, often action-oriented, exhibited in the demonstration of skills, and thereby inseparable from the knower (Blackler, 1995).

Some view knowing and doing as separate and sequential tasks, while others view them as connected and intertwined (Star, 2005). For example, to say that someone is fixing a car indicates both knowing *that* (i.e. a cognitive process of holding and accessing relevant facts about mechanical problems and their solutions), as well as operational knowing *how* (evidenced in specific skills and behaviours) (Cook & Brown, 1999). Engaging in the process of fixing a car brings the potential for developing new knowledge, emerging insight, and refined skills, thereby increasing the capacity to both know that and know how. Know *how* is “to a great extent the product of experience and the tacit insights experience provides…and is critical in making knowledge [know-*that*] actionable and operational” (Brown & Duguid, 1998, p. 95).

Michael Polanyi proposed two ‘dimensions’ of knowledge (Polanyi, 1966). Polanyi’s distinction was that *explicit* forms of knowledge are those that are articulable, whereas, *tacit* forms, are not (Brown & Duguid, 2001). However, Polanyi did not view explicit and tacit knowledges as independent of one another, but rather interdependent dimensions. The articulable dimensions do not, and cannot, convey all that the person knows. Some forms of knowledge are held deeply within the knower and are not communicable and transferable. Furthermore, explicit knowledges are rooted in and given meaning by a person’s tacit forms including life experiences, values, and perceptions of self. Contrary to some views (e.g. Nonaka et al., 2001), tacit forms of knowing are more than domains of knowledge *not yet* articulated, but forms that *cannot be* articulated and transferred to another (Tsoukas, 2003). The subjugation of tacit knowledges misconstrues what, holistically-speaking, knowledge is. Like Aristotle’s interdependent strands, the explicit and tacit dimensions mutually constitute and build ways of knowing (Cook & Brown, 1999).

Polanyi’s two dimensions have been extended further to include four interdependent types of knowledge: explicit, tacit, individual and group (or collective) (Cook & Brown, 1999). Just as explicit and tacit knowing are interdependent, individual and collective knowing are as well. Each form is “unique and irreducible” and “does work that the others cannot” (1999, p. 54). However, collective knowing is often mis-conceptualised as clustered individuals, each still fundamentally discrete. Individuals and collectives influence and shape one another in the course of learning and developing their knowledge. While there is no collective knowing without individuals, knowing is constructed in and has meaning only within human interactions and context. Communities build and hold *shared* knowledges that are conceptually distinct from an individual’s (Bouty & Gomez, 2010; Brown & Duguid, 2001) as well as *disbursed* specialised knowledges within a community that require collective action to accomplish interlaced tasks (Lave & Wenger, 1991; Wenger, 1998). The shared context is the social milieu from which collective forms of knowing develop.

Socially situated knowing involves a dynamic interplay, and an inseparable relationship between personal knowledge and social context. Individual knowing is not an isolated process, but is one borne out of interactions with others and with the world (Cook & Brown, 1999). The individual and collective are dynamic and distinct entities, nevertheless simultaneously interdependent (Brown & Duguid, 2001). Like Aristotle's interwoven nature of knowledge, each form of knowledge differs and suits particular roles, even as they are interwoven in the process of knowing. In sum, collective, individual, explicit, and tacit dimensions of knowing function in tandem and dependence upon one another.

A further example of interrelated knowledge delineates three domains of knowing: empirical, theoretical, and experiential (Brechin & Sidell, 2000). Empirical knowing is considered the most explicit. This includes research-informed knowledge derived from scientific methods direct and structured observation. Theoretical knowing suggests a conceptual reasoning process where various ways of approaching a problem are considered to constitute a plausible way of understanding what is observed. Experiential knowing involves craft and mastery that are hard-won through experience, often more evident in the doing than in any explicit articulation of knowledge.

Accounts of knowledge and knowing contain within them divergent assumptions and give rise to differing implications for how to set about the tasks of creating, sharing and using knowledge. Some of these assumptions are laid out in Table 2-1 (below), under the two broad headings of knowledge as a *thing* and knowing as a *process*. Rather than dualist opposites, these descriptors can be taken as anchors for arguments of extent. For example, to the extent that knowledge is a thing to be found, then it is seen as primarily explicit, value-neutral, and, often, individualistic; whereas construing knowing as a situated and dynamic process of discovery emphasises the social and specific context, where collective and tacit forms of knowing are an elemental part.

**Table 2-1 Assumptions about knowledge**

| **Whether knowledge is…** | |
|---|---|
| **…an object, a product, a commodity…** | **…a situated process of knowing…** |
| **… suggests these assumptions and implications:** | |
| Pre-existing knowledge | Emergent knowing |
| Objective | Subjective |
| Value-neutral | Value-laden |
| Discovered | Constructed |
| Certain | Uncertain |
| Static | Dynamic |
| Focused on data and information | Combining information, experience, judgement |
| Meaning is found | Meaning is interpreted |
| Explicit: know that | Tacit: know how |
| Content knowledge | Skills and judgement |
| Generic, generalisable, independent of context, de-contextualised | Specific to a time and place, context-dependent, situated |
| Individual | Collective |
| Received, interpreted, and understood by the individual | Co-constructed from and understood within the social context and system (Wittgenstein's 'all knowledge is collective') |
| Can be packaged and transferred | Cannot be packaged and transferred (Polanyi's 'all knowledge is personal') |
| Getting 'knowledge into practice' | Building shared 'knowing in practice' |
| Simplified when reduced to ever smaller parts, which builds richer understanding of the whole | Deepens in complexity when narrowed to smaller focus, which further complicates understanding |
| Adapted from Blackler, 1995; Tsoukas & Vladimirou, 2001; Brown & Duguid, 2000; Duguid, 2005; Gourlay, 2006; Greenhalgh, 2010 | |

In summary, there are different views about the nature of knowledge, and many terms are used to describe knowledge and knowing. Some point to knowledge as separate from the person and the context; others hold to a dynamic interplay between different forms of knowledge within and between social beings. This overview reveals a core tension within knowledge-based terms. If we hold to a dynamic inter-play between Aristotle's strands of knowledge, as opposed to a diminished subset, as Ryle and Polanyi argued (Brown & Duguid, 2001), we begin to frame the debates around divided and reduced or interconnected and interdependent knowledges.

### 2.3.1. Evidence-Based Medicine and the Nature of Knowledge

Within the health literature, the terms 'evidence' and 'research' are used to refer to 'knowledge' (Ferlie et al., 2012a). And evidence based medicine (EBM) is the "health sector version of 'type of knowledge' debate" (Ferlie et al., 2012a, p. 1299). The aim of this section is to explore EBM, particularly in how it conceives of the nature of knowledge.

The ground was cultivated for the modern day EBM movement by Scottish epidemiologist, Archie Cochrane (Claridge & Fabian, 2005). He was concerned about the forms of knowledge that clinicians relied upon, and critical that care provision was based upon the anecdotal experience of individual physicians (Ashcroft, 2004; Dopson et al., 2003). Cochrane explained that this knowledge was untested, sometimes wasteful and potentially unsafe, and advocated for the systematic and scientific evaluation of treatments in order that physicians could better meet their professional obligations.

Work began in the 1980s that documented Cochrane's concerns by showing disturbing practice variance. The Dartmouth Atlas, using publicly available Medicare data, demonstrated variations of health interventions, spending, and patient outcomes by geographic location. For example, a subset of primary care practitioners ordered twice as many CT scans as other doctors, and some cities placed coronary stents at three times the rate of neighbouring cities (Skinner & Fisher, 2010). The overuse, underuse, and misuse of interventions had concerning implications for both the quality of care for patients, as well as waste of health system resources (Rushmer & Davies, 2004; Timmermans & Mauck, 2005).

The explanation for these widely varied practices was that physicians were drawing upon non-scientific sources of knowledge (Haynes & Haines, 1998). Physicians relied upon knowledge generated from professional experience, potentially out of date material from their foundation training and textbooks, or as time elapsed, important information was forgotten. The pre-EBM professional knowledge systems relied upon the serendipitous capture of relevant journal articles and periodic attendance at continuing education activities (Sackett & Rosenberg, 1995). Up to date information in medical journals was disorganised, and due to time constraints, physicians' information needs were most often obtained by asking colleagues and regional experts (Sackett & Rosenberg, 1995). The wide range of practices seen in the Dartmouth Atlas sharply called into question the reliability of both these systems and sources of knowledge that doctors were using.

A promising solution to this knowledge in practice problem appeared called Evidence Based Medicine. The influential *Journal of the American Medical Association* published what was described as “a new paradigm for medical practice” (EBM Working Group, 1992, p. 2420) (with Gordon Guyatt as chair). The new paradigm “de-emphasizes intuition, unsystematic clinical experience, and pathophysiological rationale as sufficient grounds for clinical decision-making and stresses the examination of evidence from clinical research” (EBM Working Group, 1992, p. 2420), the sources that concerned Cochrane. Guyatt and colleagues also pointed out that physicians sought out clinical experts' opinions and used reasoning based on biological principles and logic instead of “established facts based on data” (Sackett & Rosenberg, 1995, p. 330). Rather than depend upon others' expert clinical opinion or one's own experience and judgement, the Working Group made the case that knowledge to guide clinical practice should be drawn from large, unbiased quantitative data sets that were systematic, observable, measureable, and reproducible, in other words, based on the scientific method encapsulated in a randomised controlled trial (RCT).

EBM required new skills from practitioners. These skills were methodological. The patient problem could be framed in such a way that aligned with the research literature. The clinician completed an “efficient” search of all relevant research in order to “resolve the problem” (EBM Working Group, 1992, p. 2421), assessed the validity of each piece by “applying the rules of evidence” (p. 2421), determined the clinical action(s) recommended by these data, and applied it to the patient. Namely, reliable forms of knowing were drawn from the systematic and rigorous search for science-based information.

Thus, at its inception EBM upended the epistemological basis of medical practice. EBM advocates were clear that not all knowledge was equally reliable. Where reasoning based on pathophysiological mechanisms of disease, years of clinical experience, and the resulting clinical judgement were considered sufficient for clinical expertise, the new EBM paradigm questioned the basis for each of these knowledges (Dopson et al., 2003; Goldenberg, 2006; Greenhalgh et al., 2014). The primary fulcrum shift was one of authority. Authority moved from that which was derived from clinical opinion based on experience, or *expert*-based medicine, to methodological expertise, or *evidence*-based medicine (Godlee, 2014). The forms of knowledge and skills considered trustworthy and reliable transferred from specialist clinicians to methodological experts.

The perceived benefits were that EBM would save time, be efficient, provide shared language between specialties and professions, align educational efforts, and provide credible information to guide practice (Sackett & Rosenberg, 1995). These authors recognised that even once clinicians began to learn EBM methods, further strategies were needed to incorporate EBM into everyday practice. Sackett and colleagues (1989, 1992, 1995, 1996) recommended drawing on evidence-based summaries and protocols generated by methodological experts. One such example, was the Cochrane Collaboration, established in Oxford to collate and distribute unbiased scientific reviews (Dopson et al., 2003). The ascendency of the randomised controlled trial, and soon systematic reviews of RCTs and the meta-analyses of collated systematic reviews, established a hierarchy of valuable and valid evidence. New journals, the *ACP Journal Club* and *Evidence Based Medicine*, were established with the dedicated goal of publishing methodologically rigorous content for the clear communication of evidence.

The underlying message was clear: not all knowledge is equal. Reliable and trustworthy evidence was available from scientifically rigorous epidemiological and bio-statistical sources (Goldenberg, 2006). Statistical data based on studies of populations superseded clinical experience and judgement. The use of these data, instead of clinical judgement, was the answer to the research in practice problem (Dopson et al., 2003).

Initial backlash to EBM was fierce. Some took umbrage at the implication that they were not already using evidence (Dopson et al., 2003; Sackett et al., 1996). Some described EBM as 'cookbook medicine' that did not adequately take into account patient values, views or local concerns (Berg, 1997; Dopson et al., 2003). In contrast to the statistical power of RCT data, clinicians' hard-earned professional experience was considered unsystematic and biased, and thereby deemed unreliable. This shift of authority represented a potential loss of clinical and professional autonomy, and there was suspicion that managers would manipulate EBM structures for cost-cutting purposes.

A few years later, the definition of EBM was modified saying,

> [EBM] is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. By individual clinical expertise we mean the proficiency and judgment that individual clinicians acquire through clinical experience and clinical practice. Increased expertise is reflected in many ways, but especially in more effective and efficient diagnosis and in the more thoughtful identification and compassionate use of individual patients' predicaments, rights, and preferences in making clinical decisions about their care (Sackett et al., 1996, p. 71).

This definition intended to calm concerns and defuse the controversy around EBM. This definition of EBM remains intact today. The revised definition appears to re-join and revalidate the spectrum of clinical knowledges; yet, further in the document the authors reaffirmed the preeminent position of RCTs.

> Because the randomised trial, and especially the systematic review of several randomised trials, is so much more likely to inform us and so much less likely to mislead us, it has become the "gold standard" for

> judging whether a treatment does more good than harm (Sackett et al., 1996, p. 72).

In other words, clinicians must rely on other forms of knowledge when RCTs are not available or relevant, but should otherwise depend upon the objective, unbiased data that RCTs provide in order to treat patients.

Nevertheless, caution must be used regarding the phrase “EBM” as if it encapsulates a unified perspective. While often narrowed to exclusively focus on the scientific inputs as appropriate and acceptable bases for practicing medicine, Sackett, amongst others, adhered to a fuller conceptualisation of knowledge (Thornton, 2006). And yet despite the more nuanced 1996 definition, EBM is often narrowed to a reliance upon scientific evidence alone (Sehon & Stanley, 2003). While EBM is sometimes conceived as drawing upon a wide range of knowledges, with standards of evidence based on the results from epidemiology and systematic trials studies, there is little doubt that in function, EBM heavily favours explicit forms of knowledge over all others (Fitzgerald & Harvey, 2015). The results of which are increasingly witnessed as many public accountability structures that are heavily weighted in favour of explicit guideline- and protocol-based care (Ferlie et al., 2012a).

EBM has been paraded as one of the greatest medical achievements in the last 200 years (Hofmeijer, 2014). The widespread acceptance of EBM and use of RCTs has indeed put important information into the hands of clinicians. For example, high blood pressure for elderly patients was once considered acceptable and not necessary to treat. Large RCTs showed the opposite (Greenhalgh, 2002). We now know that radical mastectomy is not necessary for many patients with breast cancer (Montini & Graham, 2015).

In the midst of these advances, concerns have been raised about the overly optimistic, and perhaps dogmatic, view of what the EBM method can accomplish (Dopson et al., 2003; Gabbay & le May, 2011; Rycroft-Malone et al., 2004). One critique is the overrating of scientific evidence as a definitive source of knowledge for clinical decision making (Ingold & Monaghan, 2016; Miles et al., 2007). EBM has been seductive in seeming to offer certainty (Dopson et al., 2003) when decisive findings are rare. A study of Cochrane reviews found just 1% indicated enough certainty that further studies were not required (El-Dib et al., 2007).

Another concern is that the proliferation of RCTs, systematic reviews, and meta analyses has spawned a number of difficulties. Carrying out RCTs is costly, consequently, the majority of trials are funded by companies with commercial interests in the outcome (Timmermans & Mauck, 2005). The dominant source of funding for RCTs has raised concerns that organisations drawing on these studies, such as the Cochrane Collaboration, are inadvertently giving credibility to vested interests (Greenhalgh et al., 2014; Ioannidis, 2016). Furthermore, contrary to the premise of EBM, RCTs are not ‘objective’ and value free (Hofmeijer, 2014; Ioannidis, 2016). Lastly, EBM has been criticised for providing research outputs that were either irrelevant, unrealistic or both within clinical work precisely because highly relevant voices are silenced in the clinical setting, including those of patients and carers.

Nutley and colleagues explain that quality evidence depends upon what it is we want to know (Nutley et al., 2013). RCTs of the kind that Sackett and Guyatt promote can produce useful efficacy data for generalised populations. But EBM, in its strict stepwise system for obtaining credible knowledge, rejects an Aristotelian understanding of complex, multidimensional ways of knowing. As a result, what constitutes evidence is highly contested and critics of EBM say that it inappropriately narrows what counts as useful knowledge (Buetow & Kenealy, 2000). Furthermore, the seemingly adversarial relationship between clinical judgement and evidence is a false dichotomy. Judgement is intertwined across the full spectrum of knowledge creation and use (Greenhalgh, 2002; Hofmeijer, 2014).

The tensions regarding EBM are not about *whether* scientific evidence is a useful source of knowledge, but rather the role of, or *how*, evidence is used in practice. Critiques of EBM do not dispute that research-informed evidence has an important role to play in clinical practice. Their objections rest on the grounds that what constitutes evidence, and ‘best’ science for clinical practice, is contested and that clinical expertise entails a wider conception of knowledge in practice (Miles et al., 2000). They resist the perceived hierarchy of explicit forms of knowledge and "emphasize the value of clinical experience and the judgment of individual physicians...and sometimes emphasize the *art* of medicine, and contrast this with the *science* of medicine, or they speak of *techne* vs. theory or compassion vs. reason" (Sehon & Stanley, 2003). This correlates with other studies that purport that giving codified, decontextualised knowledge privileged status misunderstands the role of experience, artistry and competent clinical judgement, and does not reflect the realities of exemplary professional practice (Gabbay & le May, 2011; Harvey et al., 2011; Rich, 1997).

In summary, the debates around the EBM movement are largely epistemological debates about what constitutes (and which methodologies uncover) trustworthy forms of knowing. One side represents a shift away from dependence on clinical expertise to dependence on (often others') bio-statistical methodological expertise. On the other side is a complex, interdependent conceptualisation of knowledge where rather than competing, forms of knowledge complement and work in tandem. While the refined 1996 EBM definition eased the controversy and marked a turn in widespread acceptance, we have witnessed over the last two decades an engrained overreliance on a diminished construction of knowledge alongside difficulty getting this knowledge 'taken up' in practice. At the same time, we have seen the introduction of rich conceptualisations of knowledges and calls to consider research use strategies based upon continually evolving interconnected forms of knowledge within complex systems (Best & Holmes, 2010; Gabbay & le May, 2011; Rycroft-Malone et al., 2004).

### 2.3.2. Clinical Mindlines and Interconnected Ways of Knowing

Clinical Mindlines is one such conceptualisation of interconnected knowledges (Gabbay & le May, 2004, 2011). Clinical Mindlines theory was based on an extensive ethnographic study of an exemplary primary care practice. The study set out to understand how clinicians acquired and used their knowledge. A growing body of literature made it clear that, despite extensive efforts to promote evidence based medicine (EBM), clinicians appeared to frequently ignore research-informed evidence in their practice. Gabbay and le May reasoned that if they stood alongside members of an ordinary, yet high-performing, general practice, they would witness first-hand how these clinicians made use of various sources of evidence (e.g. research findings, new treatment information, guidelines) in their clinical decision-making. The authors observed what they called 'clinical mindlines', which "blend formal, informal, tacit and experiential evidence" (2011, p. xiii) seamlessly in action. Mindlines, in essence, are the clinician's "internalized guidelines" (2011, p. 47) that are drawn from an amalgamation of their professional training, experiences, evidence-informed materials, and interactions with colleagues and patients. These mindlines entangle to the degree that, in most cases, one source cannot be clearly distinguished from the others. Mindlines are "a complex social construction, linked to a web of sources that...build and reinforce the embedded knowledge and values that allow the clinicians to function" (2011, p. 46).

Clinical Mindlines is a conceptualisation of multidimensional, interconnected knowledges that provides an empirically rich articulation of the countless sources that enrich clinicians' ever-evolving knowledge over their lifetime (see Figure 2-1). Emerging from tacit, explicit, individual and collective ways of knowing, mindlines inform, direct, and shape their practice. In this way, Clinical Mindlines theory provides a picture of knowing in practice that aligns with Aristotle's view where knowing is the interplay of many strands of knowledge that are continually evolving, and blend to form holistic knowing. Clinical Mindlines theory presents an alternative view of what 'is' (ontologically speaking) that challenges EBM's prevailing positivist-based view of reality.

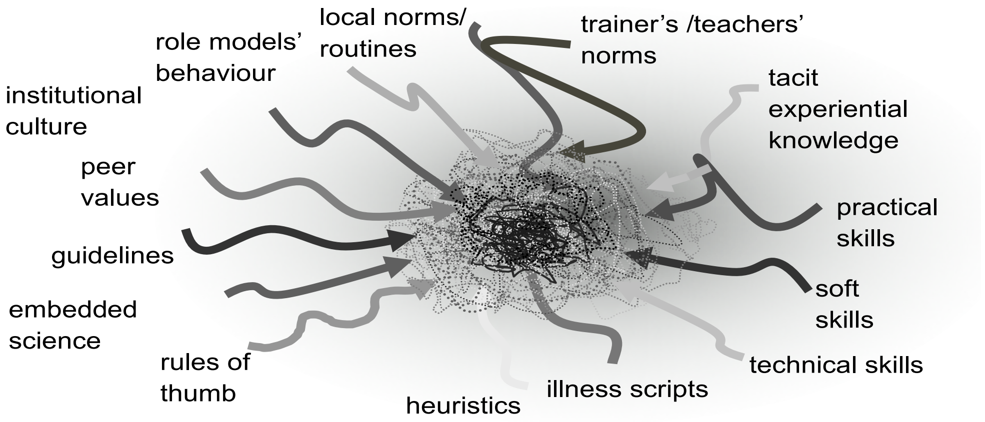


*Figure 2-1 A schematic representation of accumulated content of mindlines*
*(Source: Gabbay & le May, 2011, Figure 4.1, p. 73)*

Collective mindlines widen the lens from the individual to incorporate interconnected actors resembling an interconnected web of knowing (see Figure 2-2). Gabbay and le May (2011) point out the inherently social nature of clinical mindlines as they "were being implicitly shared and checked, refined and continually developed through interactions between colleagues" (p. 130), most often through engagement with trusted colleagues that was part of the regular flow of clinical practice such as "informally swapping stories, sharing experiences, helping each other solve tricky problems, collectively making sense of new ideas they had come across, and changing how they behaved" (Gabbay & le May, 2016, p. 402). In this way, individual and collective mindlines develop in tandem through social interactions.

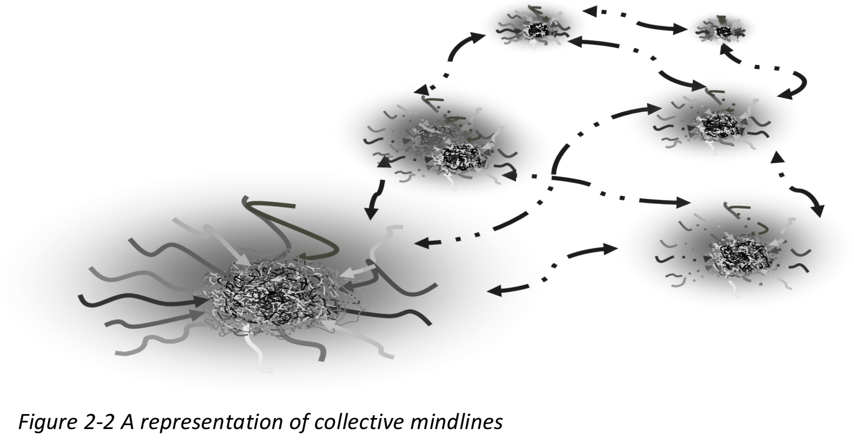


*Figure 2-2 A representation of collective mindlines*
*(Source: Gabbay & le May, 2011, Figure 7.1, p. 131)*

Mindlines’ incorporation of Polanyi's tacit dimension of knowledge is not set in opposition to the explicit sources, but draws together tacit and explicit knowing as working together. Similarly, knowing is both individual and set within a context of mutuality with colleagues as well as the wider realm of knowers that includes teachers, trainers, researchers, and guideline developers.

A review of Clinical Mindlines indicates this framework has received a mixed reception in the health services literature (Wieringa & Greenhalgh, 2015). The original 2004 publication has been nominated as one of the most influential pieces in the *British Medical Journal* over the last decade (Greenhalgh et al., 2016). And yet, some authors have dismissed Clinical Mindlines as misguided and subversively supportive of non-evidence-based practice because tacit and social forms of knowing are considered important as well as scientific sources (Wieringa & Greenhalgh, 2015). Other authors mistakenly distil the Clinical Mindlines concept down to ‘consulting colleagues’ (Gupta et al., 2009), missing essential elements such as prior professional experiences and explicit forms of evidence. Wieringa and Greenhalgh conclude that “mindlines offers a philosophically and theoretically sophisticated perspective on knowledge and clinical method” (2015, p. 14).

### 2.3.3. Implications for Conceptualising Knowledge to Improve Practice

A clear articulation of how we understand knowledge matters because how one conceptualises knowledge provides the foundation upon which we base our understanding about how our knowledges develop, are shared and used. The spectrum described thus far shows that often the premise of knowledge within EBM is reduced to an object, in the form of quantified data from RCTs, which is readily transferable regardless of context. Whereas a conceptualisation of interconnected knowledges, such as Clinical Mindlines, provides different picture. This view brings together knowledges of varying forms and sources that are distinct (including RCTs) and yet no one subjugates another. These domains, explicit, tacit, individual and collective (Cook & Brown, 1999), are interdependent and work in tandem, each providing input that another cannot.

How we conceptualise the nature of knowledge also has implications for learning, both individually and at the organisational level. If knowledge is an object, then individual learning is often construed as a linear, stepwise process of knowledge acquisition. This is demonstrated in Bloom and Krathwohl's (1956) six levels of learning, which are ordered from the knowledge of something to the ability to evaluate and offer a critique of it. Alternately, when knowledge is viewed as socially constructed, emergent, and having meaning drawn from a particular context, then learning is both an individual and collective process of transformation (Merriam et al., 2007). This view shifts the focus from individual knowledge acquisition to how individuals and groups change, transform, and learn as a result of connecting and engaging over a shared task (Wenger, 1998). In this way, learning is viewed as social, interactive, influenced by system structures, and a life-long process (Illeris, 2002).

In sum, this section has reviewed the literatures around the array of knowledge and knowing terminologies and the philosophical frames linked with differing views on the nature of knowledge. It is questions about the nature of knowledge that are at basis of the ongoing debates around EBM. For the tensions regarding EBM are not about *whether* scientific evidence is a useful source of knowledge, but rather the role of, or *how*, evidence is used in practice. Frameworks such as Clinical Mindlines provide a contrast to positivistic views and help explain why "knowledge obstinately refuse[s] to be driven unproblematically into practice"(Greenhalgh & Wieringa, 2011, p. 501).

## 2.4. Research on Knowledge in (or into) Practice in Healthcare

As already indicated, how one conceives of the nature of knowledge not only shapes one's understanding of the knowledge in (or into) practice problem (Ward et al., 2012) but the strategies used to enhance the knowledge base for practice. If knowledge is an object and understood as a 'flow of information', knowledge creation, diffusion and use look very different than if knowledge is a complex fusion of interconnected domains, that is socially constructed and context-dependent. A clear delineation of the philosophical underpinnings being employed clarifies why particular strategies are deemed to have merit in constructing solutions to knowledge construction, diffusion, acquisition, and use challenges in professional practice.

As the problematic divide between what we know (our knowledge) and what we do (our practice) becomes apparent, various strategies have emerged in the health services research literature to address the knowledge use problem. Ways to improve the use of knowledge in practice have been grouped into three categories: linear, relational, and systems approaches (Best & Holmes, 2010). The next section will consider each approach in turn by highlighting some of the dominant knowledge use strategies that fit within the scope of each approach, drawing out the assumptions made about the nature of knowledge, and, finally, explaining what the literature says about the effectiveness of the strategy for getting knowledge used in practice.

### 2.4.1. Linear-Based Views

*Linear models* for promoting knowledge use are those that envision a stepwise and uni-directional progression. Knowledge is produced by researchers and flows to users in policy and practice communities. With these kinds of models, the 'knowledge in practice' problem is understood as a 'knowledge *deficit* in practice' problem, and thus the solution is to provide the information that will change behaviour resulting in improved outcomes. Names such as 'research uptake' and 'knowledge pipeline' provide an apt description of these models (Best & Holmes, 2010).

Within the healthcare literature a "lively subfield" (Nicolini et al., 2008, p. 248) on knowledge use has an ever-growing proliferation of terms and metaphors to capture the process, 'knowledge translation' being the most common among them (McKibbon et al., 2010). Knowledge translation is a close kin of 'knowledge transfer', and was defined by the Canadian Institutes for Health Research as:

> The iterative, timely and effective process of integrating best evidence into the routine practices of patients, practitioners, health care teams and systems, in order to effect to optimal healthcare outcomes and to optimize health care and health care systems. (Davis, 2006, p. 8)

This definition aligns the goals of those drawing on a knowledge translation view with the EBM movement. Both conceptualise the problem of less than optimal care provision as a knowledge gap, where knowledge is often reduced to an evidence product (Cooksey, 2006; Davis et al., 2003).

As for how the evidence product would make its way to practice, the assumption was that evidence would naturally find its way to those who needed it (Oborn, et al., 2013). An often used example, where Captain James Lancaster's discovery in 1601 (that citrus fruits can prevent scurvy) took a further 264 years to wend its way to British naval policy, illustrated that important information often is not applied as soon as would be desirable (Berwick, 2003). The knowledge deficit problem became a diffusion and dissemination problem. A more active distribution of research-based information was needed.

Linear-based theories and interventions emerged as a key strategy for closing the gap in a timelier manner (Straus & Mazmanian, 2006). The introduction of mandatory participation in regular continuing professional development is one example of pushing research along the pipeline more quickly. With the exponential growth of clinical information in the EBM age, ways were needed to address the deficit, distribution and increasingly information overload problem (Hall & Walton, 2004). As noted earlier in the chapter, Cochrane, Sackett and others advocated for evidence summaries, clinical guidelines, and meta-analyses drawn from RCTs to make the transfer and translation of credible data easier for the busy clinician.

For linear-based models, assumptions about knowledge fall more heavily on the object or product side of the spectrum (depicted earlier in Table 2-1) because it is viewed as generalisable and can be readily packaged and transferred. Linear models tend to dominate knowledge sharing practices in part because they are comparatively easy to implement (Davies et al., 2015). Indeed, information technology has played a vital role in the linear delivery and advancement of EBM materials (Claridge & Fabian, 2005; Crilly et al., 2010). And yet differing knowledge translation studies apply different and, at times competing definitions of knowledge. As a result, what 'knowledge translation' actually means has been irreparably lost (Davies et al., 2008; Oborn et al., 2013).

Dependence on linear models has increasingly been met with criticism (Balconi et al., 2010). Some of the criticisms are that these perspectives depend upon a reductionist view of the nature of knowledge (i.e. to mean only explicit scientific, technical forms), misrepresent knowledge use as a cerebral, rational activity, and support a disproportionate power balance between researchers and practitioners (Gabbay & le May, 2011; Rich, 1997; Rycroft-Malone et al., 2016). Because evaluations of knowledge translation-based interventions rely primarily on instrumental, usually quantitative, approaches, these have also been criticised because essential voices were being silenced (Locock et al., 2014; Locock et al., 2017; Oborn, 2013).

Numerous studies have shown that linear-based strategies were not achieving the goal of closing the knowledge gap. While didactic content delivery via continuing professional activities could influence behaviour (Olson & Tooman, 2012), educational lectures did not consistently change clinical performance that brought about improved health outcomes (Forsetlund et al., 2009; Marinopoulos et al., 2007). Similarly, adherence to clinical guidelines was disappointing (Cabana et al., 1999; Grimshaw et al., 2004; Gabbay & le May, 2011). As a result, it became increasingly clear that the context of research use could not remain an after-thought in the ‘transfer’ or ‘translation’ of knowledge. Reality on the ground of research use rendered the ‘transfer’ and ‘translation’ metaphors insufficient to the task (Davies et al., 2008; Kitson, 2009). There were calls for a wider range of metaphors and models that might contribute to a richer understanding of the link between knowledge and practice (Davies et al., 2008; Greenhalgh & Wieringa, 2011; Regehr, 2010).

### 2.4.2. Relational-Based Views

*Relational models* can be viewed as an evolution of linear-based models (Best & Holmes, 2010). Within this perspective the knowledge in practice problem was seen to be more than a knowledge deficit issue: it was reconceived as a social connectivity problem. Relationship-based strategies for knowledge use acknowledge a social foundation for knowing and focus on the linkages between people. Solutions to knowledge problems are found by bringing knowledge creators (e.g. researchers) and knowledge users (policymakers and practitioners) together. The weight of emphasis shifted from crafting explicit content to facilitating interactions between stakeholders. The goal was to build relationships such that mutuality and reciprocity could form, understanding could increase, and as a result researchers would design relevant studies that took into account users' needs (Crilly et al., 2010). The 'transfer' metaphor altered to 'knowledge exchange' (Lomas, 2000), which was reflected in the World Health Organization's (WHO, 2006) updated definition of knowledge translation: "the synthesis, *exchange*, and application of knowledge by relevant stakeholders to accelerate the benefits of global and local innovation in strengthening health systems and improving people's health" (*emphasis added*, 2006, p. 2).

Knowledge use strategies and models based on a divided or two community understanding of the knowledge and practice problem proliferated (Oborn et al., 2010). These included the 'push' and 'pull' strategies associated with a linear perspective alongside 'linkage and exchange' models for specific researcher-user partnerships, and the incorporation of knowledge intermediary groups that enabled linkage and exchange on a larger scale (Lavis et al., 2006). For example, the Knowledge to Action framework (Graham et al., 2006) and Integrated Knowledge Translation (Kothari & Wathen, 2013) emphasised the two-way flow of knowledge borne out of partnership and collaboration (Oborn et al., 2010; Ward et al., 2009). Similarly, Mitton et al. (2007) defined Knowledge Transfer and Exchange (KTE) as "an interactive interchange of knowledge between research users and researcher producers (Kiefer et al., 2005). The primary purposes of KTE are to increase the likelihood that research evidence will be used in policy and practice decisions and to enable researchers to identify practice and policy-relevant research questions" (Mitton et al., 2007, p. 729).

In addition to a focus on relational connectivity, what changed in the relational models was that research generation, synthesis, sharing, implementation and use was envisioned as an integrated social activity, and part of an ongoing cyclical partnership (Lomas, 2000). Ongoing relationships between the research and use communities were the foundation of knowledge and practice. Relationally-based strategies, such as engaging opinion leaders and knowledge brokers to form knowledge-based networks and communities of practice, help knowledge use to blossom (Gagnon, 2011).

Despite some enthusiasm for the promise of relational approaches to knowledge mobilisation, there remains the question of what, precisely, “is this knowledge that we seek to ‘exchange’?” (Greenhalgh, 2010, p. 492). Just as knowledge translation includes contradictory stances about the nature of knowledge involved, so do the relational models. Davis (2006) asserts that “Lomas’ model, while clearly comprehensive and holistic, is highly linear” (2006, p. 9). The research enterprise may be a mutual, engaged and social process, but knowledge often remains viewed as a (now more useable) research product derived by one constituency and used by another.

Indeed, the effectiveness of relational strategies remains inconclusive. Various studies have shown promise for research use, but barriers continue to confound this promise and measurable outcomes are considered either inconclusive or sub-optimal (Gagliardi & Dobrow, 2016). Fazey and colleagues (2014) questioned whether the chosen methods of evaluating effectiveness were suited to the task and proposed instead the use of mixed method evaluations to assess the efficacy of knowledge exchange work. Their reasoning was that quantitative methodology is not useful for identifying a multiplicity of factors that influence the complex dynamics of context or the outcomes of the interventions.

### 2.4.3. Systems-Based Views

*Systems models* for knowledge use include elements of linear and relational models, but incorporate these with an appreciation of complexity of the whole system, and tend to view healthcare as a complex adaptive system (Best & Holmes, 2010; Davies et al., 2015). Complex adaptive systems are distinct from mechanical systems. They encompass both individuals and collectives who simultaneously contribute to and are affected by change as a result of their interconnections (Crabtree et al., 1998). “Complexity is not simply about there being many moving parts: it is about what happens when these parts interact in ways that cannot be predicted but that will nonetheless heavily influence or shape the probabilities of later events” (Holmes et al., 2017, p. 547). Complex adaptive systems are viewed as a self-organising entity, and the influence of one upon another is not predictable. Thus cause and effect relationships are difficult, and often impossible, to observe (Holden, 2005). Examples of complex adaptive systems are evident throughout the natural world and within “just about any collection of humans” (Plsek & Greenhalgh, 2001, p. 625).

Given the intractability of the research in practice problem, there is a growing view that the qualities of complex adaptive systems explain the impotence of linear and even solely relational models for bringing about desired clinical behaviours (Holmes et al., 2017). Echoing this sentiment, Kitson (2008) states, “The (healthcare) system is best viewed as a complex, interactive, organic entity where experimentation, experiential learning and reflection are central to creating a culture of innovation, improvement and consequently effectiveness” (p. 220). A re-visioning of not just knowledge but of the context of knowing is required.

With the recognition that ‘research use’ does not adequately capture complexity, a broader term of ‘knowledge mobilisation’ has been proposed. It is intended to convey complex knowledges within and between the research, policy, and practice communities (Davies et al., 2015). A knowledge mobilisation frame also aims to embrace the multiplicity of actors and groups acting within a complex adaptive system. Individuals, teams, organisations and wider networks are nested together as multifaceted, emergent, and interdependent parts of a system. There is a mutual web of interdependence between people who make up the system, and the system structures themselves. Within the web, stakeholders “selectively interpret and use knowledge as it serves their own purposes, fits their unique situations, and reflects their relations with their practicing community” (Van de Ven & Johnson, 2006, p. 804). With this perspective, the diffusion process is better understood as a highly complex, iterative, contingent, unpredictable, and social process where clinicians are more than users. They are producers and creators in their own right (Van de Ven et al., 2008; Olson et al., 2010). Research-informed evidence does not simply insert or supplant previous understanding, but is more aptly depicted as entering a socially-based “mêlée” (Gabbay & le May, 2011).

Of theories, models and frameworks that focus on knowledge and knowledge use and arguably crossover from relational to system-based views, only a few have been tested in empirical settings (Davies et al., 2015). Two such frameworks provide noteworthy exceptions: Promoting Action on Research Implementation in Health Services (PARIHS) framework (Kitson et al., 1998) and Knowledge to Action framework (Graham et al., 2006). PARIHS was created as an alternative framework to linear models that did not adequately account for contextual aspects of implementing research in practice. The PARIHS framework proposed that successful implementation resulted from the intersection of strong evidence, effective facilitation and contextual readiness (Kitson et al., 1998; Harvey & Kitson, 2016). The framework provided practical planning tools that could be used in the design and implementation phases of bringing research into practice. However, while well over a dozen publications used PARIHS to predict and explain the success or failure of implementation efforts (Davies et al., 2015; Harvey & Kitson, 2016), only one empirical study used PARIHS in this fashion (Rycroft-Malone et al., 2013). Rycroft-Malone and colleagues (2013) concluded that the framework did not sufficiently account for individual agency within the implementation process. Harvey and Kitson (2016) have responded to this and other critiques and offered a refined version, ‘integrated’ PARIHS.

The Knowledge to Action framework worked to synthesise over 30 knowledge translation-based planned action theories that had sprouted in the literature (Graham et al., 2006). The Knowledge to Action framework envisioned two distinct yet still fluid aspects of translating knowledge: the knowledge creation funnel and the action cycle. And each aspect had further phases. The Knowledge to Action framework placed a heavy emphasis on the involvement of end-users throughout the knowledge creation and application processes.  Both PARIHS and Knowledge to Action frameworks sought to address the deficiencies of linear models that ignored research users and the complexities of context-based factors that affected the implementation of research in practice. But a common criticism of these frameworks was that despite the attempt to address important facets of using research, they were overly complex and thereby difficult to operationalise (Davies et al., 2015).

The development of Clinical Mindlines theory was the result of a lengthy empirical work. Many have resonated with Gabbay and le May's work, especially as an explanatory theory of professional knowledge (Wieringa & Greenhalgh, 2015; Greenhalgh et al., 2016). But as yet only one study has employed Mindlines to conduct empirical work (Cowdell, 2018). Cowdell (2018) executed an ethnographic study of patients and carers with eczema based in the primary care setting to investigate if and how mindlines were developed by lay people. Cowdell found that participants took varied approaches to managing their eczema and as a result differed in their information needs. Their openness to interacting more with the practice staff and seeking additional sources of information about eczema, which could potentially shape their thinking, varied. The study concluded that influencing and shaping individual mindlines remained a challenge.

While there is a growing move to embrace a systems view for understanding knowledge and knowledge use, methods have not yet developed that align to the fresh perspective (Davies et al., 2016; Riley, 2012). In fact, Davies and colleagues (2016) observed that "there are many key aspects of a systems approach to knowledge that have not yet had sufficient attention, including the nature of evidence and knowledge, the role of leadership, and the role of networks" (p. 288).

### 2.4.4. Implications for Conceptualising Knowledge Use

The foregoing discussion highlights an apparent distinction where the knowledge and knowledge use theories, models and frameworks fall into two camps. On one side are explanatory theories and on the other are intervention-oriented models. Whereas some theories excel at capturing complexity, they appear unable to provide clarity for action. And models that provide operational action plans for interventions have yet to be substantiated for reliably reflecting how things actually work. Greenhalgh and Papoutsi (2018) identified this challenge. They said that while recognition of complexity has grown as yet no one seems to be able to capitalise on this understanding for planning purposes.

Adopting a knowledge mobilisation frame that utilises both complex knowledges (such as Clinical Mindlines) and complex adaptive systems perspectives provides richer explanations for the research use problem. It explains why strategies that focus primarily on the individual's use of explicit materials may miss the interconnectedness of knowledges as well as the interconnectedness of knowers. The emergence of relational and, more recently, systems-based ways to support knowledge mobilisation have the potential to address these shortcomings. Drawing on a holistic knowledge mobilisation frame, we need to consider how interpersonal interactions influence the relationship between knowing and doing (Davies et al., 2008, 2015).

## 2.5. Conclusion

These literatures highlight the tensions between differing conceptualisations of knowledge and the importance of digging beneath the often unclear knowledge terminology to uncover the philosophical perspectives that provide meaning. The nature of knowledge and knowing is highly contested and, in health contexts, too often entails pitting forms of knowledge against one another. These contestations are apparent in the health literatures as well. EBM often gives pre-eminence to explicit, scientific forms of knowing. Yet the influence of social science research, drawing on an Aristotelian conception of complementary and interpretive knowledges, has increased. Concepts such as Clinical Mindlines provide a useful explanation of how science-informed sources can work in tandem and productive tension with experience, judgement and wisdom, both within individuals and collectives.

Such conceptualisations of knowledge and knowing directly influence the ways we structure solutions to our research in practice problem. Dependence upon linear-based strategies for getting research used has not reliably resulted in the desired outcomes. Relationship-based strategies, while appearing to hold promise, are emergent, take time and are often ephemeral, and thus difficult to measure and demonstrate efficacy based upon scientific methods. This has led some health services scholars in recent years to question the dominant paradigm of knowledge and knowledge use in place, and turn to embrace complex adaptive systems as a more satisfying explanation for the ‘wicked’ challenges we encounter (Greenhalgh & Papoutsi, 2018; Holmes et al., 2017; Reed et al., 2018).

The knowledge mobilisation frame captures the interconnectedness of individuals and communities within a complex adaptive system and brings to the fore a diversity of socially-situated knowledges. Knowledge mobilisation builds upon the social nature of knowledge and links complex knowledges within a complex set of interdependent knowers. Yet, as Boaz and colleagues said, “evidence for ‘what works’ in knowledge mobilisation remains patchy” (2015, p. 146). We have only begun to draw upon the knowledge mobilisation frame in order to better understand the implications for developing, sharing and using of our individual and collective knowledges. This thesis contributes to understanding how interactions between actors can facilitate knowledge mobilisation throughout the health system.

As a result of traversing these literatures on different types of knowledge and knowledge use strategies, and reflecting on how these literatures shape this study of interconnected networks, a further refinement of the research question has emerged. Based on a view of knowledge that involves a dynamic interplay between different forms of knowledge (from Clinical Mindlines) a further sub-research question is:

Sub-RQ 1: What are the sources, forms and ways of knowing involved in mobilising research-based knowledge in practice?

Finally, this chapter has exposed the importance of articulating assumptions about the nature of knowledge because depending on how knowledge is conceptualised impacts our understanding of how knowledge is used. Relatedly, conceptualisations about knowledge and knowledge use shapes the ways health organisations and systems organise for mobilising such knowledge. If knowledge and knowing are indeed social processes, then a deeper examination of the social interactions between actors, within teams and across networks is warranted. Thus, the next chapter turns to examine some common ways of organising for knowledge mobilisation.

# 3. Chapter 3—Organising for Knowledge Mobilisation: Teams and Networks

*Effective knowledge utilization requires a degree of division of labor, coordination and collaboration throughout the social system*
*(Ronald Havelock)*

## 3.1. Introduction

From the early days of research utilisation studies scholars recognised that knowledge-based work was social and collective in nature (Berger & Luckman, 1966; Havelock, 1969). Subsequent work around the creation, diffusion and utilisation of knowledge further emphasised that knowing is a process set within a social context (Brown & Duguid, 2001; Gabbay & le May, 2011; Nonaka et al. 2008; Nutley et al., 2007). More recently, Kitson et al. (2018) claimed that "the growing acknowledgement of the inherent complexity in [knowledge mobilisation] … includes recognising the important role of actors, relationships and networks, in order to actively mobilize knowledge" (Kitson et al., 2018, p. 231).

The previous chapter considered varying conceptualisations of knowledge and how these views influence strategies for fostering knowledge use. The purpose of this chapter is to explore and problematize some of the prevalent social structures used in health services to organise many actors' knowledge for patient care. Specifically, this chapter considers the structural arrangements of actors and how these structures are often predicated upon underlying assumptions about how knowledge is mobilised.

The chapter is divided into two sections. The first section considers how *teams* have been a dominant approach for drawing together dispersed actors and their divergent forms of knowledge. The second section turns to the *network* literature to consider how networks have been seen as a way of conceptualising and analysing knowledge within and between organisations. The second section also presents Soft Knowledge Systems (Engel, 1997), a network-based lens for understanding knowledge systems. It is used in this study (in conjunction with Clinical Mindlines) to examine how actors in the sepsis research, policy and practice networks organised to address their knowledge mobilisation problem. This chapter is principally concerned with the structural configurations of actors because they reveal assumptions about how health services and the surrounding architecture are set up to mobilise knowledge.

## 3.2. Organising for Knowledge Mobilisation: Teams

The first section considers literature on teams and how they provide a structural approach for mobilising knowledge. The content is covered in five steps. Firstly, the section explains the dependence on teams in health systems as a way of organising knowledge for the provision of care. Then the section considers in turn three common team structures utilised for mobilising sepsis knowledge: multidisciplinary teams, rapid response teams, and critical care outreach teams. These different team structures illustrate assumptions (often implicit) that underpin these arrangements of actors. Finally, the section explores the problem of relying upon teams to address social and epistemic boundaries in order to mobilise knowledge.

### 3.2.1. Teams in Healthcare

Teams dominate the organisation of professional work (Edmondson et al., 2007; Waring & Currie, 2009). In the healthcare sector, as in most professional contexts, teams are the essential unit for accomplishing organisational goals (Janhonen, 2011; Olson et al, 2010). Especially in health services rarely can one person or profession know and deliver the spectrum of care required, and thus a team is considered the smallest unit that holds the requisite knowledge and resources to accomplish the provision of care (Ferlie & Shortell, 2001).

The NHS has capitalised on teams as a primary strategy for managing complexity and providing efficient, high quality care (Bleakley, 2014; Fleissig et al., 2006). For example, various studies have shown that teams can reduce the length of hospitalisation, medical errors and related costs, and can increase patient safety and staff satisfaction (Borrill et al., 2000; West & Lyubovnikova, 2013). Teams both know and can accomplish what individuals alone cannot, and as a result, the majority of care is delivered by teams (West & Lyubovnikova, 2013; West & Markiewicz, 2016).

There is broad consensus that teams are social entities, composed of multiple actors who have a level of task interdependency for accomplishing shared objectives

(Ghebrehiwet et al., 2016; Hollenbeck et al., 2012; Salas et al., 2008; West & Markiewicz, 2016). Mohrman and colleagues (1995) expand the definition of a team, defining it as,

> [A] group of individuals who work together to produce products or deliver services for which they are mutually accountable…they are interdependent in their accomplishment, and they affect the results through their interactions with one another. Because the team is held collectively accountable, the work of integrating with one another is included among the responsibilities of each member (Mohrman et al., 1995, in Borrill et al., 2000, p. 2).

In addition to team members depending upon one another to accomplish their responsibilities, Mohrman et al. propose that a level of interaction-based integration is needed in the process. Rather than an aggregate of individuals, teams are groups of people  negotiating and coordinating with one another, to varying degrees of success, in order to meet their collective goals (Gorski, 2013).

The distinction between definitions is key to understanding the implications for mobilising knowledge. With the initial, basic definition, the team structure contains the actors needed to carry out their knowledge-dependent roles. In other words, teams are organisational structures that overcome spatial separations (i.e. geographic boundaries) and connect the different knowledge bases (i.e. epistemic boundaries) needed for undertaking a task.

In the second (Mohrman et al.’s) definition, a team is more than a collection of actors but a matter of interdependent team functioning. At stake is whether they are able to coordinate and cooperate (or not) to perform as a collective unit. Van der Haar et al. (2013) agreed, saying that teamwork was “a set of interrelated thoughts, actions and feelings of each individual team member that are needed if the team is to really function as a team” (2013, p. 2). Collective functioning is different than individuals functioning in the same location. Competent individuals can combine with other competent individuals and create an incompetent team (Lingard, 2012). Teams are more than structural units that address proximity issues and the division of knowledge-based roles; they are social units set within complex contexts (Lingard et al., 2012; West & Lyubovnikova, 2013).

Unfortunately, the health literature does not reflect the complex social dimensions of teamwork particularly well (Greenhalgh & Papoutsi, 2108; Lingard et al., 2012; Reed et al., 2018). Borrill and colleagues (2000) studied healthcare team effectiveness in 400 teams across the UK, involving over 7000 NHS staff and clients. They said that "approaches to understanding teams at work have been dominated by the input-process-output structure, mainly because of its categorical simplicity and utility" (Borrill et al., 2000, p. 32). The study found that positive qualities of team-working were related to effectiveness and recommended establishing conditions for effective team work. One example was that "individuals should feel that they are important to the success of the team. When individuals feel that their work is not essential in a team, they are less likely to work effectively with others or to make strong efforts…Roles should be developed in ways which make them indispensable and essential" (Borrill et al, 2000, p. 239). The report concluded that "revolutionary organisational change" (p. 10) throughout the NHS was necessary to take advantage of benefits that a team-based structure could provide. To accomplish this, the health system needed to facilitate team working by training managers and staff on team working. However, descriptive guidance of how to help nurture belonging and importance in team members was lacking.

Lemieux-Charles and McGuire's (2006) review of 33 studies of healthcare team effectiveness used similar groupings: team design (inputs), processes, and effectiveness (outputs), where effectiveness was assessed based on variations in inputs and processes. These authors found that the most common method for measuring effectiveness was the randomised controlled trial, which compared teams and usual (non-team) structures. The variables associated with team effectiveness were: context, task features, team composition, team processes, and traits. Furthermore, Lemieux-Charles and McGuire highlighted that building team effectiveness through collaborative processes involved a high level of participation by members and a high degree of conflict resolution to help facilitate group cohesiveness. In other words, these findings speak of social boundaries, yet specific ways that teams might encourage participation and resolve conflict in order to build cohesive relationships were unspecified.

Furthermore, a large segment of the literature casts the nature of team knowledge in product-orientated terms. Some examples are: teams “transferring knowledge” (Janhonen, 2011), teams as “information-processing units” that “encode, store and retrieve information” (Henttonen, 2010, p. 75); as well as the “science of teams” (Gillam & Siriwardena, 2013; Salas et al., 2008) that begin with hypotheses and then seek out replicable cause and effect factors. In this perspective, teams and team-working are separated from messy, emergent, real-life contexts.

The omission of descriptive interactions that help resolve conflict and generate cohesion and belonging in these literatures are the result of limited study methods (Lingard et al., 2012). There are few studies that use observational methods to capture teams in their workday. “Direct observation of collaborative practice in everyday work settings holds promise as a method to better understand and articulate the complex phenomena of interprofessional collaboration, yet only a small number of studies to date have attempted to directly observe such practice” (Morgan et al., 2015, p. 1217).

Where observational methods have been used, they tend to be narrowed to one locale and unit of analysis, rather than conceptualising teams as nested within wider organisational and inter-organisational social structures. Examples of these locales include operating theatres (Edmondson, 2003; Lingard et al., 2004), intensive care units (Alexanian et al., 2015; Pronovost & Berenholtz, 2003; Tucker et al., 2007), cancer units (Fleissig et al., 2006; Jain et al., 2016; Oborn & Dawson, 2010) and primary care settings (Iliffe, 2008; Sargeant et al., 2008; Solheim et al., 2007; Xyrichis & Lowton, 2008). As a result, these

> [L]ocalised studies of teamwork fail to reflect the highly permeable inter- and intra-disciplinary boundaries between…health care

> providers…[and they] strip away the richest aspect of a specific story: the meaningful sense of human interaction derived from consideration of the inter-relationships among a series of activities accumulating over time and space (Lingard et al., 2012, p. 870).

Nevertheless, these studies provide useful insights on team interactions. For example, Edmondson (1999) found that psychological safety, or the degree to which team members feel safe taking interpersonal risks, is associated with team effectiveness. Other work found that higher levels of psychological safety contributed to knowledge sharing within teams (Kessel et al., 2012). Alexanian et al.'s (2015) ethnographic study of intensive care units found that teamwork involved collaborative decision-making, team coordination, communication, trust, and a lack of conflict.

In an overview of team functioning studies over the course of two decades, Edmondson (2012) identified four social behaviours that exemplified effective team working: the ability for all team members to speak honestly; a collaborative mindset characterised by mutual respect in the process of meeting shared goals; a tentative and experimental approach where mistakes are expected; and regular communication amongst team members that solicits critical reflection. Yet, Edmondson recognised that high-pressured environments, such as hospitals, are not readily conducive to creating these socially safe environments. Instead, hospital teams face "social and cognitive barriers to teaming" (Edmondson, 2012, p. 60). In other words, social and epistemic boundaries inhibit productive teamwork and thereby constrains knowledge sharing.

A further deficiency of most empirical studies of teams is that they lack a theoretical grounding (Lingard et al., 2012; Olson et al., 2010). Absent a theoretical anchor, research findings remain detached from one another. Thus they limit the contribution they can make to creating robust empirical support that is tethered to theoretical explanations (see, for example, Broom & Broom, 2018).

In sum, this section has shown that health systems are dependent upon teams. Moreover, there are differing views around whether a team is merely a name given to a composite of actors, or if instead teams are integrated in their functioning where team functioning occurs in social interactional processes. But much of the empirical literature lacks a theoretically-linked understanding of how teams work together in order to mobilise knowledge. Furthermore, healthcare team structures are predicated upon different assumptions about what knowledge is and thereby how knowledge mobilises. To illustrate some assumptions that underpin team structures, this section now turns to consider and analyse the literature from three team structures commonly used to manage sepsis care: multidisciplinary teams (MDTs), rapid response teams (RRTs), and critical care outreach teams (CCOTs).

### 3.2.2. Multidisciplinary Teams

Multidisciplinary healthcare teams (MDTs) can be differentiated from broadly defined teams in that they are made up of a collection of members representing diverse health care occupational areas, including medical, nursing, allied health and, at times, social care professionals (Solheim et al., 2007). The organisational goal of building multidisciplinary team structures was to capitalise on the synergy of bringing together actors from diverse, specialised areas of knowing, with a variety of skills and perspectives, but with a shared objective (Ghebrehiwet et al., 2016; Oborn & Dawson, 2010). The diversity of knowledge was linked to the individual member’s roles and responsibilities in respect to care provision. As in the general literature on teams above, literature on MDTs displays tension over whether they are teams in name or in function (Jessup, 2007; Madge & Khair, 2000).

The formation of multidisciplinary teams has been encouraged for many decades, and they are now found throughout acute, primary, and public health settings (Fleissig et al., 2006; Iliffe, 2008). MDTs share a patient population and are often located in an area dedicated to their disciplinary expertise, for example, breast cancer, cardiac intensive care, and accident and emergency. Multidisciplinary teams are predicated upon the assumption that assembling the relevant professions together will unproblematically result in shared knowing and knowledge use (Oborn & Dawson, 2010; Sargeant et al., 2008). In other words, the assumption is that teams who occupy the same physical space, and have shared responsibilities for patients, will collaborate.

However, outcomes from MDTs are mixed (Bleakly, 2014; Ghebrehiwet et al, 2016; West & Lyubovnikova, 2013). Various studies point to difficult relationships between professional groups as the reason. Powell and Davies's (2012) study of acute pain services found that boundaries between professions "make inter-professional communication, collaboration and teamwork more challenging and can jeopardise the provision of safe, high quality patient care" (p. 807). Similarly, Oborn and Dawson's (2010) work examining urological cancer care teams found that tensions between professional groups undermined patient care. In this case study, medical team members' forms of knowledge were privileged over the nursing staff's areas of expertise, and the privileging of some actors' knowledge "then becomes embedded in the practices of the group" (Oborn & Dawson, 2010, p. 1835). Again, Alexanian et al. (2015) found that professional and epistemological hierarchies amongst health care professional cultures set doctors, nurses, and other allied health professionals apart and thereby impeded interprofessional collaboration. Nurses, pharmacists, and dieticians, etc., tolerated and thereby supported medical dominance, giving deference to doctors rather than insisting on a shared decision-making process.

Within the critical care setting, where specialists in sepsis care are often located, the divisions between doctors and nurses existed as well (Stein-Parbury & Liaschenko, 2007). Stein-Parbury and Liaschenko (2007) pointed out that reliance on different forms of knowledge was most evident during times of crisis. In these times, nurses' "patient knowledge" (p. 472) was diminished in favour of doctors' scientific knowledge. "Collaboration broke down when physicians dismissed nurses' clinical assessment and concerns about a patient because the nurses' contributions did not fit into a schema of case knowledge" (Stein-Parbury & Liaschenko, 2007, p. 475).

Nor are the communication patterns better between physicians and nurses on the general wards. Zwarenstein et al.'s (2013) study of professional interactions in this context found that unscheduled communication between medics and nurses was very low. Nurses rarely offered unsolicited input even in scheduled interchanges. Furthermore, it was not uncommon for doctors to disregard and completely ignore nurse-initiated contact. “No particular planning with regards to effective interprofessional collaboration and communication had gone…beyond the act of bringing different health professionals together. Consequently, there did not seem to be a clear idea of how effective collaboration would be achieved” (Zwarenstein et al., 2013, p. 4).

Thus, the dominance of medical power in multi-professional teams influences the interactions between team members (Hall, 2005; Zwarenstein et al., 2013). But the hierarchies within medical specialisations (intra-professional boundaries) similarly affect team interactions (Ferlie et al., 2005; Oborn & Dawson, 2010; Powell & Davies, 2012). Multidisciplinary teams are rife with social and epistemic boundaries, and thus too often fail to fulfil the organisational hope that structures bringing diverse knowledge and shared responsibilities together will improve patient care (Ferlie et al., 2005; Iliffe, 2008; Sargeant et al., 2008).

### 3.2.3. Rapid Response Teams

Rapid Response Teams (RRTs) are comprised of doctors and nurses that specialise in critical care within acute care hospitals (Kitto et al., 2015). They respond to calls from (most often) nurses on general medical and surgical wards when a patient has signs of being severely unwell. A trained critical care nurse provides the first response and assesses the patient’s condition. If the specialist nurse deems that the situation requires immediate intervention, the rest of this specialist team will tend to the patient until they are stabilised (Danesh, 2015). Medical Emergency Teams are largely based on the same model except that a physician will be the first specialist professional to respond to the alert by ward staff (Danesh, 2015).

As a knowledge mobilisation strategy, Rapid Response Teams are both similar and different to multidisciplinary teams. RRTs were a response to growing awareness of patient safety problems on general medical and surgical wards (Kitto et al., 2015). They are similar to multidisciplinary teams in that they are multi-professional and tend to be focused on particular clinical specialisations. However, they provide their specialist knowledges and experience on an as-needed basis and are not regularly resident within the unit where their services are sometimes used. They are an organisational system-based way of shoring up knowledge and skills of ward-based staff.

In a case study of four Australian hospitals, Kitto and colleagues (2015) are critical of Rapid Response Teams (RRTs) as a systems-based response to the deficiencies of ward staff knowledge. They point out that bringing in outside expertise is not a proper solution, but a work-around that does not address the social, professional, and cultural boundaries that result in the breakdown of collaboration. Rather than building interprofessional collaboration, RRTs leave the knowledge-based inadequacies in place and skirt the more challenging issues, which are to address barriers between professions. In other words, RRTs *respond* to crises, while both they and their knowledge remain segregated.

With the implementation of Rapid Response Teams over the last decade, questions have been raised about their effectiveness in reducing cardiopulmonary arrests rates and mortality within hospitals (outside the intensive care unit) (Chan et al., 2010). Chan et al.’s (2008) large single site study comparing before and after an RRT was implemented found no change in either rate at the institution. A further systematic review based on 17 publications in the critical care literature gave a mixed picture of RRT effectiveness related to patient outcomes (Chan et al., 2010). Comparatively, Solomon et al.’s (2016) systematic review and meta-analysis found a significant decrease in the relative risk of cardiac arrest (62%) and mortality (88%) tied to Rapid Response Teams. However, these potentially positive outcomes (found, for example, in Solomon et al.’s work) linked to RRT structures do not address the problem of ward staff building knowledge-based skills to proactively identify patients in decline rather than await severe indicators (Denesh, 2015). RRTs do not help build local knowledge and skills, or encourage collaborative capacity of the ward staff (Denesh, 2015; Kitto et al., 2015). The epistemic and social boundaries remain in place.

### 3.2.4. Critical Care Outreach Teams

Critical Care Outreach Teams (CCOTs) provide a further example of a structural response to general ward staff's knowledge and skills deficiencies for identifying or treating deteriorating patients (Danesh, 2015). Following a Comprehensive Critical Care report (Department of Health, 2001), NHS England and Wales invested in funding Critical Care Outreach services in hospitals in order to: (a) detect deteriorating patients earlier and minimise unplanned admissions to ICUs; (b) provide ongoing support for ward staff when patients were discharged from ICUs to generalist wards; and in the process (c) share their critical care knowledge and skills with ward staff (Department of Health, 2001; Baker-McClearn & Carmel, 2008).

Outreach teams are made up of experienced Intensive Care Unit (ICU) nurses. These nurses share a common professional background, training, experience, and specialist knowledge. A further difference to the RRT model is that CCOTs provide continuous support and advice to the ward staff, with a particular focus on high-risk patients, as opposed to temporary crisis response. In other words, outreach teams regularly spend time on the wards, they are *proactive* in their surveillance of patients, and they share their abilities to provide training and support to the existing staff.

The Critical Care Outreach Team model is based on the premise that general ward staff have less experience with an extremely ill patient population. Thus, they do not have the opportunity to build and sustain the kinds of knowledge and skills that a trained intensive care nurse would have. An outreach service, often referred to as "critical care without walls" (Baker-McClearn & Carmel, 2008), is intended to overcome hospital organisational unit boundaries and expose ward staff to critical care expertise. Thus, CCOTs address both geographic and epistemic boundaries between actors.

And yet, the effectiveness of CCOTs has also been largely mixed (Ball et al., 2003; Esmonde et al., 2006; Gao et al., 2007; McGaughey et al., 2007). Two systematic reviews found inconclusive evidence for the outcomes of Outreach services, noted the deficit of methodologically rigorous studies, and called for further work (Esmonde et al., 2006; McGaughey et al., 2007). Gao and colleagues' (2007) examination of NHS England's hospital admissions and outcomes data found that some indicators were improved (e.g. the number of patients requiring cardiopulmonary resuscitation) but a decrease in mortality rates was not statistically significant.

By comparison, Baker-McClearn and Carmel's (2008) qualitative study of critical care outreach services presented a more promising picture. Based on 100 interviews at 8 hospitals in England that had taken advantage of the funding offered in 2001, they found two main impacts resulted from CCOTs. The first was a positive impact on the organisation of patient care. Participants reported that they perceived patients received more timely care, overcame communication barriers between the ward-based staff (i.e. medics and nurses). Secondly, intensive care specialists said that they could discharge their patients onto wards with greater confidence as the specialist outreach nurses would be able to keep watch over these patients still at higher risk for problems. Finally, with the outreach team in place, there were fewer admissions into the intensive care units. This meant that the presence of the outreach team did indeed provide timely care that helped catch patients before they required intensive levels of care.

The second impact focused on the confidence levels and skills of the ward-based nursing staff and junior doctors. The participants reported that contact with specialist outreach nurses within their own work area brought more opportunities to learn and increase their skills. Some nurses expressed concerns about the financial sustainability of the outreach model, and, more specifically, worried about the impact of losing the regular support that outreach provided. Relatedly, a few medics noted that the outreach service decreased critical incidents on the wards, which in turn brought about fewer opportunities for junior doctors to learn key resuscitation skills. The potential over-reliance of ward nurses and de-skilling of junior doctors based on outreach was seen as a tension that had, overall, favourable results as patients had received safer care.

Thus a critical care outreach structure addresses the geographic separation of ICU knowledge by bringing specialists into the generalist ward areas. This contact provided opportunities for learning. And, as outreach teams are most often staffed by nurses, professional boundaries are potentially minimised within the team itself and between the team and the ward nurses. Additionally, qualitative research has shown some benefits for patients and less-experienced practitioners from the deployment of outreach teams. In some hospitals, outreach units aided communication between doctors and nurses, and specialist medics were reassured when discharging their patients from the ICU to the ward. However, these data do not explain *how* the outreach teams overcame social boundaries between actors. Further work is needed to understand the relational dynamics that underpin effective knowledge mobilisation.

### 3.2.5. Teams Section Conclusion

This section has shown that team structures carry with them implicit assumptions about how knowledge is mobilised. Within health services, a division of knowledge and labour is inescapable. Yet the literature above illustrated that the difference between *intended* and *actual* interdependency between team members often remains unrealised. Tensions between team members were common. These tensions impeded the mobilisation of knowledge (Ferlie et al., 2005; Oborn & Dawson, 2010). Social and epistemic boundaries and related power differentials inhibited the flow and knowledge between actors (Ghebrehiwet et al., 2016; Oborn & Dawson, 2010).

In conclusion, each team member has a share of partial knowledge that stands incomplete on its own (Brown & Duguid, 1998). Different forms of knowledge and the diversity of actors that hold their knowledge must be woven together for effective knowledge mobilisation (Nicolini et al., 2008). Knowledge mobilisation breaks down at both the epistemic and social boundaries. This has left some scholars urging a shift of focus to the relational interactions that facilitate productive interactions between healthcare professionals (Alexanian et al., 2015; Zwarenstein et al. 2013).

## 3.3. Organising for Knowledge Mobilisation: Networks

This section considers the network literature as another structural approach for integrating actors to mobilise knowledge. Just as team structures arose from the recognition that multiple domains of knowledge and different roles were needed to provide care, networks are an equivalent concept but with broader organisational and inter-organisational scope. A spectrum of knowledge and forms of labour are needed from different sectors to address complex problems.

The content of this section is covered in five steps. To begin, the section outlines the healthcare networks literature and provides two conceptualisations of what ‘network’ means in these materials. One view considers ‘network as metaphor’, whilst the others uses ‘network as method’ (Oliver & Faul, 2018). These conceptualisations are considered in turn. The metaphorical use of ‘networks’ represents complex social architectures that depict multiple organisational groups with intersecting interests. The second subset of literature focuses on ‘network’ as a method of analysing these social structures. Next, the section presents Soft Knowledge Systems (Engel, 1997), and, finally, the section revisits the problem of persistent social and epistemic boundaries in networks that inhibit the mobilisation of knowledge.

### 3.3.1. Networks in Healthcare

For reasons similar to creating team structures, growing attention has been given to capitalising on network structures as an organising principle to address complex knowledge-based problems (Ferlie et al, 2012b; Health Foundation, 2014; Sheaff & Schofield, 2016). Where teams provide the (largely intra-organisational) structures to bring multiple individuals’ knowledge together, networks link collective knowledge dispersed throughout various organisational domains since many problems span across these inter-organisational boundaries (Bailie et al., 2018; Swan et al., 2016). For example, sepsis care depends upon different domains of knowledge coming from researchers, policymakers, and practitioners. And these knowledge-based needs stretch beyond any single group’s remit. As a result, stakeholders have increasingly recognised the necessity of reducing the silos that separate organisations with overlapping concerns. Their reasoning is that in order to address complex problems, we must build system-wide strategies whereby policy organisations join with professional societies, academic research units, and clinical providers to build inter-organisational networks (Ferlie et al., 2012b; Fitzgerald, 2016; Holmes et al., 2017).

The network literature focuses on these connections between actors in two ways (Oliver & Faul, 2018): firstly, as a *metaphorical concept* that represents the complexity involved in ties between actors (e.g. separate worlds, communities and systems, see Bailie et al., 2018; Locock & Boaz, 2004; Ward, 2017); and secondly, as a *method of analysis* for unveiling the structure of actors (e.g. structural position in a social system, see Cunningham et al., 2012; Henttonen, 2010). Both the 'network as metaphor' and 'network as analytical method' literatures are relevant to this thesis and are covered in turn.

### 3.3.2. Networks as Metaphor

The healthcare network literature provides varying definitions of a network with a range of terms often used synonymously including: groups, partnerships, alliances, collaborations, interconnected sectors or communities, and systems (Bailie et al., 2018; Health Foundation, 2014; Kitson et al., 2018).

One example is the Health Foundation's (2014) case studies-based review of networks. This study defined networks as:

> [A]n interconnected group or system [that] are established or evolve spontaneously to facilitate the movement or exchange of resources or commodities…A network can be defined as 'a cooperative structure where interconnected groups or individuals coalesce around a shared purpose on the basis of trust and reciprocity'. (Health Foundation, 2014, p. 7)

According to this view, a network encompasses a broad set of actors, more than those contained in a single organisation, and joins together multiple organisations and (most likely) multiple sectors. These sectors reflect varying kinds of otherwise separated actors. Examples include research, policy and practice communities or acute, primary, public health and social care settings. Thus, networks are a metaphorical 'collective space' or 'nexus' made up of actors that share a common concern, but where control is diffused throughout the network structure.

Networks are not all of a type, but fall along a spectrum (Health Foundation, 2014). At one end of the spectrum networks can be intentionally formed, formal, coordinated collaborations and at the other end, networks can be self-organising, loose, informal connections. A separate review of public service networks (including healthcare) said that networks were made up of multiple organisations tied together by "some form of structural interdependence" (Turrini et al., 2010, p. 529). In this view, networks were defined as actors who were dependent upon one another's knowledge while not necessarily being subordinate to another. Ward and colleagues (2018) take this view further saying that "networks are viewed as a descriptive representation of underlying patterns of relationships which make a certain set of actions possible. In other words, patterns of relationships merely represent the potential routes for knowledge creation" (Ward et al., 2018, p. 480). In other words, a network's potential for knowledge sharing can be realised or not. Networks are a metaphorical way of envisioning the inter-organisational complexity of health systems research throughout the various sectors, who represent many overlapping networks (Oborn et al., 2016).

In comparison, Sheaff and Shofield (2016) take a definition of networks closer to the active formation of communication channels between groups. They said that a network is made up of "regular coordinating links for coordinated care planning, referrals, and information exchange about patients across the providers involved [including]…acute hospital and primary care…physical and mental health care" (Sheaff & Shofield, 2016, p. 434). While recognising some level of interdependence, these definitions present different conceptualisations of networks where the formalisation and deliberate coordination of ties between organisations differ.

Increasingly, systems thinking is aligned with network-based studies as both are concerned with ties between inter-organisational actors (Bailie et al., 2018; Best & Holmes, 2010; Holmes et al, 2017; Kitson et al., 2018). For example, "health system strengthening requires bringing together networks of stakeholders across traditional disciplines and fields in order to achieve relevant goals and objectives" (Bailie et al, 2018, p. 1). Systems-thinking is about aligning organisational and inter-organisational bodies for collaboration, as collaboration between them is necessary for easing knowledge spread between groups.

Networks are, at times (and particularly in the knowledge mobilisation literature), portrayed metaphorically as divided knowledge communities, worlds, or camps (Locock & Boaz, 2004; Crilly et al., 2010; Kislov, 2014; Scarbrough et al., 2014). Each 'community' represents a group of stakeholders that are homogenous in some way. The most common example is the research, policy, practice, and, increasingly, patient (Boaz et al. 2015; Cowdell, 2018) groupings. "Ideally, research and practice would not be seen as separate activities undertaken by distinct groups of people (researchers and practitioners or policymakers), but would be conceptualised as an overall approach to linking the generation and use of evidence" (Holmes et al., 2017, p. 549). Indeed, overcoming the boundaries that unhelpfully segment and separate communities is the raison d'etre for knowledge mobilisation studies (Fitzgerald & Harvey, 2015; Oliver & Faul, 2018). "Networked organization[s]", according to Swan et al. (2016), "create the type of collaborative relationship between researchers and practitioners that can generate and mobilise knowledge" (Swan et al., 2016, p. 103).

Thus an examination of the 'network as metaphor' concept reveals a close relationship to the knowledge mobilisation literature (Davies et al., 2016; Reed et al., 2018; Swan et al., 2016). "Mobilizing knowledge is about making connections. Much of the literature on knowledge mobilization discusses the complex institutional, professional, and social environments within which knowledge is created and flows (or, more often, gets stuck)…[there is] specific consideration of the role of specific networks of interests or the practical configurations…" (Davies et al., 2016, p. 286). And yet there are few studies that examine the complex task of sharing knowledge between organisations using a network perspective (Provan et al., 2007; Fitzgerald & Harvey, 2015; Oborn et al., 2016) despite widespread recognition that the lack of alignment between organisations inhibits knowledge spread and use (Ferlie et al., 2005; Fitzgerald & Harvey, 2015).

In response, several national governments have sought ways to address this fragmentation in health systems by proactively building infrastructure and funding initiatives that integrate researchers, policymakers, clinicians and social workers (Walshe & Davies, 2013; Newell & Marabelli, 2016; Wehrens et al. 2011). In England and Wales this has been seen in funding the creation of Academic Health Science Centres, Academic Health Science Networks, and Collaborations for Leadership in Applied Health Research and Care (CLAHRCs) (Walshe & Davies, 2013). CLAHRCs, also called “translational networks” (Evans & Scarbrough, 2014; Fitzgerald & Harvey, 2015), incentivised partnerships between universities and NHS organisations. They were intended to build cross-organisational capacity for using research in practice settings. And over the last decade, studies on CLAHRCs have begun to provide a growing empirical literature about interventional efforts to capitalise on inter-organisational networks.

Currie et al. (2013) conducted a qualitative study of all nine (at the time) CLAHRCs and in-depth case studies in four of the initiatives. They found that absent directives from policymakers, the CLAHRCs each devised their own structure. These structures varied widely based upon key decision-makers’ assumptions of knowledge and how knowledge is mobilised (Currie et al., 2013; Oborn et al., 2013). Oborn et al.’s (2013) examination of all the CLAHRC structures during that time frame found that they consolidated down to five archetypes (multidisciplinary research, centralised management with designated knowledge brokers, modular independence between research- and practitioner-based actors; capitalisation on existing networks without a centralised body; and centralised control).

Most CLAHRCs were led by actors from university settings. Currie et al. (2013) speculated that the constrained time scale for early collaboration between university and NHS actors was a part of the challenge. Academic partners were better positioned to write a clearly articulated bid for CLARC funds. As a result, CLAHRC initiatives tended to meet researchers' need for academic outputs rather than practitioners' desires for service improvement (Currie et al., 2013; Kislov et al., 2012; Fitzgerald & Harvey, 2015). CLAHRCs that had asymmetrical structuring of stakeholders' priorities and limited contact time between disparate groups led to tensions between inter-organisational (academic and NHS) actors (Kislov et al., 2012; Fitzgerald & Harvey, 2015). However, some CLAHRC initiatives that established mixed project teams with collaboratively-oriented governance structures from the outset found ways to 'blur' the social, geographical, and (sometimes) epistemic boundaries (Evans & Scarbrough, 2014; Oborn et al., 2013).

Oborn et al.'s (2016) study of the nine CLAHRCs found that each professional community favoured and elevated certain forms of knowledge above others. For example, epidemiologists relied upon statistical data; clinical academics favoured rigorously controlled clinical trials data; while nurses and managers preferred qualitative data coming from action research and evaluation studies. These different forms of data elicited different perspectives, which then had to be negotiated in order to arrive at compromises.

Some studies showed that the CLAHRCs led by small groups that reflected the range of stakeholder interests helped to build overall cohesiveness between inter-organisational members and provided clearer planning guidance for the initiatives (Scarbrough et al., 2014; Fitzgerald & Harvey, 2015). And yet for CLAHRCs that maintained the segmentation between different actors' groups, their "divergent views persisted and were supported by the structural division between the teams and separate lines of coordination and communication" (Fitzgerald & Harvey, 2015, p. 197). They concluded that the "composition and the processes of operation of the network board were flawed" (p. 198). Where hierarchies between different stakeholders' needs, priorities, and knowledge remained intact, and actors' tasks, responsibilities and time remained detached, social and epistemic divisions persisted. And while upon reflection, various CLAHRC publications recognised that these tensions between actors might be overcome through communication and facilitation, they also said that little research informs how to organise network-based structures that integrate actors’ knowledge and resources (Evans & Scarbrough, 2014; Fitzgerald & Harvey, 2015).

Scarbrough et al. (2014) suggested that in order for knowledge mobilisation to happen, networks must hold two capabilities: integrative and relational capabilities. Integrative capabilities involve bringing together different forms of knowledge from different professional, disciplinary, and geographic areas. Whereas, relational capabilities focus on the ability to help different groups to work together. “Lateral co-ordination across professional and epistemic boundaries is demonstrably as important as inter-organizational co-ordination…Arguably, in translational networks, with complex inter-linkages, relational co-ordination is crucial” (Fitzgerald & Harvey, 2015, p. 194).

In sum, the healthcare network literature presents a myriad of metaphors describing overlapping groups with intersecting interests. Until recently, empirical research on knowledge mobilisation within inter-organisational networks was limited. Deeply rooted divides between network actors with separate control mechanisms, fractured accountability, and distinct priorities and responsibilities remain in place (Locock & Boaz, 2004; Newell & Marabelli, 2016).

The “CLAHRC experiment” (Currie et al., 2013, p. 27) provided insights into ways that nested, overlapping groups with intersecting interests might be helpfully structured for collaboration. These studies also concluded that varying views of knowledge and how knowledge is mobilised affected the ways actors were structured in these initiatives. However, these data do not show how inter-organisational networks might self-organise for sharing their knowledge. Given the diffuse nature of healthcare research, policy and practice bodies worldwide, and the impossibility of overall centralised control, further exploratory work is needed to understand how these different sectors might harmonise the development, sharing and use of their knowledge.

### 3.3.3. Analytical Methods

In addition to the metaphorical category described above, ‘network’ in academic discourse also refers to an analytical lens used to examine ties between actors, or ‘social systems’ (Oliver & Faul, 2018). In this category, networks are the methodological unit of analysis that examines the arrangement (i.e. structure) of actors in the network. A prevalent network theory-based method is Social Network Analysis (SNA). Another gaining in use is Soft Systems Methodology (SSM), and yet a further network analysis tool is Soft Knowledge Systems (SKS). Each of these will be covered in turn.

Firstly, a large body of work concerned with connections between individual and collective knowers employs SNA as a framework to trace patterns and structures within social systems (Henttonen, 2010; Long et al., 2013; Poghosyan et al., 2016; Sabot et al., 2017; Scarbrough et al., 2014; Yousefi-Nooraie, 2012). This analytical lens is concerned with questions such as how connections are distributed in a social system, the position of actors, and where clusters of actors (i.e. nodes) exist. Most commonly, SNA employs a quantitative methodology. Strengths of connection are determined by calculating numbers of ties. This research method uses a highly specified way to frame social networks, for example, that of “betweenness” and “centrality” (Long et al., 2013, p. 159) of actors. As a result, SNA studies tend to leave the qualities of connections between actors unexamined.

A growing collection of studies in healthcare have used Soft Systems Methodology (SSM), developed by Checkland (Checkland & Scholes, 1999), as a qualitative way to understand complex systems. SSM provides a methodical structure to explore complexity within messy real world settings. It is a learning and sense-making tool that begins with a problem situation and brings to the fore various stakeholders’ ontological assumptions about ‘how things work’. Checkland advocated for simple sketches (i.e. models) that captured these ‘programme theories’. By comparing the perspectives of multiple stakeholders depicted in the models, and together reflecting on how the models did or did not capture the ‘real world’, this methodology provided a systems-based way to develop interventions for change (Williams, 2005).

Clarke and Wilcockson (2001) used Soft Systems Methodology to explore the intersection of professional and organisational learning within nursing practice developments. Using a comparative case study design, the researchers created a model of healthcare practice development that included three processes: using and creating knowledge, understanding and engaging in patient care, and putting in action the newly developed practice. Drawing on Checkland's methodology enabled the researchers to model how an individual's knowledge affected the organisation, which had a cyclical effect and affected the individual's knowledge. This work demonstrated the mutual influence of individual and collective knowledge when making changes in an organisation.

Pentland and colleagues (2014) also employed Soft Systems Methodology in an interventional study to improve the evidence based practices of two NHS specialist mental health teams. The knowledge of concern in this study was explicit, research-based forms, which fit with the study's focus of getting research into practice. They used Soft Systems Methodology to inform their intervention development. The study results showed a shift from individuals accessing research-based information to where teams shared their acquisition process with one another. In other words, team members found the value of drawing on collective ways to manage their knowledge needs. Because the study limited its focus to explicit forms of knowledge, an understanding of evidence use in relationship to, for example, tacit forms of knowledge was unexplored.

Lastly, a University of Bangor research team recently promoted the value of SSM when paired with realist approaches. Dalkin et al. (2018) noted that their realist driven approaches and SSM both emphasise engaging with stakeholders and address complexity of systems within real life contexts. They pointed out that SSM helpfully brings multiple understandings to bear on designing changes within systems. The study reported two case studies that usefully employed SSM for organisational interventions and advocated for further work using these complementary approaches.

In summary, SSM is a practical method for exploring complex problems. However, it is primarily intended for intervention-based projects.

### 3.3.4. Soft Knowledge Systems

Soft Knowledge Systems (SKS) is also social network theory specifically designed for understanding how knowledge gets used in practice contexts (Engel, 1997). SKS drew on the methodological strengths of Checkland's Soft Systems Methodology and paired it with Röling's Knowledge Systems (1992) to provide a particular focus on knowledge. Engel developed SKS in response to what he saw as a problem of using simplistic and linear methods to study complex social problems.

Engel drew on Röling's conceptual work, Knowledge Systems (1992), and Checkland's methodological work, Soft Systems Methodology (1988), to construct Soft Knowledge Systems. For Röling (1992), 'system' meant a configuration of actors. Röling explained that a 'knowledge system' was:

> The articulated set of actors, networks and/or organizations, expected or managed to work synergically to support knowledge processes which improve the correspondence between knowledge and environment and/or the control provided through technology use in a given domain of human activity (Röling, 1992, p. 48).

Knowledge systems included actors (both individual and collective) that perhaps did not act as partners in a whole system but were nevertheless expected to manage their work in synergistic ways.

Thus, in Engel's combining of Knowledge Systems and Soft Systems Methodology into Soft Knowledge Systems, SSM provided a methodological way to consider a plurality of views in the dynamic setting of social interactions. And Knowledge Systems provided an ontological understanding of interdependent actors at a 'whole network', as in an individual, team *and* organisational, level.

Soft Knowledge Systems (SKS) is concerned with understanding how actors organised their 'knowledge network'. Engel defined a knowledge network as a group of actors that have "a relatively stable pattern of communication and interaction…[and] who share a common concern" (Engel, 1997, p. 38) for sharing their knowledge. Therefore, SKS focuses on the generation, sharing and use of knowledge amongst the network's actors. A 'knowledge system', therefore, analyses the structural configuration of knowers, the interactional processes and materials they use to coordinate the flow of knowledge amongst network actors. Processes are the activities or ways actors connected to develop, share and use their knowledge. Some examples include meetings, procedures, consensus-building activities like voting, as well as the activity of reading (other actor's work). Materials are physical objects created by actors that are explicit presentations of actors' knowledge for development, sharing and use. Some examples are guidelines, patient observation charts, journal articles, and checklists.

Soft Knowledge Systems was developed and has been primarily used in its original discipline of agricultural sociology. One study by Olson and colleagues (2010) employed the network theory lens in the health sector. Olson et al.'s (2010) comparative case study of multidisciplinary teams in three US hospitals found that team members drew on multiple actors in the knowledge network in addition to their own complex knowledge for effecting practice improvement. Indeed, the success of the projects appeared to hinge on the teams' ability to blend individual, collective, explicit and tacit forms of knowledge, a process that Olson et al. (2010) described as *bricolage* ("making do with whatever is to hand", p. 512). The primary argument of the study was that practical forms of knowledge (i.e. practice-based evidence in contrast to evidence-based practice) should not be dismissed in practice improvement endeavours.

### 3.3.5. Networks Section Conclusion

This section has shown the relationship between the network and knowledge mobilisation literatures, and exposed the ongoing, but relatively unexplored, tensions between organisational actors. As observed in the prior section, teams hold partial knowledge; this section revealed that organisational actors and sectors in healthcare do as well. Knowledge must be woven together from intersecting and overlapping networks in order for knowledge to mobilise. And yet, as seen in the CLAHRCs body of work, once again, knowledge mobilisation breaks down at both epistemic and social boundaries even when geographic boundaries have been (to some degree) addressed. Studies of networks take into account the complex ties between actors for developing, sharing and using their knowledge, and Soft Knowledge Systems dovetails with these interests.

## 3.4. Conclusion

In summary, this chapter reviewed and problematized prevalent structures used to mobilise knowledge. The teams and networks literatures point to the promise these structures hold for mobilising knowledge, however, the effectiveness of these structures to provide reliable outcomes remains variable. If bringing actors together is not enough, how then is knowledge mobilised? Personal contact and interactions between people and organisations establish the connections which in turn enable evidence to be incorporated within practice (Lomas, 2007; Reed et al., 2018; Ward et al., 2009). And yet the interactions between actors are unpredictable (Greenhalgh et al., 2004). The ways forward for aligning, and strengthening the inter-relationships between the research, policy and practice networks require further exploration.

We have seen that crossing professional and organisational boundaries is difficult and this difficulty inhibits the spread of knowledge (Ferlie et al., 2005). We need a richer understanding of networks and how they influence knowledge mobilisation (Swan et al., 2016). Furthermore, these literatures have shown that physical proximity is a first step but does not guarantee knowledge mobilisation. And thus, Soft Knowledge Systems was selected as a theoretical framework for two reasons. Firstly, it is primarily concerned with exploring knowledge within networks. Secondly, the theory specifically focuses on how research-informed knowledge is infused by and within connected actors, as well as the processes and materials they rely upon to share their knowledge. An underlying assumption of SKS is that actors, individual and collective, are both generators and users of knowledge. Actors depend upon their individual and collective knowledge when conducting their work, observing and addressing problems, and constructing solutions to meet their goals.

Set alongside the overarching research goal from Chapter 1 of how to better understand knowledge mobilisation within and between the research, policy and practice communities, and the knowledge and knowing literature from Chapter 2, this review of prevalent structures used to mobilise knowledge provides an additional area of analysis. A further sub-research question based on Soft Knowledge Systems is:

Sub-RQ 2: How are knowledge systems (actors, processes, and materials) organised for mobilising knowledge?

The next chapter will present the methodology and methods of this study.

# 4. Chapter 4—Methodology and Methods

## 4.1. Introduction

This purpose of this chapter is to describe the methodology, design and methods selected for this study, and explain why these choices were made. To do so, this chapter revisits the research aims and questions that emerged from the exploration of the literatures and then turns to unpack the philosophical underpinnings of this inquiry. The chapter explains why a qualitative methodology was chosen for this research project, and a case study design was deemed best suited for the research aims. Finally, the chapter provides a detailed account of how the research project was carried out.

There is one over-arching question that captures the broad research problem described in Chapter 1, and two sub-questions that emerged from Chapter 2 and 3 that delineate the interrelated lines of inquiry within this work.

RQ: How is knowledge mobilised within and between the research, policy and practice communities for clinical practice?

> Sub-RQ 1: What are the sources, forms and ways of knowing involved in mobilising research-based knowledge in practice?
>
> Sub-RQ 2: How are knowledge systems (actors, processes, and materials) organised for mobilising knowledge?

## 4.2. Methodology: Research Approach

### 4.2.1. Philosophical Foundations

The goal of this inquiry is to build deeper and richer understanding of how individuals and collectives interrelate for knowing, and how their interdependent knowing contributes to the mobilisation of different types of sepsis knowledge for patient benefit. ‘Truth’ in this context is interpreted, situated and emergent, and thus an interpretive perspective was used to understand these socially constructed phenomena.

Health services research straddles distinct (and at times mixed and opposed) ontological and epistemological paradigms. This study was conducted using an interpretivist perspective. Such a view sees the world as made up of physical and social entities where physical objects and social phenomena are inherently different in their nature. And thus, the ways of knowing and methodologies used to understand them differ. This study sought to understand how research-based sepsis knowledge was mobilised and used in three interconnected research, policy and practice communities. The inquiry centred on how actors organised and connected with one another to collaborate and share their knowledges. Because the aim of this work was firmly set within the socially constructed world, an interpretive epistemology was chosen because it adheres to a socially constructed understanding that underpins the interconnections of knowers and interconnectedness of their knowledges.

### 4.2.2. Qualitative Research

The goal was an interpretation-based search for meaning by understanding when important and relevant phenomena occurred. *Interpretive* forms of research are utilised to understand processes and lived experiences and they sit within a social constructivism paradigm (Bhattacharya, 2008). Qualitative research methodology asks questions of ‘how’, ‘who’, ‘why’ and ‘what’ (Creswell, 2013). Qualitative research emphasises interpretation to build understanding from within the ordinary and messy context of real world experiences rather than stripping meaning away from its context. This methodological pathway embraces complexity and multiple interpreted realities rather than seeking a reductionist or quantifiable explanation as it is intended to explore meaning within social contexts (Kincheloe, 2001). Qualitative methodology fits with the aims of this research project, which is interested in the multiple socially constructed perspectives of diverse actors and their complex knowledges. This methodology is also suited to exploring social practices and interactions, and understanding how interconnected, complex knowledges and knowers support knowledge mobilisation.

### 4.2.3. Case Study Design

Case study designs are congruent with an interpretive, social constructivist epistemology (Easterby-Smith et al., 2015; George & Bennett, 2005). A case is a “real-life” and “bounded” example in that it has the potential to provide helpful insights especially for complex social problems such as knowledge mobilisation (Creswell, 2013; Merriam, 1998). Case study work is conducted within the context of interest, which allows for an in-depth look at a single (or small number) of bounded phenomena, ideally over an extended period of time (Yin, 2014). A case study design is well-suited for this research problem because our understanding of the interrelationship between human connections for complex knowledges that enables knowledge mobilisation remains sparse (Boaz et al., 2015).

A case study approach was determined to be the most appropriate design for this study for the following reasons. Firstly, the methods are appropriate to the research problem. In seeking to better understand how clinicians develop, share and use their knowledge, case study methods are useful in building understanding where little exists. Therefore, a case study is helpful in answering the question: if clinicians are not using knowledge as they '*ought'* to be, what is it that they *are* doing?

Secondly, case study work depends upon multiple sources and forms of data, including a concentrated time for observing participants' interactions, which in turn provides a more authentic foundation for the interpretation of the social phenomena (Stake, 1995). Case study work draws on the rich tradition of ethnographic research methods. It explores "extensively" and "intensively" in order to build a rich picture of life for understanding people's experiences. "Case study is the study of the particularity and complexity of a single case" (Stake, 1995, p. xi) that provides the basis for the researcher to build understanding.

Thirdly, the benefits of case study research include the in-depth study of a specific place and contextualized phenomena as these real life particulars best capture complexity. Research designs that study complex phenomena foreground the dynamic interactions from real-world contexts to be able to better understand how knowledge *actually* mobilises to care (Greenhalgh & Papoutsi, 2018). By using case study designs, the researcher is able to explore the details of interactions in the context, not decontextualized and abstract. Drawing on observations of actions, behaviours, communication (both verbal and nonverbal communication) and asking the actors how they interpret these occurrences, we are provided with the opportunity to more fully understand. This detailed, actor-informed understanding contributes to the validity of the interpretation.

These methods were selected as they value the granularity of the problems that are faced within the uncertainties of clinical work and are thus best situated to obtain data to answer the research questions. Case study research is based on the belief that “the nature of people and systems becomes more transparent during their struggles” (Stake, 1995, p. 16), and there is value in observing, first-hand, the struggles they encounter in their work.

Finally, the choice of case study design was well attuned to exploring the knowledge network and social interactions that contributed to knowing for mobilising knowledge. The rationale behind a single case design is to confirm, challenge or extend existing theory (Yin, 2014). Stake (1995) agreed and considered theory essential for single case study work. The use of theory in qualitative case study work provides direction, a way to delimit the immense range of “multiple realities” (Reeves et al., 2008), and build a reasonable case for the need to focus on specific facets of the research problem. Although drawing on similar methods as ethnography, theoretically dependent case study research enters into the field acknowledging the influence of other work in shaping our own, and providing clues of what to be attentive to in particular as we approach (and analyse) data (Yin, 2014).

### 4.2.4. Theoretical Lens

Clinical Mindlines (Gabbay & le May, 2011) and Soft Knowledge Systems (Engel, 1997) were selected as a ‘dual focus’ theoretical lens for this study. Both theories adhere to an interpretive frame of knowing within social phenomena. Engel (1997) states that “knowledge processes are *socially constructed”* (p. 32, emphasis in original). Gabbay and le May acknowledge that while theoretically divergent views were useful in developing their findings (see 2011, p. 16) understanding knowledges is an interpretive process as exemplified in their data analysis.

The Clinical Mindlines conceptual framework (discussed in Chapter 2) developed a way of understanding by exploring “what was really going on” (Gabbay & le May, 2011, p. 14) within complex clinical knowledge. Furthermore, Gabbay and le May recognised that complex knowing was not, solely, an individual process. Mindlines were “being implicitly shared and checked, refined and continually developed through interactions between colleagues” (2011, p. 130). In other words, clinicians did not ‘know alone’, but developed and used their knowledge in the midst of interacting with others. This connectedness of knowing they called a community of mindlines or “collective mindlines” (2011, p. 44).

Soft Knowledge Systems theory (discussed in Chapter 3) was also concerned with the connection of stakeholders for knowing and employed a systems lens to understand how stakeholders organised for mobilising knowledge. As mentioned in Chapter 3, in contrast to Social Network Analysis, Soft Knowledge Systems is not interested in the specifics of network structural design per se, but rather the qualities of the social web of interconnections. In other words, by building an understanding of the kinds and qualities of interactions that bind knowledge stakeholders together, we gain deeper and richer perspectives of how to encourage knowledge sharing, growth and application.

Knowledge systems, for the purposes of this work, includes actors, processes and materials. Distinguishing between the three for analytical purposes does not imply that processes and materials are separable from the knowers. Indeed, processes and materials are both created and used by actors, but examining them separately helps to unpack the actors’ underlying assumptions about knowledge that underpins them.

The reason both theories were used for this is work is that Clinical Mindlines provides a helpful conceptualisation of knowledge that was developed from ethnographic research within the world of healthcare. However, as rich of an explanatory theory that Clinical Mindlines is, at present it lacks a structured methodological way to explore actors’ ways of knowing. By contrast, Soft Knowledge Systems brings a relationship-focused systems view that explores the interconnection between stakeholders for achieving knowledge-based innovation. While Soft Knowledge Systems emphasises the collective nature of knowing, the theory lacks a nuanced depiction of complex knowledge. Engel (1997) explained that ‘knowledge’ was an actor’s implicit concepts, ideas, and routines in contrast to ‘information’, which was explicit, as yet un-interpreted, material. However, for a study of *complex* knowing within health services, a more nuanced understanding was necessary. Thus, Soft Knowledge Systems and Clinical Mindlines were paired in this research as complementary theories that each strengthened the other.

Additionally, Clinical Mindlines and Soft Knowledge Systems theories are both interested in the centrality of social interactions for knowing, which aligns well with interpretivism. They focus on the sources of knowing, and the social dimensions that (can) enrich knowledges, such as communication, coordination of disbursed knowledges and responsibilities, and the distributed nature of leadership within a knowledge network. Together they consider how stakeholders connect and organise for knowing and change via interconnected knowledges (Clinical Mindlines) and interconnected knowers (Soft Knowledge Systems).

Finally, a goal for this work was to utilise lenses that paid “attention to interconnectedness and incorporate[d] an understanding of how systems come together as a whole” (Greenhalgh & Papoutsi, 2018, p. 2). Soft Knowledge Systems theory precisely meets these requirements in at least two ways. Firstly, rather than simplifying to one level for analysis, the theory holds the individual, group, and organisation together in order to consider the whole as opposed to simplified and reduced parts. Secondly, Soft Knowledge Systems uses a qualitative methodology to focus on the links, the connections, between actors at these various levels in the whole system. Thus, a qualitative case study using Soft Knowledge Systems along with a nuanced conceptualisation of knowledge from Clinical Mindlines is well suited for the addressing the research problem.

### 4.2.5. Attending to Rigour in Qualitative Case Study Design

Whereas with quantitative analysis rigour may be assessed depending on whether the researcher follows the relevant rules and formulas, qualitative analysis involves assessing the rigour of creative pattern-making and puzzle-fitting processes (LeCompte, 2000; Pope & Mays, 2000). Both quantitative and qualitative work must demonstrate philosophical coherence between the ontological and epistemological perspectives and methods, but as a result, what constitutes a trustworthy contribution and strategies to ensure rigour differs between the two. As qualitative work is interpretive, trustworthiness is reliant upon two intertwined facets: the credibility and skills of the researcher(s), which are then demonstrated by the use of transparent methods that provide an ethical and "meaningful account of the complex perspectives and realities studied" (Cohen & Crabtree, 2008, p. 334; Patton, 1999).

While there are many views on the appropriate criteria for assessing qualitative content, there is wide agreement on the need to demonstrate the credibility and resonance of the work (Creswell & Miller, 2000; Sandelowski, 2015; Stake, 1995). *Credibility* relates to internal validity in that the primary concern is to provide an accurate portrayal of the case. And yet an interpretivist paradigm accepts that there are multiple 'truths'. As Denzin succinctly explains, "truth is always partial" (2009, p. 153). To address the 'partiality' of truth, we incorporate a broad range of perspectives by providing multiple forms (e.g. interviews, observations, documents, etc.) and sources (e.g. interviews with a variety of stakeholders) of data. When possible, we involve multiple researchers in the data collection and analysis processes, seek out contradictory examples, obtain participators' feedback, and engage in constant comparison of this multiplicity of data (Anderson, 2010; Booth et al., 2013).

The independent process of doctoral work meant there was limited additional researcher involvement. Yet the use of other expert researchers' theories to guide both data collection and analysis contributed another voice for comparison. Furthermore, many kinds of data were used, including in-depth interviews, engagement with the research context for over a year, and numerous kinds and sources of documentation. The regular visits to the practice site provided the opportunity for ongoing discussions with the participants, who gave corrective feedback, a form of member checking, for example on interpretive word choices and sketches of the knowledge network. The extended time also allowed for participant feedback to confirm and amend my evolving understanding.

The aim is also to provide a detailed account such that it is *resonant*. A common concern of qualitative case study research is that it does not produce 'generalisable' knowledge. Stake (1995) strongly pushes against the idea that case study work should seek to develop general laws or universal principles. He argues that such efforts stand in direct opposition to the precious resource that case studies data can provide—rich particularity and specificity. Rather than generalisable material as the basis of validity, Stake concludes that providing a record of findings that are *resonant* is the appropriate goal. Yin (2014) also advocates achieving resonance as one source of validation by incorporating rich description. Easterby-Smith et al. (2015) use different terms, "authenticity, plausibility, and criticality" (p. 88) that make much the same point. The work needs to demonstrate a deep understanding, must fit within the broad experiences of other similarly placed researchers, all the while providing a unique contribution. Ultimately, qualitative work "should be believable" (Easterby-Smith et al., 2015, p. 89).

An interpretivist paradigm holds that exact replicability and reproducibility is not achievable in the dynamic social world (Morse, 1997). Social contexts are complex and ever-changing. Sandelowski (2015) argues that evaluating qualitative work is "a matter of taste" (p. 86), where 'taste' is a deep level of discernment acquired through extensive focus over an extended period of time. An appropriate external assessment of rigour in qualitative research then is based on a refined judgement, a "connoisseurship" (Sandelowski, 2015, p. 90) grounded in experience. The researcher must provide sufficient and clear data that convinces an expert evaluator.

Thus, the interpretive process is to weigh, explain and draw out the specifics of a particular case, puzzle and turn it and see how it fits or does not fit with the existing theoretical and empirical literature. In this way, we can see that ‘rigour’ is also an interpretive determination bound to one’s philosophical perspective.

## 4.3. Methods: Carrying out the Case Study

### 4.3.1. Identifying, Recruiting and Selecting a Case

Identifying a case was a blend of purposive, purposeful, and theoretically-guided decision-making process (Emmel, 2013). Choosing a case was *purposive* in that it was shaped and influenced by existing work, for example, Clinical Mindlines (Gabbay & le May, 2011), when developing a research focus and related questions. These research questions then guided the determination of what cases would be useful for answering the questions. In line with Gabbay and le May’s methods, I chose to study high-performing contexts. Thus selection was *purposeful*, or strategic, because the goal was to locate cases more likely to provide ample data for the area of inquiry, a reservoir with the potential for rich resources that would provide insight to the central issues and questions (Patton, 2002). Finally, selecting a case contributes to a *theoretical* base because as we generate data and engage in the analysis process we extend or reframe the original theoretical work and refine theory (Burawoy, 2009). Furthermore, “constructivists opt for selecting theoretically ‘crucial cases’” (Blatter, 2008, p. 4). In sum, the reasoning behind seeking a high-performing context of practice was (similar to Gabbay and le May, 2011) that we could learn about how knowledge mobilises better from an example of exemplary practice.

Soft Knowledge Systems theory also provided the bounds of the case. A ‘knowledge network’ is framed as individual and collective actors whose knowledge contributes to a shared concern. Using Röling’s (1992b) explanation, a knowledge network is a “set of actors, networks and/or organizations [who] expected or managed to work synergistically to support knowledge processes” (Engel, 1997, p. 31). A knowledge network overlaps in ways with a Community of Practice (Wenger, 2000), but also differs in key ways. A community of practice is broadly defined as a group of people who share a common interest, “concern, a set of problems, or a passion about a particular topic, and who deepen their understanding and knowledge of this area by interacting on an ongoing basis” (Wenger et al., 1998, p. 4). Whilst actors in a knowledge network would have adjoining concerns, they may not interact directly. Their interactions may be mediated through physical materials such as guidelines and the content deemed important and placed on a patient observation chart. In a community of practice, the shared interactions and learning result in a shaping and transforming of individual member's identity. Members have a sense of belonging to the community (Wenger et al., 2002). However, while each subset of the larger knowledge network (the Surviving Sepsis Campaign research network, NHS Scotland's Sepsis Collaborative policy network, and Aurora Hospital practice network) might well fit the remaining criteria, interactions between actors in the whole knowledge network cannot be characterised as "ongoing". While they are interrelated, they are not one community. And often it is this lack of direct connection that separates actors and exemplifies the knowledge mobilisation problem.

To build depth of understanding of the 'whole network' involved in building complex knowledge for mobilisation, a single case study, bounded by overlapping research, policy and practice communities within a sepsis knowledge network case, was selected. This complex array of stakeholders includes the Surviving Sepsis Campaign research and guideline development community, the NHS Scotland policy community, and Aurora, a Scottish hospital. Each community represents a subset of the case as each has distinct responsibilities and yet they are united in the ultimate goal of mobilising their sepsis knowledge for service provision.

The reasons for choosing a case in the patient safety area were four-fold. First, quality improvement efforts, namely the Scottish Patient Safety Programme (SPSP), along with comparable initiatives in NHS England, have been a high priority in UK health systems in recent years. Numerous initiatives have been launched, tracked, and provided a potential breadth of relevant contexts of study. Second, these initiatives included outcome measures that incorporate a wide range of judgements about what constitutes 'success'. For example, the performance measures and audit data collected over the course of the SPSP provided support to the views of those within NHS Scotland as to which boards could be considered high-performing and thus more likely able to provide informative data. Third, a focus within a patient safety clinical realm was desirable as I have previously completed research in these areas. Though not a clinician, I am familiar with patient safety terminology and procedures, lessening my cognitive load. One final benefit of choosing to explore sepsis within the hospital practice setting was that Gabbay and le May's (2011) work focused primarily on the general practice setting with limited time spent in the secondary care context.

Before recruitment began, the St Andrews's University Teaching and Research Ethics Committee reviewed and approved the ethics application in June 2014. (See Ethics Approval letter in Appendix A.) The approval was based in part on a screening by the regional East of Scotland NHS ethics body which took place earlier in February 2014. The East of Scotland review determined that the study was exempted because it was not clinical research, and recruitment could commence.

In November 2014, I attended a day-long meeting of the Scottish Patient Safety Programme's Sepsis Collaborative, the policy-based community, in Glasgow. I asked the Collaborative coordinator if she would consult with colleagues and nominate hospitals that were considered high performers in Scotland for sepsis care. In January 2015, I contacted the coordinator again, at which time she circulated an email inquiry asking specific hospitals recognised nationally for their efforts if they would be willing to participate in a research study. Aurora General Hospital agreed and I began collecting practice-based data in February 2015.

### 4.3.2. Data Collection

Consistent with case study methods, the goal was to collect data from a wide range of sources and types. This included documentation, artefacts, observations captured in field notes, as well as interviews with a range of stakeholders. The aim was to collect a wide range of data that contributed to a 'thick' depiction of the case (Baxter & Jack, 2008; Yin, 2014).

In person data collection spanned from November 2014 until April 2016. I attended my first Sepsis/VTE Collaborative meeting in November 2014 and finished at a Health Improvement Scotland meeting in March 2016. Data collection with the staff of

Aurora hospital started in February 2015 and concluded with a final visit in February 2016. Final email communication for data analysis purposes was in April 2016. Documentary sources for sepsis research and NHSS policy were publically available and collected throughout the project until January 2019.

In sum, I went searching in many areas where sepsis knowledge would be located. I looked at the relevant research, policy and practice networks and searched for peer-reviewed publications, online organisational forums, governmental reports, face-to-face meetings, formal and informal interviews with participants, and, where possible, walked alongside participants to spend time with them whilst they were engaged in developing, sharing and using their knowledge. The following sections explain the role of interview, observational and documentary data in this study, as each form played a vital part in studying the actors within the 'whole' sepsis knowledge network.

### *Interview Data*

Interviews are arguably the most common source of qualitative data (DiCicco-Bloom & Crabtree, 2006; Roulston et al., 2003). This study collected data via semi-structured and in-depth interviews. While there are different interview approaches, the primary benefit of semi-structured and in-depth interviews is that they provide direct contact with participants, and they are a flexible way of inquiring about the topic of research interest. Interviews are interactive and allow for deep exploration of topics. Furthermore, the conversational format provides the opportunity for unanticipated ideas to emerge and unfold (Britten, 2000). Initially, I used a semi-structured interview format. This allowed me to obtain multiple stakeholders' views about who the key stakeholders were within the knowledge network, the story of sepsis care at Aurora, and what were deemed to be the various knowledge sources that contributed to past as well as present systems at the hospital and their own provision of sepsis care. As time progressed, in both ongoing conversations and follow up in-depth interviews with key stakeholders, I was able to examine emerging themes in greater detail. Further email exchanges occurred regularly to clarify data and confirm my interpretations.

I drafted multiple interview guides. One was for in-depth interviews with key participants (i.e. those primarily tasked with sepsis care at Aurora) and a separate, shorter version was used during semi-structured interviews with the less central actors in the knowledge network. For both, my initial interview questions were constructed and revised to reflect the primary purpose of the research study. I used Soft Knowledge Systems and Clinical Mindlines theories to guide my inquiry. Simply put, I used narrative-based interviews and asked participants to tell me Aurora's sepsis story. I asked prompting questions about the participant's involvement and experience with the hope that this would elicit an extensive explanation. This occurred exceedingly well with some participants, and less so with others. (Due to the length of the guide, see the In-depth Interview Guide in Appendix B.)

For the less intensive interviews and those with pressured schedules, I developed a separate semi-structured interview guide that asked the open-ended questions in Box 4-1:

Semi-Structured Interview Guide:

1. Can you describe your role in providing sepsis care?
2. Who else has been involved in providing sepsis care? Within the hospital? Outside? (outlining the Knowledge Network)
3. Why would you say that Aurora has been recognized as a high-performing hospital in regards to sepsis care?
4. What sources of knowledge and information have contributed to this success? People? Evidence? Organizations?
5. What sources of data, information, knowledge do you draw upon in your role? (Explicit sources? Experience?)
6. (If they mention clinical judgement): How would you describe "clinical judgement"? What would the ingredients be?
7. When faced with uncertainty, what sources of information and inspiration do you turn to? (E.g. Where did you turn in the recent construction of the new observation chart?)

*Box 4-1, Semi-Structured Interview Guide*

For follow-up interviews, I used my field notes to construct a guide based on issues arising during the iterative analysis process (see example in Appendix C, Follow Up Interview Guide.) I used these guides for additional in-depth exploration of emerging issues in the formative analysis process, and this allowed for dialogue-based member-checking along the way.

With one exception, all interviews were carried out in person. One participant asked if we could organise our interview over the telephone to minimise the difficulty we were having setting a time. The location of interviews varied and was largely dependent on the flexibility of the participant. Interviews with senior clinicians, which included the outreach nurses as well as medics and administrative staff took place either in their offices or in a more secluded area of the dining hall. Interviews with ward-based nurses were conducted in a quiet(ish) corner off to the side of the ward. The ward location was not ideal for privacy, but the bit of space that separated us from others meant we could not be overheard, and allowed me the opportunity to talk with people I would not have otherwise been able to. Most often the ward nurses expressed concern that they would not have a helpful perspective to offer. After assurances that I very much wanted to hear their experiences and views, I found remarkable candidness by most participants despite the less than ideal setting. It appeared conducting the interview on the ward, in “their” space, helped put them at ease.

My process of (and views about) recording interviews altered during my year of collecting data. Early in the process, I requested and received permission to record each interview. By my third or fourth visit, one doctor greeted me in his office, took my papers, and then with no time to settle, he ushered me along on a walk through his ward to show me points of interest. This became an interview on the run (he walked at a fast pace). Soon after that, another medic began sharing when my briefcase containing my recorder was located elsewhere in the hospital. What had seemed unfathomable to me as an experienced qualitative researcher (not having an interview recorded) became a necessity to remain flexible to the needs and preferences of the participants in the fast-paced and emergent nature of the field. Their time was sometimes limited and their willingness to share their views with me was valuable, and I had to adapt to include other ways of capturing these data. Later, as I interviewed nurses on the wards, a recorder was both not practical and I believe very likely would have been an impediment to their comfort. For all the interviews that were not captured on the recorder, I took notes on paper at hand, and as soon as I could thereafter I captured the content of our conversation in my field notes. I came to realise the immense value of the accidental and serendipitous contacts that occurred with increased frequency during my time at Aurora.

Eighteen participants agreed to be interviewed (see Aurora Interview Data, Table 4-1). Some participants were interviewed multiple times.

**Table 4-1, Aurora Interview Data**

| | |
|---|---|
| Interviews | 18 participants<br>25 interviews |
| Interview Length Range | 22 minutes – 2.5 hours<br>(64 minutes on average) |

The next table (Aurora Interview Participants, Table 4-2) contains a list of pseudonyms given to participants. The goal was to protect the individual identity of participants to the extent possible in a small nation. I have provided pseudonyms and adjusted demographic information (e.g. swapped genders).

The pseudonyms given to actors reflects the way that the people at Aurora referred to one another in the third person. The nursing staff, including the senior level Outreach team members, spoke to and of other nurses by given names. When speaking of the medical staff, however, the Outreach staff alternated use of their first name and their title. For example, David would address Dr Lewis with his given name, whilst he alternated names during recorded interviews and when talking to others. The same phenomena appeared with Dr Adams (clinical lead in ICU) and Mr King (clinical lead in the Emergency Department). David was only known as David, and never Mr McIntyre. In essence, only senior medical staff were sometimes given honorifics (e.g. Dr Lewis, Dr Adams, Mr King), otherwise, people were mentioned by their given name or position description. In keeping with the practices of the community, Table 4-2 identifies key actors within Aurora, listing the senior medical staff with titles, while the rest of the staff are represented using a first name pseudonym.

**Table 4-2, Aurora Interview Participants**

| Name | Professional role | |
|---|---|---|
| David* | ICU Outreach Team nurse | Team lead |
| Kelly* | ICU Outreach Team nurse | |
| Jackie* | ICU Outreach Team nurse | |
| Leann* | ICU Outreach Team nurse | |
| Martha* | Clinical Governance | Patient safety asst, Former nurse |
| Sue* | Clinical Governance | Team lead, practicing nurse |
| Dr Nicholas Lewis* | Critical Care doctor | Retired clinical lead |
| Dr Adams | Critical Care doctor | Present clinical lead |
| Dr Lomas | Critical Care doctor | |
| Dr Sloan | Anaesthetist | |
| Dr Jones | Microbiologist | |
| Mr King | A&E doctor | Clinical lead |
| Hannah | Training and Development | Former nurse |
| Karen | Staff nurse | |
| Curt | Staff nurse | |
| Andy | Charge nurse | |
| Alison | Staff nurse | |
| Michael | Clinical support nurse | |
| | | (*Multiple interviews) |

I conducted five further interviews with one NHS Scotland Sepsis Collaborative leader and four Collaborative participants from hospitals other than Aurora. I met these individuals either at Sepsis Collaborative meetings or visited them in their workplace (see Table 4-3, Sepsis Collaborative Interview Data).

**Table 4-3, Sepsis Collaborative Interview Data**

| | |
|---|---|
| Interviews | 5 participants |
| Interview Length Range | 50 minutes – 2.5 hours<br>(90 minutes on average) |

I transcribed all recorded interviews. I did not transcribe my introductory or unrelated conclusion comments, nor interruptions during interviews (which occurred a few times). As the transcriptions were exclusively for my analytical purposes, I did not include “Uh huh’s” or other conversational noises. Lastly, when transcribing and an analytical thought occurred, I inserted it in the document set off by brackets.

### *Observational Data*

As the use of qualitative methods have increased in health services research, the value of close observational data has grown in recognition (Dixon-Woods & Shojania, 2016). Most months between February 2014 and February 2015 included site visits, sometimes two, that lasted at minimum 5 hours and at maximum 10 hours. My early observation data included descriptions of the physical space of the hospital and its surroundings. The length of time for the visits increased as the relationships grew. Shadowing provided direct access to naturally occurring interactions. I witnessed first-hand how stakeholders performed during their work day: the rhythm, the people, the resources, the equipment, the activities. I could see how meetings were conducted, who the team ate meals with, how they interacted with other staff and patients. Furthermore, key informants began to narrate what was happening at the time, or soon thereafter, what was going through their mind. For example, on one occasion I witnessed a discussion between an ICU consultant, an ICU specialist and one of the ICU Outreach team members. The Outreach team member and specialist were concerned about a patient and wanted to bring him from the ward to the ICU for closer observation. They did not state this explicitly but I later learned from the Outreach team member that the whole conversation was spent trying to convince the consultant to agree with them (they did not succeed). While the exchange had appeared agreeable, the Outreach nurse said that the specialist was not happy with the decision. I noted that this decision contradicted the oft-stated proactive stance of the ICU staff to prevent sepsis (which I witnessed most often). The nurse responded that they as an Outreach team could only go so far in their authority. She noted that they knew what to anticipate from each of the medics they worked with regularly, and had to assess whether it was necessary to push harder for their goal or be patient and not squander the goodwill of and relationship with the consultant.

Based on my prior qualitative experience, I had perceived that observational data typically filled a secondary, confirmatory role. However, in this study I found that observation data provided more than confirmation of interview data, but provided new insights and an enriched understanding of the relationships between the actors at Aurora. Drawing on ethnographic methods, which emphasise observational methods (Pope & Mays, 2000), I was able to hear the viewpoints of the actors during their interactions with others. I was able to watch and hear them analyse knowledge sources. I observed how and when they reached for explicit sources that were available to hand, but especially in the last months, I was also privileged to hear them reason aloud for my benefit. I was allowed 'behind the curtain' access to listen in to their reasoning, perspectives, and opinions. This involved a wide range of subjects from concerns about a particular patient, explanations of their actions, and how they felt about the staff around us. I could witness their collecting, coordinating and negotiating a variety of information sources via interactions with other staff members. I would attempt to remain out of the way, but increasingly was encouraged to come in close to see what was happening. In this way, I found shadowing to be both participative and non-participative. The observation process was interactive and did more than supplement the interview data. The time spent watching as well as talking with people built a context-based understanding that contributes to the credibility of these data (Waring & Bishop, 2010).

As my contact progressed, it became clearer to me that the richest data was in my observation material. This included unrecorded conversations around a dining table, in a break room, and when walking the wards. Recording my reflections in field notes became a high priority, and I experimented with different ways to capture my observations. In the end, when on site I carried a hand-sized notepad around with me to jot down key words and phrases. I could fit the pad in my pocket. It seemed that the less my hands were filled with 'research-ery' material, the more comfortable the hospital staff felt to just talk. But when I had a moment alone, often waiting in the hall while the staff attended to a patient, I could make notes to myself and minimise the chance I would forget something worth further consideration later. Immediately following my visit, I would take the notes and expand them to describe more fully the interaction, event or my thoughts.

In addition to shadowing clinical staff at Aurora, I began to schedule my visits on the day of the hospital's Deteriorating Patient meetings. These meetings occurred fortnightly and included clinical, management, and administrative staff throughout the hospital responsible in some way for sepsis care.

Observations for NHS Scotland's Sepsis Collaborative, the policy community, included attendance at NHS Scotland meetings that were available to me as a doctoral researcher. This included Sepsis Collaborative meetings and Health Improvement Scotland meetings that involved sepsis-related research presentations. I recorded observational notes in my research journal during these day-long meetings.

Observation data captured in field notes alongside the interview and documentary data contributed to a far more nuanced account. The result is that I am able to more confidently affirm the credibility and authenticity of my interpretation of the case (Bloomberg & Volpe, 2008; Cohen & Crabtree, 2008). I could corroborate and piece together the points made during incidences I personally witnessed, and I had the opportunity to validate or clarify my interpretations. One example, discussed in more detail later in the findings, was about the impending switch at Aurora to a new patient observation chart and scoring system. During my first site visit, I thought I had picked up tones of worry in off-handed comments during interviews as well as in informal discussions. Later, as I sat in on the Deteriorating Patient meetings, I could see that the changeover consumed the agenda over the course of my year at Aurora. Over time, I was able to talk at length with numerous stakeholders about their views and concerns (which certainly varied) about switching to a new chart system.

Ongoing observation and time in the field allowed for member checking as well. I was able to consider the emerging themes and seek clarifications and receive feedback. One example, recorded in my field notes (November 2015) said, "During my time today with [Kelly] I was trying to pick at this issue of what sources she trusted. I asked if this was information she would trust. She didn't think 'trust' was the right word. It was more a matter of trial and error. She said, 'you try and use it, does it work? No, well let's try this. You maybe just tweak it a bit. It's all that trial and error and doing PDSAs [Plan-Do-Study-Act cycles] on it.'"

Drawing on both observation and interview data also allowed me to see the holes, or the places where incongruences took place. One example (explained earlier) was seen in the consultant's lack of willingness to admit a patient of concern to the ICU despite numerous claims by various staff to 'always' be proactive in preventing sepsis. Another example was that one member of Aurora's staff gave a rousing description of teamwork and respect for all staff in their interview, but I observed first-hand and from others during interviews that this was not always the case. Having multiple sources of data, collected over time, provided the opportunity to uncover the less tidy side of knowledge mobilisation, and the ways the staff overcame these challenges.

### *Documentary Data*

The printed word has had a profound influence on our social world (Burke, 2000), and yet documents are an often underused source within qualitative research (Prior, 2003). Atkinson and Coffey (2011) explain that documents are 'social facts', meaning they are created by people with the intention to communicate ideas and concepts with others. Their construction and production are dependent on interaction with other people's ideas, content, and often direct input. Prior (2003) agrees saying that documents are not mere words on paper, but represent (and thereby are in a sense) actors engaged in "fields, frames and networks of action" (2003, p. 2).

This research project collected a wide variety of documentary materials from the research, policy and practice communities. Documents drawn from the research community included academic articles published in peer-reviewed clinical journals regarding sepsis, and sepsis care. They also included publications from the Surviving Sepsis Campaign (found in journals associated with related specialist organisations, for example, *Critical Care Medicine* and *Intensive Care Medicine*, as well as generalist journals such as *BMJ* and *JAMA*). For both the research and policy communities I also drew upon the grey literature of organisational publications and other publically available, web-based information. The organisations included the International Sepsis

Forum, the Institute for Healthcare Improvement, NHS Scotland, the Scottish Patient Safety Programme, and NHS Scotland's Sepsis Collaborative. The materials included white papers, planning materials, project evaluations, briefing papers, and organisational structure and membership information. Additionally, Aurora provided audit and performance reports, internal reports, training materials, sample patient observation charts and paper-based tools (i.e. their Sepsis Sticker) and Deteriorating Patient meeting agendas and minutes.

Indeed, all of the data from the research network were collated from documentary sources. These materials have been interrogated, weighed and cross-referenced to compile a narrative. In this way, this study did not privilege one form of data over another. The published literature was considered with as much seriousness as the data that came from interview and observational methods more readily available in the policy and practice contexts. And the Surviving Sepsis Campaign-related documents demonstrated a long-standing collaboration with ongoing engagement and interactions that continue to this day.

Data sources for the NHS Scotland policy community included the Scottish Patient Safety Programme website, peer reviewed publications such as Tarrant et al. (2015), journal publications on Sepsis 6, UK guideline bodies (SIGN, NICE) sepsis publications, publically available material on the Sepsis Collaboration (e.g. pre-recorded interviews with policy leaders, slide sets posted from collaborative meetings, evaluation documents), my own interviews with a policy leader and other Collaborative participants, interview data from Aurora, observations and informal conversations while attending two Sepsis Collaborative meetings and one Health Improvement Scotland meeting that included a sepsis segment.

The documentary materials from Aurora provided internal validation and confirmation of nationally reported performance data and supported their claims and outsiders' beliefs that they are a high-performing hospital with regard to sepsis care. Performance and audit data shared in documentary form were frequently referred to in order to provide justification for what they had done and further confirmed and corroborated information shared during interviews.

The performance and audit data also provided a point of reference during the interviews (e.g. did the person trust the data in the documents?). I thought that collecting documentation might be a sensitive matter, requiring careful planning and wording. However, as most of the quality and performance data is tracked for NHS Scotland audit systems already, the staff readily shared these data.

The documentary data were collected from sources located in peer reviewed research journals, in particular *Critical Care Medicine* and *Intensive Care Medicine* (the journals belonging to two key actors, both critical care specialist societies)*,* organisations' website content, for example the Surviving Sepsis Campaign, Institute for Healthcare Improvement (IHI), and the International Sepsis Forum websites, as well as grey literature, such as specialty organisation position statements, UK government documents, and IHI White Papers.

In this research project, research publications are viewed as a form of communication from (in this case typically) a collective actor to interested parties. For example, the Surviving Sepsis Campaign guideline development committee stated that the guideline was for wide distribution and intended for the policy and practice communities. Therefore, these documentary data are analysed using the same methods as with interview transcripts, where meaning is scrutinised and interpreted (Bowen, 2009).

Lastly, with permission, I photographed some visual artefacts from Aurora. This included pictures of charts and signs on the walls, the messy piles of binders containing sepsis materials in Accident & Emergency, and a calm moment with a key participant (face not visible) at their desk entering tracking data into their tracking log. Care was taken to exclude faces or distinguishable features. Of all these materials, when included in the findings section, the identifying markers are masked.

### *Ceasing Data Collection*

Data saturation is an oft used expression to describe when a qualitative researcher recognises that they can stop collecting data. Bradley et al. state that “this is the point at which no new concepts emerge” (2007, p. 1764). I did not find this a readily identifiable moment. Quite the contrary, I believe there was much more to learn and see at Aurora. Likewise, the research community continues to publish highly relevant articles. Ceasing data collection was a pragmatic requirement, not at all a matter of saturation. This fits with my ontological perspective that views human phenomena and experience as ongoing and emergent in nature. There will always be more that happens, more to learn, and hence more to understand. Nevertheless, all research projects must find an ending point. As a PhD researcher, time pressures necessitated that I stop and shift to bringing the project to completion.

### 4.3.3. Level of Inquiry

The level of inquiry, often referred to as the unit of analysis, provides the basis for data collection and analysis (Easterby-Smith et al., 2015). The unit can range from broad (e.g. countries, cultures) to specific (individuals, stories). While it is uncommon to incorporate multiple levels of analysis, the theoretical aims of this study justify this approach. Crossan et al. (2011) acknowledge that learning is located *within* and *across* levels. While one area can be placed to the fore, it is also helpful “to expose the multilevel relationships” (p. 454) between individuals, groups and organisations. Knowledge mobilisation is a set of complex interactions that occurs at all levels.

The case was explored both retrospectively and as events unfolded. The reasons for this are three-fold. First, a documentary analysis of sepsis-related publications and policy position papers provided a historical marker of the ongoing process of scientific research and policy decisions that the practice context experienced. At Aurora, both documentary information and interviewees provided a retrospective story of sepsis care. Asking participants to share their recollection of events provided an opportunity for reflective learning (Schön, 1987) and sense-making of how prior events contributed to their present sepsis-related activities. The complexity of work place change can sometimes make it difficult for the actors to see and understand what is important in the moment, and the role of serendipity in change is often only evident in the aftermath (McDaniel et al., 2009; Plsek & Greenhalgh, 2001). Second, because the decision was taken to choose a hospital that had succeeded in their patient safety efforts, it was important to learn how the actors made sense of their successful quality improvement efforts. Third, the time in the field at Aurora allowed me the opportunity to observe their ongoing practice during each visit as it emerged.

### 4.3.4. Data Analysis

"At no point in naturalistic case research are the qualitative and quantitative techniques less alike than during analysis" (Stake, 1995, p. 75). Whereas the quantitative researcher relies upon aggregation to demonstrate a finding of significance, the qualitative case researcher recognises the at times disproportional nature of significant data. A one-time incident, or a behaviour that deviates from the norm, can hold significant meaning. For example, many times the staff at Aurora referred to their friendly, highly relational community, and this was indeed evident. I anticipated that the collegial environment might be a primary reason why sepsis knowledge had been mobilised successfully within this hospital. I was therefore surprised when hints were dropped that mistrust also existed. While relatively rare, the revelations of communication fractures and lack of trust were important in reaching a more nuanced understanding of the knowledge mobilisation process. Disconfirming examples affected the analysis of the whole, prompted more complex interpretations, and fundamentally shaped the summative analysis and contribution of this thesis. Stake (1995) affirms the importance of noting the repetitive occurrences alongside infrequent, albeit powerful, events.

Analysis for qualitative research is also dissimilar to quantitative research in that it is not sequential but iterative and formative (Bradley et al., 2007). Analysis begins in the early stages of data collection and continues until the last word is written. Silverman (2010) recommends a two-stage analysis process. First, considering the data according to theoretical schema. Here is where the researcher endeavours to make sense of the mystery. The important and often neglected second stage is to look for connections between the themes, which provides a more defined focus. Other qualitative research scholars explain that the analysis process involves describing, classifying and connecting themes to provide the basis of interpretation (Coffey & Atkinson, 1996). Some see these occurring in separate, distinct stages (Miles et al., 2014) and others see them as overlapping and occurring in parallel (Wolcott, 1994).

To begin the formal, or summative, stage of analysis, I decided, following Stake (1995) to 'listen to the data' and not prod it into a particular shape. I entered the transcripts and field notes into N'Vivo 15 software and began coding. The primary goal at this point was to familiarise myself with the whole. "Coding is much more than simply giving categories to data; it is also about conceptualising the data, raising questions, providing provisional answers about the relationships among and within the data, and discovering the data…to open up the inquiry and move toward interpretation" (Coffey & Atkinson, 1996, referring to Strauss, 1987, on p. 31).

I began with some basic codes—'team', 'trust', 'knowledge', which quickly segmented into differing kinds of knowledge (e.g. experience, explicit). Thus, the first attempt at coding was loosely based on the research purpose, research questions, and the emerging themes from the formative stage of analysis. In the process, I expanded and divided further as ideas emerged. One example is the role of meetings: what occurred, what was the purpose of meeting collectively, who was there, who led the meeting, how did negotiations and decisions happen here, where did the negotiations take place outside the meeting space, who spoke and who didn't. These were indeed important markers for my analysis process and yet I found the software less helpful than I had expected. I was splintering the content further and further down to ever more specific codes and nodes. I was capturing some big ideas, but dismantling the interdependent whole in such a way that I found it difficult to "see". The process simultaneously helped me begin to sharpen my understanding of the whole but also fragmented my data. Thus, the coding process was less useful for my ultimate purposes than I had anticipated. In the end, my use of NVivo was valuable for retrieving specific quotes, but was less helpful for moving forward the analysis process. I found separating data into electronic pots did more to confuse than to move the analysis process forward.

Instead, I shifted to a theory-directed analysis process to illuminate the data (Kelly, 2010; Reeves et al., 2008). This entailed a cyclical process of interrogating the data, having reflective discussions with experts, and returning to the Soft Knowledge Systems and Clinical Mindlines theoretical material. I listened through all of my recordings, whilst reading the transcripts. I found hearing the voices of my participants, the additional sensory component, helpful. I listened to each interview two times, and key participants between three and five times. I reviewed each of the key Surviving Sepsis Campaign definition and guideline documents (see a list of key documents in Appendix D) and located the areas that spoke of multiple forms of knowledge and the connections between individuals and groups. Similarly, I re-examined the Scottish Patient Safety Programme materials related to sepsis.

Eventually, from Soft Knowledge Systems and Clinical Mindlines, I developed an *analytical guide* to interrogate these data. I asked questions such as: Who are the actors involved? How were they arranged in their setting to create, share, or use their sepsis-based knowledge? What are they doing? What knowledge(s) are they tending to? How are they organising their knowledge? How do varying forms of knowledge work together within the knowledge mobilisation process? What (explicit or implicit) processes did each community depend upon to facilitate knowledge mobilisation? What materials did they devise and use to accomplish their work? How does the community connect with the other communities in the whole knowledge network?

Thus I used Soft Knowledge Systems and Collective Mindlines as tools to explore and then organise, interpret and make sense of the data (Llewelyn, 2003). Soft Knowledge Systems helped me methodologically define the case boundary as the interconnected knowers that made up a ‘whole’ sepsis knowledge network. In the findings chapters I use Soft Knowledge Systems to explore and understand *how* the actors connected and the ways they were dependent upon one another to accomplish their shared goal of bringing a consistently high standard of sepsis care.

Using theory both as a way to collect and analyse these data allows for an element of ‘theory-testing’: is Soft Knowledge Systems resonant (or not); is it credible, confirmable, and dependable? Does this theory prove a cohesive way to account for interconnected knowers? Does Soft Knowledge Systems hold up in the context of this study? These questions hold for Clinical Mindlines as well. Using theory in these ways explicitly connects this work to the academic literature, and provides both theoretical and empirical contributions (discussed further in the Discussion Chapter).

## 4.4. Conclusion

In summary, this chapter has explained the research methodology, design and methods which support this study. The next chapter, Chapter 5, begins to unfold the actors and events in the research and policy networks, and then Chapter 6 turns to Aurora General Hospital.

# 5. Chapter 5—The Research and Policy Networks

The preceding chapters have framed the research problem, described the methodology and methods used in this study, and explored the health services literature regarding knowledge and the organisational structures that are relied upon to facilitate knowledge mobilisation. The following two findings chapters provide an empirical account of the actors that were part of this sepsis-focused knowledge network, and their events, processes, and materials for mobilising sepsis knowledge in this study.

This first findings chapter traces the development of collective actors, concepts, evidence and initiatives around sepsis in the research and policy networks. These data provide the foundation for the next chapter’s account at Aurora General Hospital. Furthermore, these data provide glimpses of interactions within these two community sectors that contributed to their mobilising knowledge for care.

The content within this chapter is divided into two main sections. The first section focuses on the international research network, specifically the knowledge systems that constitute the Surviving Sepsis Campaign actors, processes, and materials. The second section turns to consider the NHS Scotland policy network tasked with sepsis care, the Sepsis Collaborative. These actors and activities are not comprehensive representations of their respective areas, but are the subsets explicitly identified by many participants at Aurora General Hospital. A third section provides a summary table drawn from the research and policy content that consolidates the sepsis specific terminology presented in this chapter and is intended to be a helpful reference point moving forward.

As explained in the last chapter, Soft Knowledge Systems and Clinical Mindlines shaped the design and data collection as well as the analysis of this research project. These chapters present and analyse the findings to answer the primary research question and the sub-research questions drawn from the literatures in Chapters 2 and 3. As a reminder, the questions are:

RQ: How is knowledge mobilised within and between the research, policy and practice communities for clinical practice?

> Sub-RQ 1: What are the sources, forms and ways of knowing involved in mobilising research-based knowledge in practice?
>
> Sub-RQ 2: How are knowledge systems (actors, processes, and materials) organised for mobilising knowledge?

The content for each community unfolds in three parts to answer these questions. The first part presents a largely chronological account of sepsis-focused activities in the network. The narrative introduces concepts relevant to the Soft Knowledge System sub-research questions: who the key actors are in the community and what they did. The second part shifts to analyse the data in relationship to the knowledge systems (the structural arrangement of actors, the processes, and materials). Finally, the third part draws together the key findings.

## 5.1. The Research Network: Surviving Sepsis Campaign

The chapter now turns to focus on the Surviving Sepsis Campaign and related organisations' efforts to provide sepsis definitions and guidelines for practicing clinicians. The Surviving Sepsis Campaign, while only a part of the worldwide sepsis research body, was the research body named repeatedly and by numerous study participants at Aurora General Hospital and the Sepsis Collaborative. As explained in Chapter 4, the following content was distilled from journal publications, grey literature, and organisational websites.

As noted above, this section has three parts. The first part provides an overview of the sepsis research community actors and events. The second part more explicitly analyses the knowledge systems within the research community by applying the Soft Knowledge Systems and, where possible, the Clinical Mindlines theories' lenses. The third part uses these data to answer the research questions within the research community.

### 5.1.1. Sepsis Story

Sepsis has been around for a very long time. The condition appears in Homer's works and was first given a name by Hippocrates (Funk et al., 2009). Despite centuries of awareness, the precise cause and what circumstances precede a patient's maladapted response to infection remains unknown. As recently as 1989 Bone and colleagues found it necessary to publish a piece declaring that sepsis was indeed *"a valid clinical entity"* (Bone et al., 1989, p. 389). It is only in recent decades that the biomedical and clinical research community have come together in a concerted effort to address a confusing array of sepsis definitions and recommendations.

#### *Bone's Consensus Conference*

The definition for sepsis has gone through three consensus-based iterations, Sepsis-1, Sepsis-2, and Sepsis-3. Sepsis definitions and Surviving Sepsis Campaign-related guideline developments were first spearheaded by members from two North American medical specialist societies, the Society for Critical Care Medicine (SCCM) and the American College of Chest Physicians (ACCP). They gathered together in Chicago in 1991 for the first Consensus Conference for sepsis. Chaired by Roger Bone, 35 experts seeded an alliance and began a collaborative effort that continues to this day. The 1991 Consensus Conference marked the first attempt to draw together otherwise disconnected experts with intersecting interests, many of whom were well-established academic writers in a growing body of sepsis research literature. Attendees were affiliated with a variety of prestigious medical schools, universities, and hospitals as well as a handful of pharmaceutical and device companies. Bone and colleagues produced the seminal consensus-based definitions for sepsis (eventually referred to as "Sepsis-1") as well as the first set of sepsis practice guidelines. These materials were published together in a single 12-page document (1992).

**SIRS Criteria**

| | |
|---|---|
| Temperature | >38°C or <36°C |
| Heart Rate | >90 beats/min |
| Respiratory Rate | >20 breaths/min |
| WBC Count | >12K/mm$^3$ or <4k/mm$^3$ or 10% immature band forms |

*Box 5-1 SIRS Criteria*

Bone et al.'s publication (1992) proposed a descriptive definition of sepsis based on observable clinical phenomena present in septic patients. They said that the physical manifestations were the result of Systematic Inflammatory Response Syndrome, or SIRS. SIRS was based on four criteria (see SIRS Criteria, Box 5-1). The consensus-based definition stated that when two or more SIRS criteria fell outside of normal parameters *and* there was a confirmed or suspected infection, the patient was septic. As a result, the SIRS definition itself provided four quantifiable criteria that could be used as an early warning score. Severity scores are a quantified set of variables drawn from a patient's physical measurements that predict how sick a patient is. These early alert tools (given various names, including scoring systems), are now common place in health services, but at that time were only beginning to emerge in the critical care setting. Additionally, the experts set out further definitions that identified a continuum of sepsis severity. The stages moved from a) SIRS to b) sepsis, which progressed to c) severe sepsis (signs of organ dysfunction), and on to d) septic shock (continued organ dysfunction despite treatment) (see later Summary Table of Sepsis Terms, Table 5.1).

### *The International Sepsis Forum*

The next step in the development of a sepsis-focused research network took place in 1997 with the formation of the International Sepsis Forum (ISF). The ISF was described as a "multidisciplinary organization made up of international opinion leaders in the field of sepsis" (Marshall et al., 2010, p. 276). The coalition was comprised of the Society for Critical Care Medicine (SCCM) and their European counterparts, the European Society of Intensive Care Medicine (ESICM), and involved various individuals from Bone's earlier meeting. The ISF was funded by commercial parties in order to build collaboration between industry and the academy, and "capitalise on advancements to reduce the burden of sepsis worldwide" (internationalsepsisform.com, accessed 17 March 2017).

The first task of the ISF was to review and update Bone et al.'s definitions and guidelines (Matot & Sprung, 2001). In a 2001 supplemental issue of ESICM's journal, *Intensive Care Medicine (ICM)*, the ISF authors affirmed the SIRS-based definition of sepsis. While they acknowledged that SIRS had "certain problems" (Matot & Sprung, 2001, p. S5), subsequent research had not yielded a more useful framework. Thus, the Sepsis-1 definition remained intact. The *ICM* supplement's further eight articles updated and expanded Bone et al.'s material (Sprung, Bernard & Dellinger, 2001), totalling 134 pages of content.

Until this point the tasks of determining definitions and developing guidelines were done in tandem. However, following the International Sepsis Forum's 2001 supplement, further efforts were segmented into two related but distinct work streams. One focused on definitions, whilst the other addressed guidelines. The ESICM and SCCM jointly presided over both definitions and guidelines work, with some individual actors engaged in both initiatives.

### *Further Efforts to Agree Definitions*

To date there have been two further consultations to reconsider sepsis definitions. The first was sponsored by five professional societies. In addition to the SCCM and ESICM, the American College of Chest Physicians, the American Thoracic Society, and the Surgical Infection Society joined the effort. The International Sepsis Definitions Conference met in late 2001 and observed that the SIRS definitions had been widely adopted around the world. And yet, "there was impetus from experts in the field to modify [them]" (Levy et al., 2003, p. 530). Competing editorials demonstrated a stiff difference in expert opinion. Vincent (1997) penned an article titled, *"Dear SIRS, I'm sorry to say that I don't like you*" in the SCCM's journal *Critical Care Medicine (CCM)*. Dellinger and Bone responded with a *CCM* piece of their own headed, *"To SIRS with love"* (1998). In the end, the conference attendees decided to keep the SIRS-based definitions. As a compromise they added an expanded list of diagnostic criteria (Levy et al., 2003) that was later distinguished as “Sepsis-2”. However, the lack of major revision was considered important to the Sepsis-2 authors: “The fact that no new definitions for sepsis are introduced in this conference report is noteworthy” (Levy et al., 2003, p. 537) given some actors’ considerable dissatisfaction with SIRS-related definitions (Abraham et al., 2000).

In 2016 a further Sepsis-3 Definitions Task Force markedly shifted sepsis definitions by removing all connection to SIRS criteria. Citing considerable scientific advances, the ESICM and SCCM partnership reassembled to examine the sepsis definitions. In contrast to the last gathering, the Task Force determined that SIRS had outlived its usefulness. “The Bone paradigms have served a useful purpose but are now outdated” (Singer, 2017, p. 41). The Task Force sought to uncouple the definition from visible symptoms that could be seen at the bedside (Coopersmith & Deutschman, 2017). In a 2016 *JAMA* publication, 32 worldwide specialist societies agreed to discard SIRS as the basic definition for sepsis, endorse a new definition and eliminate ‘severe sepsis’ as a part of the sepsis continuum (Singer et al., 2016). In SIRS’s place, the Sepsis-3 definition was explained as, “a life-threatening organ dysfunction caused by a dysregulated host response to infection” (Singer et al., 2016, p. 805). Relatedly, a new early warning score system replaced the SIRS criteria. Instead, the Sepsis-related Organ Failure Assessment score (SOFA), developed by the ESICM (Vincent et al., 1996; Vincent et al., 1998), was the tool they endorsed for diagnosing sepsis.

Definitions for sepsis continued to prove an unsettled topic amongst the research community (Gary et al., 2016). While Vincent, along with others, succeeded in their drive to redefine sepsis separately from SIRS (Balk, 2014; Vincent & Moreno, 2010; Vincent et al., 2013), the decision to overturn SIRS was met with a new set of critics. A range of authors pointed out that while SIRS might be imprecise, it had been implanted in practices around the world. Indeed, from their perspective, using SIRS had worked to increase awareness of and reduce deaths from sepsis. They warned of the dangers of changing the definition and related tools in the absence of urgent need

(Angus, 2016; Cortez-Puch & Hartog, 2016; Rodriguez et al., 2017; Simpson, 2016; Sprung et al., 2017).

### *Further Guidelines Efforts: Surviving Sepsis Campaign*

Meanwhile, sepsis guideline development also continued in a dedicated work stream. In 2002, the SCCM, ESICM, and International Sepsis Forum launched the Surviving Sepsis Campaign (SSC). The founders set forth specific goals in the Barcelona Declaration. The Declaration called on “health care professionals, governments, health care agencies and the public” to recognise the “urgent need” (SSC website, accessed 5 January 2018) for building awareness and providing guidance in order to reduce the burden of sepsis by 25% within 5 years (Slade et al., 2003). The Surviving Sepsis Campaign functioned as the quality improvement arm of the SCCM and ESICM with the purpose of assessing, summarising, and mobilising sepsis evidence in order to save lives (Dellinger et al., 2004; Levy et al., 2004). Under the rubric of the SSC, they produced four sets of guidelines: in 2004 (Dellinger et al., 2004); 2008 (Dellinger et al., 2008); 2012 (Dellinger et al., 2013); and most recently, in 2016 (Rhodes et al., 2017).

Soon after formation, the SSC partnered with the Institute for Healthcare Improvement (IHI). Despite the wide dissemination of earlier sepsis guidelines, use in the care setting had proven disappointing (Marshall et al., 2010). A SCCM/ESICM survey of critical care specialists suggested that sepsis remained largely unrecognised and, as a result, untreated (Poeze et al., 2004). The IHI organisation specialised in quality improvement and patient safety. They advocated for the standardisation of care through, among other quality improvement techniques, the development of care bundles. Care bundles simplified clinical practice guidelines into a set of defined tasks. Typically including three to seven steps, care bundles were promoted as a way to standardise and audit care provision, ensuring the ‘transfer of evidence’ to care delivery (Dellinger & Townsend, 2013; Damiani et al., 2015). Furthermore, IHI held that bundles were synergistic practices and all tasks must be completed within the designated time frame in order to be effective (Resar et al., 2005).

The SSC-based research knowledge network continued to grow as more specialist societies joined the collaboration. Eleven organisations participated in the 2004 set of guidelines. Sixteen organisations participated and endorsed the 2008 materials, 30 organisations joined together by 2012, and in 2016, the total specialist societies sponsoring and endorsing the guidelines expanded again to involve 36 organisations (see Appendix F, Growth of Sponsoring and Endorsing Organisations).

However, in addition to growth, the SSC's work was also marked by controversy (Finfer, 2010; Marshall et al., 2010). After the 2004 guideline publication, a string of editorials posed serious questions about the Campaign's funding by companies with commercial interest in sepsis (Landucci, 2004; Eichacker et al., 2006; Singer, 2006) and recommended use of bundles (Eichacker et al., 2006; Singer, 2006). Relatedly, the articles questioned the seemingly selective inclusion of research materials as well as the interpretation of the evidence in the creation of recommendations. For these reasons the Infectious Diseases Society of America (IDSA), a highly influential professional society, did not endorse the 2004 set of guidelines (Landucci, 2004). By 2008, IDSA was not alone. Two prior collaborators withdrew their endorsement for the 2008 materials (the American Thoracic Society and Australian and New Zealand Intensive Care Society). While "strongly" supporting SSC intentions, the Australian and New Zealand Intensive Care Society "reluctantly" questioned SSC's interpretation of evidence (Hicks et al., 2008).

A particular area of concern for these actors was a new medication created by a pharmaceutical company that funded the SSC. The medication was costly and had, in their view, a weak evidence base to support the strong recommendation it was given in the guidelines. "Clearly, 'Best Evidence' is a dynamic construct and some of the less well supported 2008 Guidelines may become acceptable" (Hicks et al., 2008, p. 149). It later became clear that these organisations' cautions were well-founded. The medication, a lingering flash point of criticism, was rescinded from the market due to dangers of excessive bleeding.

In response to these and other robust criticisms, the International Sepsis Forum formally withdrew as a SSC collaborator (Marshall et al., 2010). A founding member of the SSC, they departed in 2008 “to avoid any misconceptions about industry involvement” (survivingsepsis.org website, accessed 10 March 2017).

More recently, a further dispute has centred on the time allocation given for bundle completion, with particular concern about the timing of antibiotic administration. The sepsis bundles have been revised with each new set of guidelines. Initially there were two bundles, a 6-hour resuscitation bundle and a 24-hour management bundle (Dellinger et al., 2008). In 2016, the time to complete the bundle was reduced to 1 hour. The time frame known as the “golden hour” (Kumar et al., 2006, p. 1594) for sepsis care was introduced in a research publication by Kumar and colleagues (2006). Their work showed a stepwise decrease in survival by 7.6% for each hour an antibiotic was delayed (see Figure 5-1, Kumar graph). The golden hour was a part of prior guidelines, but had not been incorporated into the bundles.

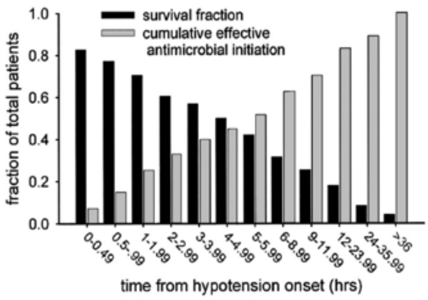


Figure 1. Cumulative effective antimicrobial initiation following onset of septic shock-associated hypotension and associated survival. The x-axis represents time (hrs) following first documentation of septic shock-associated hypotension. *Black bars* represent the fraction of patients surviving to hospital discharge for effective therapy initiated within the given time interval. The *gray bars* represent the cumulative fraction of patients having received effective antimicrobials at any given time point.

*Figure 5-1 Kumar graph, from Kumar et al. (2006) p.1592*

Subsequent attempts to replicate Kumar’s work have not shown the same relationship between antibiotic administration and survival. Nor have they produced the symmetrical, linear graph (Puskarich et al., 2011; Sterling et al., 2015). Yet the most recent update to the SSC bundle reduced the time to complete the tasks to one hour (Levy et al., 2018). Masur, the chief of Critical Care Medicine for the US National Institutes of Health and named author on earlier SSC guidelines, co-wrote a Position Statement on behalf of IDSA (2017) saying that the 1-hour time scale for antibiotic administration was a prime reason that IDSA did not support the 2016 SSC guidelines. IDSA has been accompanied by a vocal opposition made up of a subset of the US medical community (see https://emcrit.org/pulmcrit/ssc-petition and https://first10em.com/petition-to-retire-the-surviving-sepsis-campaign-guidelines). As a result, various standard-setting bodies have delayed the incorporation of the new bundle. The SCCM has responded. They posted a statement on their website saying:

> The Society of Critical Care Medicine (SCCM) and the American College of Emergency Physicians (ACEP) acknowledge concerns expressed about the recently released Surviving Sepsis Campaign (SSC) Hour-1 bundle and the appropriateness of implementation in the United States. Both organizations understand the importance of prompt and optimal sepsis diagnostics and treatment. SCCM and ACEP along with other involved international experts are organizing a meeting as soon as possible to carefully review the recommendations, and provide guidance on bundle implementation and care of potentially septic patients who present to emergency departments in the United States. We recommend that hospitals not implement the Hour-1 bundle in its present form in the United States at this time. (survivingsepsis.org, accessed 28 December 2018)

In sum, the story of the Surviving Sepsis Campaign research community thus far can be characterised by both continuity as well as growth. From an early collaboration between two North American professional societies, the most recent set of guidelines names 36 organisations. These organisations represent countries from every inhabited continent on the globe. In addition to mobilising across geographic boundaries, the SSC also addressed professional divides. Nurse and microbiologist professional societies joined the medical groups beginning in 2004. In 2016, a patient representative was added to the guidelines committee.

Meanwhile, there has been a stability of membership. Three faculty that took part in Bone’s 1991 meeting, Dellinger, Marshall, and Sprung, remain active authors today. Further collaborators (Angus, Bernard, Gerlach, Levy, and Vincent) joined the SSC work soon after and are signatories on the most recent guideline documents. Furthermore, this continuity of individual actors represents the partnership between key collective actors, namely the Society for Critical Care Medicine and the European

Society for Intensive Care Medicine. The SCCM and ESICM societies provide the leadership and (latterly) the funding for the Surviving Sepsis Campaign.

The SSC has endeavoured to knit together a diverse array of specialist knowledge. Marshall (1997a) observed that sepsis-related research appeared in at least 43 separate journals, covering seven distinct disciplines. The incorporation of many related disciplines is partly indicated by the growing amount of sepsis research content included. Where Bone and colleagues cited 45 references contributing to their work in 1992, by 2016 the SSC guideline committee listed 655 relevant articles, which did not include further digital content.

Nevertheless, it is also apparent that partnering with a full range of interested parties has been laden with challenges. The SSC's affiliation with industry brought censure. Some viewed the SSC's materials as tainted by the connection. Despite the SSC's efforts to untangle the network and separate from their commercial partners, a residue of doubt remains due to their prior association. How the SSC addressed these (and other) concerns provides clues as to ways they have overcome the boundaries that have stood in the way of developing and sharing their knowledge.

Thus far, this section has identified key research community actors and provided an overview of key events that brought them together from different geographic, disciplinary and professional bodies. The chapter now turns to further analyse the SSC community's knowledge systems by looking at their organising processes and the materials they used to forge consensus and the knowledge they drew upon along the way. It then addresses how the SSC mobilised to share their knowledge with other communities.

### 5.1.2. Understanding Knowledge Systems

This section provides further analysis of the research knowledge network content with a more explicit use of Soft Knowledge Systems to focus on three parts of the knowledge system: 1) how the actors organised; 2) the processes; and 3) the materials they used to accomplish their shared task. Additionally, where possible in the data, the section draws out the various kinds of knowledge involved in the mobilisation process and shows the Clinical and Collective Mindlines of the actors in the network.

*Bone 1992*

Bone and colleagues' (1992) Consensus Conference document provided a limited account of how the attendees organised. They did point out that this was the first time their professional organisations had assembled to coordinate a sepsis effort. Only one face-to-face meeting was mentioned; however, the document did note the positions of a "Conference Chairman" (Bone) and seven "Session Chairmen". The remaining 27 attendees were listed as "Faculty". And while their specific tasks are not explained, the segmentation suggests the eight chairmen held additional organising responsibilities and, importantly, they comprised the named authors on the joint 1992 publication. The article appeared simultaneously in both the sponsoring organisations' (American College of Chest Physicians and the Society for Critical Care Medicine) journals (*Chest* and *Critical Care Medicine*, respectively).

The Chicago meeting brought together not just distinct professional societies, but actors from different locales, roles, and a wide range of specialisations. The list of attendees showed that they came from geographically dispersed areas across North America. Titles revealed they were a combination of medical school administrators, researchers, practicing clinicians, and six attendees were employed by industry (e.g. Genelabs Technologies Inc. and Roerig/Pfizer Pharmaceuticals). Their areas of specialist knowledge were also wide ranging, including pharmacy, surgery, medicine, infectious diseases, and emergency medicine, as well as pulmonary, respiratory and critical care. A considerable diversity of knowledge domains were represented. By contrast, there was little professional (or gender) diversity. Nearly all present held M.D. degrees. The two deviations were from pharmaceutical companies and held a Pharm.D. and a Ph.D.

Overall, the makeup of the research knowledge network displayed a diverse array of epistemic backgrounds from a range of locations. Normally separate actors were brought together. The processes for accomplishing their tasks and building the consensus-based content was not disclosed. However, there are clues that the makeup of the committee influenced the materials' content. As mentioned earlier, quantifiable scoring systems had only just entered the health arena (Bouch & Thompson, 2008). The first scoring system was created by W.A. Knaus to rapidly predict the severity of illness (the APACHE score). Knaus was one of the seven Session Chairmen. The 1992 publication advocated for the use of quantified measures (i.e. a scoring system) to identify patients at risk for sepsis, at least potentially because Knaus was involved in the materials production.

The purpose of the materials was two-fold. Firstly, to provide an expert-approved set of recommendations for practicing clinicians. *"We expect that the broad definitions proposed in this report will improve our ability to make early bedside detection of the disease possible"* (Bone et al., 1992, p. 1644). The second intent was to assist the sepsis research community. Bone et al. (1992) said that the growing research field was fragmented and the lack of agreed terms was *"an additional source of confusion…To eliminate confusion in communication…by standardizing terms…*[allowed for] *the ability to compare protocols and evaluate therapeutic interventions"* (p. 1645). Thus, the newly developed materials were envisioned to meet the needs of both practitioners and researchers.

Indeed, Bone and colleagues called for alignment in what they saw as a symbiotic relationship between the research and practice. The authors drew a direct relationship between research and practice outcomes. *"An improved understanding of these mechanisms will lead to improved therapeutic management…This issue of different terminology, if it is not soon addressed, could potentially hinder future advances in the treatment of this syndrome"* (Bone et al., 1992, p. 1646-8). Earlier bedside detection of sepsis would in turn inform research work. Each community informed the work of the other. The research and practice communities needed to work interdependently in order to bring knowing and their respective practices together.

Intertwined within this view of shared responsibility between actors were mixed views of knowledge as well as how knowledge is shared. Until the end, the document focused exclusively on explicit sources of information: definitions, scoring systems, and recommendations. Numerous times in the document, Bone et al. stated that with the alignment of information, the necessary knowledge could be harnessed, which would in turn result in progress for patients, clinicians, and researchers. Relatedly, with the publication came the expectation that the dissemination of information would both reach and be applied by the practice community. And yet, the last paragraphs of the article conveyed that they did not think information transfer alone was sufficient for improvement. In order to apply their recommendations properly, they proposed "the placement of physicians with expertise in the diagnoses…to guide…These physicians should be readily available…on-site expertise is preferable" (p. 1653). Bone and colleagues thought that to better mobilise specialist knowledge, direct interaction and expert guidance would help.

The 1991 meeting and resulting article (1992) have had a profound influence on subsequent sepsis initiatives. Their work established the starting point. Meeting participants such as R. Phillip Dellinger, John C. Marshall, and Charles L. Sprung led collaborative work for decades to come.

### *International Sepsis Forum 1997*

The International Sepsis Forum was an important collective actor in the sepsis knowledge network because the organisation marked a key intersection between Bone's consensus conference and future Surviving Sepsis Campaign work. Of the 17 *"international experts and opinion leaders"* (Sprung et al., 2001, p. S1) listed as ISF sepsis guideline authors, four participated in Bone's 1991 gathering (Bernard, Dellinger, Marshall, and Sprung). And along with a further five (Abraham, Cohen, Calandra, Carlet, and Vincent, refer to Appendix E), 9 of 17 ISF actors continued to collaborate in further endeavours. Indeed, Marshall et al. (2010) made clear that the Forum provided the foundation for the Surviving Sepsis Campaign.

In addition to functioning as a linking organisation, the ISF also marked a geographical branching out of the research knowledge network. The ISF expanded beyond North America to include researchers and practitioners in Europe. Dellinger and Bone (1998) viewed the spread as useful for propelling sepsis work forward. They said "The rapid transition to global, as opposed to national, collaborative efforts will facilitate success of future consensus projects" (p. 179). They considered more actors in the knowledge network as an asset.

And yet at the same time the ISF-based research network appeared to contract in terms of the specialisations involved. The ISF described their membership as *"healthcare professionals in critical care and infectious disease committed to improving the understanding and clinical management of patients with severe sepsis"* (Sprung et al., 2001, p. S1). The stated specialisations narrowed to encompass only critical care and infectious diseases. There were fewer authors involved in the *ICM* supplement. The ISF publications listed 17 names as compared to Bone's earlier total of 35 participants.

Nevertheless, the ISF explicitly stated they were continuing and updating Bone and colleagues' work by revisiting the sepsis definitions and developing a set of detailed consensus-based guidelines. Two sources (Sprung et al., 2001; Marshall et al., 2010) described how the ISF organised their system processes and tools in fuller detail than Bone et al. had. The ISF's organising system is particularly important as it established the committee structures and processes used for product development in subsequent work by the Surviving Sepsis Campaign over the following decades.

As explained in the supplement's introduction (Sprung et al., 2001), the ISF established a Steering Committee. These members (Sprung, Bernard and Dellinger) provided oversight and final edits on the definitions and guidelines publications. Nine subgroups were formed each focusing on a specific area (e.g. Definitions, Hemodynamics or Infection), led by one or two senior experts (Marshall et al., 2010). Each subgroup conducted a systematic literature review of their clinical remit using Sackett's (1989) levels of evidence. They summarised the data into recommendations, and then presented drafts at a full committee meeting for discussion. Based on the feedback they received, the subgroups made edits to their respective documents. Another ISF member reviewed the revised materials before a final appraisal by one of the Steering Committee members.

The description provides a window into what were regular interactions between network members. Sprung et al. (2001) referred to it as “a sustained effort” (p. S1). The group met over the course of years, gathering together for at least four face-to-face meetings. How the group reached consensus was not disclosed, but they said that *“the recommendations represent the groups [sic] assessment of the evidence-based medicine literature together with clinical practice and personal experience”* (Sprung et al., 2001, p. S1). The authors acknowledged that for devising and using the information other forms of knowledge were required. Judgement, based on clinical experience, played a role. However, this broader view of knowledge was qualified. They went on to explain that it was because some clinical areas lacked RCT studies, they (and practitioners) needed to “use their judgement in interpreting these recommendations” (Sprung et al., 2001, p. S2).

Finally, this network engaged in research activities explicitly in order to reach the practice community. *“We believe this supplement will be an extremely helpful source of practical information for the clinician”* (Sprung et al., 2001, p. S2). The ISF conducted workshops and lecture series to promote these evidence based practices. And yet for all the contributions the ISF made to the broader sepsis knowledge systems, the involvement of industry funding increasingly attracted heavy criticism (Marshall et al., 2010).

### *Further Definitions Committees*

The Sepsis-2 Definitions Conference included 29 participants representing five professional organisations. The two conference co-chairs represented SCCM (Levy) and ESICM (Ramsay). Following the ISF process, they formed subgroups to focus on a particular clinical area (Levy et al., 2003). Subgroups “corresponded electronically” (p. 531) before the entire committee came together in person. At the conference, a subgroup spokesperson reported their groups' deliberations to the full committee. A dedicated writing committee collated materials and feedback, which they shared with the group. Further materials and subsequent revisions were made "via telephone conferences, email, and live discussions" (Levy et al., 2003, p. 531).

The process by which committee members made joint decisions was not reported. However, the final report makes evident that there was "considerable debate" (Levy et al., 2003, p. 536). The group had convened with the belief that a new definition might be warranted. In the end, it was the consensus of the group that the needs of the bedside clinician for a stable SIRS-based definition outweighed the challenges it presented to clinical trials researchers. The ESICM (in their journal, *ICM*) and SCCM (in *CCM*) jointly published the conference materials.

The Sepsis-3 Definitions Task Force was convened by the ESICM and SCCM. They said that the definitions for sepsis had been in place for decades and Bone et al.'s work needed re-examination. The organisations once again each nominated a co-chair who jointly led the effort (Shankar-Hari et al., 2016). Singer (for ESICM) and Deutschman (for SCCM) selected a further 17 members for the task force based on their expertise in "sepsis pathobiology, clinical trials, and epidemiology" (Singer et al., 2016, p. 801). Thus, inclusion was based on group affiliation and specialist knowledge.

Once the process of selecting actors was completed, their processes were dedicated to materials production. The task force set about reviewing the literature and engaging in a consensus-building procedure to generate updated materials. Shankar-Hari et al. (2016) reported that the team conducted a "systematic review and meta-analysis" (p. 775) to populate content for a Delphi process.

The Delphi method elicited and combined the judgements of task force members. The "Delphi is a multiple iteration survey technique that enables anonymous systematic refinements of expert opinion with the aim of arriving at a combined or consensual position" (Bowles, 1999, p. 32). The method was deemed useful as a way to negotiate agreement amongst the task force in the face of their diverging views. There were three rounds of surveys with accompanying written discussion and “questionnaire items were accepted if agreement exceeded 65%” (Shankar-Hari et al., 2016, p. 776). The task force said that they desired consensus but realised that complete agreement was unlikely. “Pragmatic compromises were necessary” (Singer et al., 2016, p. 807).

Indeed, one long-standing member of the sepsis research community (and signatory on the final Sepsis-3 definitions document), spoke directly to the difficult negotiations. Angus (2016) said that there was “vigorous debate; opinions were not unanimous, and the subsequent reaction of the broader community reflects many of the same points of contention” (p. 14). In order to move forward, he said “intentional compromise” (p. 15) was necessary and all parties needed to “stop claiming sepsis is currently ‘knowable’” (p. 15).

Further to the three Delphi surveys and additional email correspondence, the group met together face-to-face four times in a one-year span. The resulting materials, with wholly new definitions and scoring systems, were then circulated to relevant international professional societies for peer review and endorsement. Thirty-two organisations from across the world supported the work (see Appendix G).

However, some societies declined to endorse the Sepsis-3 definition, including the American College of Chest Physicians, an original organising member for the two prior definitions (Bone et al., 1992; Levy et al., 2003), the Infectious Disease Society of America, and the American College of Emergency Physicians. Publication titles illuminated the disagreement: “New sepsis criteria. A change we should not make” (Simpson, 2016); “To SIRS with love—An open letter” (Sprung et al., 2017); and “New definition of sepsis and septic shock: What does it give us?” (Rodriguez et al., 2017). Harris (2017) pointed out that “not only did the Sepsis-3 taskforce continue the [Bone et al.] 1991 tradition of combining expert opinion with empirical data but also the wider critical care community has immediately responded with an empiric evaluation” (p. 848).

### *Guideline Committees of the Surviving Sepsis Campaign*

The SSC Guideline Committees for 2004, 2008, 2012, and 2016 largely followed the International Sepsis Forum's familiar pattern of organising. They appointed two co-chairs drawn from ESICM and SCCM, assembled the committee's members, divided into subgroups based on clinical domain and selected a Steering Committee. Each subgroup met, gathered recently published materials, assessed the quality of evidence, agreed on updated recommendations, and reported their work to the full committee. After several iterations and once sufficient agreement between members had been obtained, they consolidated the materials for publication. As a further indicator of their collective effort, the final sets of guideline materials were published in both the ESICM and SCCM's respective journals.

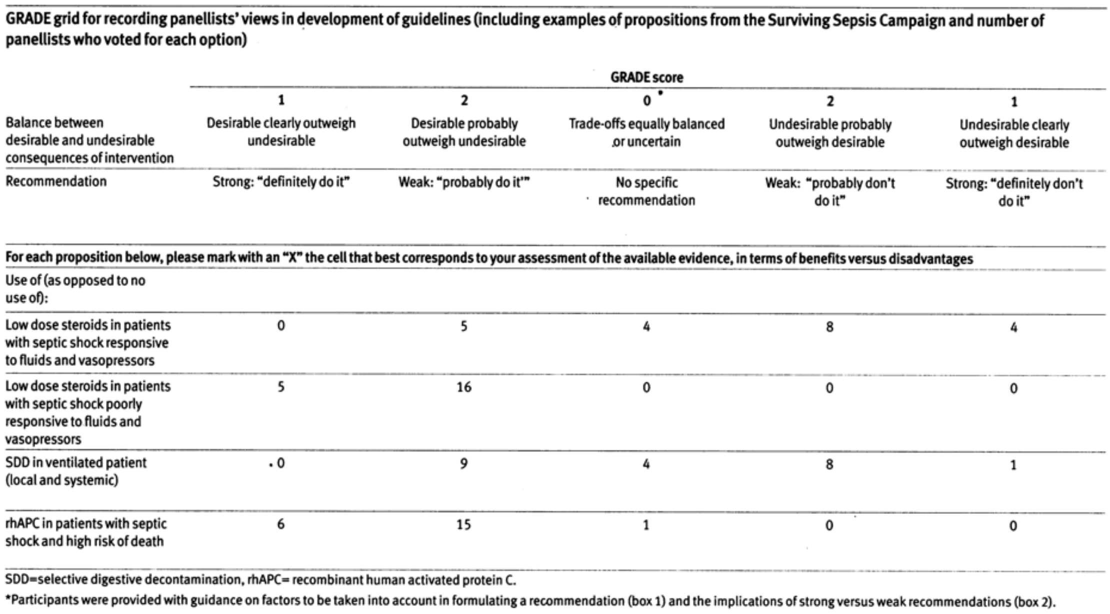
The process of assessing research content evolved over time. Sprung et al. (2001) merely stated that they used Sackett's (1989) "evidence-based methodology" (p. S1). For the 2004 edition, the SSC provided a further explanation saying they used Sackett's material to guide the development of a "modified Delphi methodology" for grading recommendations (2004, p. 858). After receiving extensive of criticism (Eichacker, 2006; Landucci, 2004; Singer, 2006), a new, more in-depth process was developed for the 2008 set of guidelines in conjunction with evidence-based methodology experts from McMaster University (Guyatt et al., 2008a; Guyatt et al., 2008b).

A separate paper provided an account of the SSC's updated process for reaching decisions "when consensus is elusive" (Jaeschke et al., 2008, p. 327). They developed and used a method called Grading of Recommendations Assessment, Development and Evaluation or GRADE. Jaeschke et al. (2008) reflected that guideline committees had grown in size responding to the need of bringing a diverse array of expert views into the process:

> The resulting large and diverse panels present challenges for decision making, such as ensuring that all participants have a voice and can influence the results of the debate, ensuring transparency, dealing with disagreement, achieving consensus, and resolving situations in which consensus is not possible (p. 327).

And without a formal decision-making process, they said, group interactions could be dominated “by individuals with powerful personalities and intimidating reputations” (Jaeschke et al., 2008, p. 327).

Hence, the SSC developed the GRADE grid (see Figure 5-2) as a method to provide a structural process to address these challenges. They used the grid in conjunction with a Delphi survey. They explained that the Delphi method provided a way to independently gather views. An anonymised summary of survey results was circulated that included the rationales provided by each respondent for their choices. Another round of the survey was sent and each participant was asked to respond taking into consideration the reasoning provided by their (unknown) expert colleagues. Eventually, they said, the responses generally converged to a view that the group could support.



**GRADE grid for recording panellists’ views in development of guidelines (including examples of propositions from the Surviving Sepsis Campaign and number of panellists who voted for each option)**

| | GRADE score | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 0* | 2 | 1 |
| Balance between desirable and undesirable consequences of intervention | Desirable clearly outweigh undesirable | Desirable probably outweigh undesirable | Trade-offs equally balanced or uncertain | Undesirable probably outweigh desirable | Undesirable clearly outweigh desirable |
| Recommendation | Strong: “definitely do it” | Weak: “probably do it’” | No specific recommendation | Weak: “probably don’t do it” | Strong: “definitely don’t do it” |
| **For each proposition below, please mark with an “X” the cell that best corresponds to your assessment of the available evidence, in terms of benefits versus disadvantages** | | | | | |
| Use of (as opposed to no use of): | | | | | |
| Low dose steroids in patients with septic shock responsive to fluids and vasopressors | 0 | 5 | 4 | 8 | 4 |
| Low dose steroids in patients with septic shock poorly responsive to fluids and vasopressors | 5 | 16 | 0 | 0 | 0 |
| SDD in ventilated patient (local and systemic) | 0 | 9 | 4 | 8 | 1 |
| rhAPC in patients with septic shock and high risk of death | 6 | 15 | 1 | 0 | 0 |

SDD=selective digestive decontamination, rhAPC= recombinant human activated protein C.

*Participants were provided with guidance on factors to be taken into account in formulating a recommendation (box 1) and the implications of strong versus weak recommendations (box 2).

*Figure 5-2 GRADE Grid, Jaeschke et al. (2008) p. 328*

The second group process Jaeschke et al. (2008) described was the nominal group technique. The nominal group technique was used during face-to-face meetings and provided all members the “equal opportunity to speak” (p. 328) allowing for the expression of different views. To build consensus, a summary of divergent positions was drafted. Attendees privately ranked their choices in order of most to least acceptable. For both the Delphi and nominal group methods, the process continued until agreement was reached or responses did not change.

The acceptable threshold for consensus changed over time as well. In 2004, Dellinger et al. said that the committee's goal was "total consensus" (p. 860). By 2008, 80% agreement was sufficient where at least half of the committee voted. The level of agreement was not recorded in the 2012 materials other than to say that "strong agreement existed among a large cohort of international experts" (Dellinger et al., 2012, p. 167). The statement in the 2016 materials reported "substantial agreement" (Rhodes et al., 2017, p. 488) with an 80% threshold out of at least three-quarters of members voting.

The SSC put in place a formal and permanent knowledge network for professional societies with intersecting interests in sepsis. The first consensus conference chaired by Bone was an ad hoc event. But the SCCM and the American College of Chest Physicians did not put a plan in place for continuing their collaboration and updating the materials. Next, the International Sepsis Forum continued the work by bringing together various academic and industry actors for collaboration, but related professional bodies were not (officially at least) a part. Thus, the SSC took what had been a periodic partnership and established a sustained collaborative effort that focused on the revision, production, dissemination and use of sepsis guideline materials.

Bundles were an important materials-based part of the knowledge system, firstly because they demonstrate the influence of IHI as an actor in the knowledge network. For sepsis, bundles were a by-product of the collaborative effort between the clinical experts within the professional organisations (SCCM and ESICM) and IHI (Dellinger et al., 2004, 2008). Illustrating the combination of expertise necessary for creating ways to change clinical behaviour, authors from SCCM, ESICM and IHI published a piece in SCCM's specialist journal entitled "Sepsis change bundles: converting guidelines into meaningful change in behavior and clinical outcome" (Levy et al., 2004).

Secondly, bundles were also a point of contention. Singer (2006) questioned the validity of bundles and said that the SSC was “in cahoots” with IHI. Marik et al. (2013) also disagreed with the bundle concept. Marik et al. (2013) found the lack of flexibility in bundle compliance “alarming” (p. 375). Amongst other concerns “there is no scientific data to support [the all-or-nothing] notion” (p. 375) and was potentially dangerous if applied as directed to every patient. He pointed to the SSC’s prior error in strongly recommending a medication that lacked sufficient scientific proof. Dellinger and Townsend (2013) defended bundles. They said that bundles minimised the unacceptable variance of care provided to patients and helped clinicians provide evidence-based care. The belief was that converting guidelines into a distilled set of actions would remedy the long and “tortuous process…of transfer[ing] research from the bench to the bedside” (Levy et al., 2004, p. S595). Indeed, bundles have been held up as the tool that simplifies the complex problem of shifting research into practice. Thus, bundles have provided a simplified and reductionist version of knowledge.

Despite the lack of evidence for bundles, Resear and colleagues, in their 2012 IHI White Paper, reason that it is the coordination and communication required amongst the healthcare team to accomplish the bundle, rather than the clinical intervention itself, that has brought about the improvement results. If this is the case, it means that rather than a biomedical solution, the bundles have provided an impetus for team collaboration. Bundle implementation requires the coordinated efforts of medical, nursing, and laboratory staff at minimum. They must work interdependently to accomplish the tasks for a mutual target. Rather than the clinical intervention or evidence for sepsis, it is the increased social interaction of the team that benefits the patient.

Finally, some point out that the continuous shift to simplified, protocol-ised care (in these step-wise guides such as bundles) inhibits the development of clinical judgement (Engebretsen et al., 2016). Determined nevertheless, SSC and IHI offer continued assurances for the value of bundles-based care. Despite the lack of supporting evidence, the recent 2016 guideline committee states that “the implementation of a core set of recommendations ("bundle") has been the cornerstone of sepsis performance improvement" (Rhodes et al., 2017, p. 493).

Regardless of periodic strife, the Surviving Sepsis Campaign successfully mobilised their knowledge. They reached beyond the bounds of their research community, informing and influencing the policy and practice domains.

### 5.1.3. Mobilising Knowledge in the Research Network

This section brings together themes that emerged from using Soft Knowledge Systems and Clinical Mindlines across these data. Specifically, this section identifies the social and epistemic boundaries within the research community's knowledge systems and answers how these boundaries were addressed.

The story of the SSC research knowledge network presents a series of familiar names. These include Bone, Dellinger, Levy, Marshall, and Vincent. There were dedicated individual and collective actors in this community as they banded together within the SCCM and ESICM organisations. They worked to build a coordinated effort to address problems around sepsis care rather than rely on a separate and thereby disjointed transmission of information to make a difference.

These actors provided vision, took the initiative, coordinated and consolidated their efforts. They organised regular meetings to mitigate geographic separations and eventually included experts from every continent. In between meetings, they utilised other channels to support ongoing communication. They were active rather than passive collaborators. They arranged actors, set up processes, and produced materials. They developed a knowledge system.

Individual and collective actors were both important in the knowledge system. One example is highlighted in a memorial dedication to Roger Bone. John Marshall (1997b) wrote that Bone was *"a visionary"* whose *"ideas transformed clinical research in sepsis"* (p. 9) as a researcher and organising leader of the research community. *"He led a revolution…He was a prolific and articulate writer, a passionate and demanding thinker, whose ideas were at once profound, unsettling, urgent, and courageous"* (p.

9). Roger Bone provided influential and instrumental leadership that reverberated within the literature of the sepsis research community. Other individuals, such as RP Dellinger, M Levy, J Marshall, J-L Vincent, among others, took up the baton. They led further sepsis guideline committees and publications in 2004, 2008, 2012 and 2016, and their names continue to appear on sepsis-related publications today.

However, these individual actors were accorded a wider platform for sharing their knowledge via the structures of their collective actor organisations. The SSCM and ESICM, in their joint work under the SSC umbrella, provided specialist organisation legitimacy to the Campaign. One indicator of the level of collaboration between the two societies is the joint SSC publication strategy. Since 2004, guidelines along with guideline-related publications are in each society's journal with a notification saying, "This article is being simultaneously published in *Critical Care Medicine* and *Intensive Care Medicine*."

The influence of individuals upon collective materials can be seen as well. For example, the influence of individual actors' knowledge on the collective SSC materials could be seen with Knaus and the inclusion of early scoring systems for sepsis in 1992. The eventual change to Sepsis-3 definition can at least in part be attributed to Vincent's creation of the SOFA tool (credited in some materials to the ESICM, of which he was president). And Kumar, the leader of the SSC Guidelines Antibiotics subgroup, kept the 'golden hour' of antibiotic delivery in the 2016 materials despite the lack of further replication studies. The individual actors involved in the knowledge network influenced the collective actors' knowledge (i.e. collective mindline) as represented in the knowledge outputs.

The SSC membership also had a continuity of actors. The named authors on definition and guideline documents covering nearly 30 years indicate a long-term commitment by many. There is a repetition of names and many actors were involved in both the Definitions Taskforce and International Guidelines Committee (as both groups are populated from members of the SCCM and ESICM) (see Appendix E for Table of SSC Actors).

One example is the 2001 Definitions Conference membership (the meeting that resulted in the Sepsis-2 definition, see Levy et al., 2003). Of 27 conference participants, 20 had either participated in Bone's original meeting, were members of the International Sepsis Forum, were members of future Surviving Sepsis Campaign committees, or all three. The overlap was substantial. However, based on the same documentary sources, the SSC was not a closed group. Each publication involved new people, some of whom went on to provide continuity at future meetings and in future publications. The SSC, as a knowledge network, was inclusive, invited wide involvement and grew from a collaboration between two organisations to, most recently, 36 organisations (see Appendix F for Growth of Sponsoring and Endorsing Organisations for SSC Guidelines).

And yet, the SSC's inclusiveness was, at times, problematic. The presence of pharmaceutical companies in the knowledge network raised concerns. Many feared that pharmaceutical funding and representation influenced the experts' judgement and thereby their recommendations. The 2008 guidelines presented an illustration of actor involvement that at the minimum appeared to shape knowledge. Eli Lily had, at that point, funded up to 90% of SSC's activities in the form of an unrestricted grant. The SSC's strong recommendation for their new medication came despite it having only one, single-centre trial to support its effectiveness. That trial was paid for by Eli Lily as part of the original proof of efficacy necessary for regulatory approval. This scenario illustrates the relationship between actors, their connections in a knowledge network, that in turn influence how they collectively think as seen in the materials they produce.

This controversy suggests that some within the wider SSC research community believed that connection to the pharmaceutical industry (and its financial support) influenced behaviour. Eichacker et al.'s (2006) concern was that biases formed as a result of working together. By collaborating with commercial members, the resulting relationships would influence the experts' interpretation of the evidence and resulting guidelines. The concern was an indicator that they believed the social milieu, the professional relationships, influenced the evidence product. The basis of these accusations was that partnering with commercial actors, thus including members in the knowledge network who had competing and ulterior goals, influenced the collective knowledge such that the evidence assessment process and the resulting materials were tainted.

Connecting via regular meetings and other forms of contact were part of sustaining the relationships within the network. And the SSC, as individuals and organisations, connected often. A sampling of face to face meetings mentioned in the publications includes Chicago (in 1991), Paris (in 1997), Brussels (in 2000), Barcelona (in 2002), Amsterdam (in 2003), London (in 2003), Berlin (in 2011), Puerto Rico (2013), Honolulu (2017). Smaller groups met together in subcommittee meetings. The SSC literature mentions “teleconferences”, and by the 2004 guideline document there were regular “electronic-based discussions” (Dellinger et al., 2004, p. 858) that took place amongst small subsets as well as the full committee.

The mix of meetings, phone calls, and email addressed the geographical barriers that separated the actors. Furthermore, the ongoing contact developed long-standing partnerships and professional friendships. Dellinger (2015) acknowledged his gratitude for their shared work saying:

> I thank Mitchell Levy, MD, Sean Townsend, MD, and Christa Schorr, RN, MSN, for their input on this Foreword, but even more importantly for the incredible journey we have shared together, along with our European SSC leadership colleagues, over the last 11 years with the Surviving Sepsis Campaign (Dellinger, 2015b, p. 1789).

Similarly, Marshall et al. (2010) credited the SSC’s success to “the remarkable dedication of a diverse international group of practitioners to engaging in such a process of change” (Marshall et al., 2010, p. 279).

To coordinate the diverse international specialists’ knowledge required developing and executing a plan to address the geographic and epistemic boundaries. Prior to the first meeting between SCCM and the American College of Chest Physicians in 1991, actors were working and producing materials for sepsis but they were not coordinating their work or considering the ways their work might affect each other. In this way, their dispersed knowledge equated to knowledge in disarray. It took an organising initiative to meet together and address the fragmentation hampering both research and practice activities.

The SSC put in place knowledge systems for overcoming boundaries. The leadership structure, subcommittees, evidence assessment processes, consensus building processes, materials production and continuous communication depict many forms of structural engagement. The guideline endorsement process also works to address epistemic boundaries. The SSC asked colleague organisations to provide peer review, feedback, and, if appropriate, join the consortium for mobilising the support and promotion of the materials. Conversely, the organisations that, at varying points, decided that they could not endorse the publications' content, underscored a boundary issue as well. Infectious Diseases Society of America (IDSA), for example, rejected the involvement of industry stakeholders in the guideline body in 2008. IDSA observed a misalignment of goals between industry and the other stakeholders represented in the guidelines. It was IDSA's view that the knowledge-based recommendations inappropriately represented their epistemic position and declined to add the organisation's name to the list of sponsors.

Indeed, these processes involved "considerable debate" (Levy, et al., 2003, p. 536) and "passionate disagreement" (Marshall, et al., 2010, p. 276). Marshall and colleagues (2010) describe the SSC community this way: "The story of its [SSC's] origins, successes, and failures bears a resemblance to a work of classic theatre—part comedy, part high drama, both set against a backdrop of tragedy—the continuing toll of deaths from one of the leading causes of preventable death around the globe" (p. 276). The SSC knowledge system included the full gamut of human engagement.

A primary goal of the SSC organisation was to build consensus between actors who held a wide range of specialist expertise to produce knowledge-based materials for dissemination. Singer et al. (2016) said that the GRADE and nominal group processes involved “iterative discussions” to reach “expert consensus” (p. 802). Angus was blunter: “The [Sepsis Definitions] task force reached its recommendations after vigorous debate; opinions were not unanimous, and the subsequent reaction in the broader community reflects many of the same points of contention. Debate is welcomed, but one disconnect is the certainty with which some views have been expressed, despite the widely acknowledged uncertainties plaguing sepsis” (Angus, 2016, p. 14). In other words, gathering expert actors’ opinions happened within the messy muddle of human interactions.

The SSC discussed, listened, debated and negotiated internally, but there are many signs that they also responded to external critiques. The International Sepsis Forum, an academic and business partnership, withdrew from the SSC alliance. The SSC funding shifted to a separate, non-industry related, source. They increased transparency of funding structures in their publications. They brought in the GRADE methodology to address concerns about evidence assessment. They may even have sought out their critics. For example, Singer published an article in 2006 entitled “The Surviving Sepsis guidelines: evidence-based…or evidence-biased?”. The piece spoke of “dodgy advice” (Singer, 2006, p. 244) and pointed to the lack of evidence to support bundles. Because, he said, the SSC was “in cahoots with the Institute for Healthcare Improvement” (Singer, 2006, p. 245). A decade later, Singer took part in the guideline development (Dellinger et al., 2017) and was the co-chair and lead author for the Sepsis-3 (newest) definition publication (Singer et al., 2016). Given that bundles are still a part of the SSC guidelines, and Singer went from critic in 2006 to co-chairing a publication a decade later in 2016, his stance appears to have shifted. Lastly, the SCCM responded to concerns and placed a moratorium on their recommendation for the implementation of the 1-hour bundle in the US context.

The development of evidence-based guidelines is an interactional process and includes difficult social exchanges. Indeed, Marshall, Dellinger, and Levy pointed out that disagreement and conflict bring value to the evidence sifting process**.** “Such controversy is not only inevitable, but invaluable to a process that reflects the continuing evolution of knowledge and the attempt to apply that knowledge optimally to patient care" (Marshall et al., 2010, p. 279). Tensions are part of the social interactions that accompany the production and dissemination of evidence for sepsis.

Many diverse areas of knowledge were necessary. Sepsis as a clinical entity involves many diverse specialisations including "basic scientists whose backgrounds include immunology, cell biology, microbiology and biological chemistry, and…clinicians whose expertise ranges from surgery to pulmonology to intensive care medicine to infectious diseases (Marshall, 1997b, p. 5). Because many actors' knowledge is important, the study of sepsis suffers from fragmentation as a result of complexity surrounding the disease.

Angus et al. (2016) agreed.

> One's values and priorities shape in important ways how one judges the performance of a particular classification scheme. Broadly speaking, a disease or syndrome classification scheme helps four purposes: clinical care, basic and clinical research, epidemiology and surveillance, and quality improvement and audit. Even with perfect access to information, practitioners of each of these different applications may favor different classification schemes. For example, an immunologist would likely give greater weight to a scheme that divided individuals based on host immune response patterns. Such a scheme would also be useful to clinicians if therapies were based on select immune responses. But because current treatments are initiated largely in response to nonspecific clinical features, clinical diagnostic criteria are likely rated more important by the clinician. Furthermore, the clinician seeks a disease classification that can be applied prospectively to guide treatment decisions. In contrast, an epidemiologist may favor a scheme that most accurately parses cases from non-cases, even if that scheme included postmortem findings (Angus et al., 2016, p. e115).

In other words, while different areas of knowledge were important, the weight of importance, or 'value', given to these different forms of knowledge was often linked to profession and role. Given the range of actors in the SSC, the diverse bases of knowledge, all with a concomitant range of views, agreeing a course of action took negotiation.

### 5.1.4. Conclusion

In conclusion, the ways that the SSC (and related actors) mobilised knowledge was by overcoming social and epistemic boundaries. These practices exemplify what I have termed ‘shepherding’. Rather than accept existing boundaries that hampered the mobilisation of sepsis knowledge, the SSC actively sought out a range of stakeholders to join the knowledge network. They recognised that a condition such as sepsis required the involvement of diverse specialisations and professions. Along the way they made decisions that proved highly contentious. But they also sought to increase transparency and manage the conflicts of interest. They tended and listened to concerns. Sometimes they vigorously defended their positions. Other times, they responded and adjusted. They were tenacious. And some recorded that their continuous labour together resulted in a hard-won comradery.

Creating structural systems to address boundaries was important; however, the structures did not, in and of themselves, resolve the boundaries that arose between actors in the network. Resolving tensions at epistemic and social boundary points was both structural and relational work.

Furthermore, the explicit, ‘research-based’ knowledge that emerged from this network was not singular or straight-forward. These data show that their knowledge was complex and evolved over time. Members active in the network shaped and influenced their collective epistemic outputs. Amongst these actors, knowledge was constructed, created and refined through a careful tending process. In other words, the interaction between individual and collective mindlines was evident in the research network.

Mobilising knowledge in the research knowledge network involved a combination of the more controllable aspects (i.e. providing system structures) and emergent aspects, such as the less controllable interactions between actors. The organisation of actors, the processes, and materials provided a platform for engagement. And yet, these knowledge systems did not in and of themselves bring about epistemic agreement between diverging views. The interactions between actors that were less easily depicted, the disagreements and negotiations glimpsed in the documentary sources alongside the periodic signs of professional regard and friendship, provided hints that knowledge was mobilised in the messy social arena of the knowledge network. Furthermore, there were glimpses in these data that various members tended and nurtured the interpersonal interactions to promote productivity.

The chapter now turns to consider the actors, events and knowledge systems that constitute the policy part of the knowledge network.

## 5.2. The Policy Network: NHS Scotland's Sepsis Collaborative

The remainder of the chapter focuses on the policy community, namely the Scottish Patient Safety Programme's Sepsis Collaborative. This section has three parts. The first part provides an overview of the sepsis policy community actors and events. The second part analyses the knowledge systems using Soft Knowledge Systems and, where possible, the Clinical Mindlines lenses. The third part draws out the themes illuminated using the theory-based analysis. The following content was distilled from journal publications, grey literature, organisational websites, interviews with a national policy advisor and Aurora's staff, and observations at multiple policy-led meetings.

### 5.2.1. NHS Scotland's Sepsis Story

NHS Scotland's sepsis story began soon after the devolution of health care to the nation in 1999. Two governmental reports (one in England and one in Scotland) were released concerning deteriorating patients. The separate critical care studies directed attention to the problem of undiagnosed sepsis in hospital wards across the UK. The Comprehensive Critical Care Report (NHS England, 2000) and Better Critical Care Report (NHS Scotland, 2000) supported the concerns of the Surviving Sepsis Campaign research community. The reports said that hospitalised patients were at risk of deterioration from sepsis whilst admitted in the hospital. Because deterioration was often undetected, sepsis was not diagnosed, and as a result intervention by critical care specialists came too late.

NHS England and NHS Scotland responded differently to the reports. NHS England decided to develop critical care outreach teams (CCOTs). The rationale for using CCOTs was that identifying and treating sepsis draws on forms of knowledge, namely specialist experience and expertise, that those outside the critical care context may not have. As explained in Chapter 3, CCOTs are made up of highly specialised clinicians (most commonly nurses) who are adept at managing patients with immediate, life-threatening problems. An outreach team are regularly present outside the ICU and extend critical care support throughout a hospital by bringing their expertise to patients and staff when emergency situations arise.

NHS Scotland decided instead to focus on ways to help existing staff on the wards better detect patient deterioration. Rather than specialist intervention teams, NHS Scotland encouraged the use of early warning systems by incorporating these data and trigger score calculations into the patient observation chart. A handful of different early warning tools existed and, at that time, each board selected the tool that best suited them.

Another development has profoundly influenced sepsis care practices in Scotland. Two UK critical care physicians developed a bundle (Sepsis 6) to treat sepsis outside the ICU setting (Robson & Daniels, 2008; Daniels et al., 2011). Sepsis 6 was a further simplification of the 2008 SSC guidelines' 6-hour bundle, though specifically tailored for non-specialists. The bundle combined six tasks (see Box 5-2) and, unlike the SSC bundles of the day, utilised Kumar et al.'s (2006) golden hour for bundle completion.

Sepsis 6 Bundle

1) Start High Flow Oxygen
2) Take Blood Cultures
3) Give Antibiotics
4) Give Fluid Bolus
5) Measure Lactate Level
6) Measure Hourly Urine

*Box 5-2 Sepsis 6 Bundle*

In 2008, the then health secretary, Nicola Sturgeon, hired the Institute for Healthcare Improvement (IHI) and established the Scottish Patient Safety Programme (SPSP). According to the SPSP website, NHS Scotland was the first health service in the world to adopt a systematic, nationwide approach to improving patient safety. As part of the SPSP, the Sepsis Collaborative was formed in January 2012 and officially concluded in

December 2014. The Sepsis Collaborative used IHI's Model for Improvement and Breakthrough Collaborative Model structure (Tarrant et al., 2015). The goal of the Sepsis Collaborative was to reduce harm and mortality from sepsis and the focus of the improvement project was on early detection and timely treatment of sepsis. The Collaborative used early warning scores to identify sepsis and adopted the Sepsis 6 bundle as the quality improvement method to treat sepsis.

In 2012, the Royal College of Physicians (RCP) published a report saying that "the multiplicity of early warning systems used in different hospitals in the UK [was] causing a lack of consistency in detecting deterioration of patients' conditions and [called] for urgent medical help" (RCP, 2012, p. vii). The RCP report presented a standardised observation scoring system and related chart for use in hospitals throughout the UK called the National Early Warning System (NEWS). The Sepsis Collaborative decided to adopt the NEWS chart and related early warning score system as the recommended method of identifying an acutely unwell patient. And as of 2018, all 14 regional boards in Scotland have adopted NEWS (McGregor, 2018).

The impact of the Sepsis Collaborative for sepsis care throughout the country appears encouraging. NHS Scotland audit data shows that there has been a 21% reduction in sepsis mortality compared to the baseline data taken early in 2012; and an 11.2% drop in the hospital-based mortality ratio in that same time period (McGregor, 2018).

### 5.2.2. Understanding Knowledge Systems

This section now turns to provide more in-depth analysis of the policy network. As employed earlier, a Soft Knowledge Systems view was taken to focus on how actors were arranged and the processes and materials they used to mobilise their knowledge. Furthermore, where possible, these data were scrutinised for various forms of knowledge that were used by actors in this sector.

#### *Scottish Patient Safety Programme*

The SPSP brought together a range of collective actors including NHS Scotland, Scottish Government, the Institute for Healthcare Improvement (IHI), NHS Quality Improvement Scotland, professional bodies, and patient representatives (Rooney &

Leitch, 2010). The SPSP was a coalition of stakeholders designed to reduce adverse events and improve patient safety by using “evidence-based tools and techniques in defined areas of clinical practice” (Rooney & Leitch, 2010, p. 99). The ‘tools and techniques’ were IHI’s Model for Improvement (quality improvement techniques) and collaborative structures (IHI, 2003). Each collaborative focused on a specific clinical area that was “ripe for improvement” and not using the “best scientific knowledge” (IHI, 2003, p. 3). IHI described the Breakthrough Series Model (i.e. using collaborative structures) as the way they facilitated, coordinated, and built professional connections so that “organizations can easily learn from each other and from recognized experts” (IHI, 2003, p. 1).

The IHI/SPSP Collaboratives assembled together clinical experts, ideally at least a dozen separate multidisciplinary healthcare teams, and quality improvement methodologists (Kilo, 1998). Collaborative members met together face-to-face at ‘learning sessions’ where they devised and agreed upon plans and “shared their experiences in overcoming barriers and creating solutions” (Haraden & Leitch, 2011, p. 757). In between meetings, the healthcare teams would return to their organisation and implement the quality improvement strategies and collect data for monthly progress reports. There were further monthly calls with representatives from each area, the national clinical leads, and policy leaders. Additional supports were provided, such as a collaborative website for sharing tools and resources. NHS Scotland funded new patient safety staff positions within the health board’s clinical governance departments to support the increased administration of the SPSP performance measurement system.

Indeed, data collection was an early challenge that had to be addressed in the new safety initiative. The SPSP called for different kinds of data to be collated in addition to existing NHS Scotland’s data reporting requirements. A publication describing the SPSP process said:

> There was sizable overlap between the patient safety program and the work of other national organizations whose mission it was to create safe and high-quality care. This often resulted in different definitions

> and measures for the same clinical outcome… To solve this problem, the patient safety program leadership had to work closely with expert clinicians to agree on definitions. The Scottish Patient Safety Programme leadership team met bimonthly with stakeholders to align the new program's focus, clinical changes, measures, and definitions with existing national programs (Haraden & Leitch, 2011, p. 756).

The 'evidence' that the IHI and NHS Scotland relied upon, in this case the definitions of diseases and the related data needed for measuring progress, differed. The SPSP had to address the misalignment between interpretations of the research. In an interview a national policy advisor explained,

> *"Part of the debates were around operational definitions. The two most contentious parts [for sepsis] were monitoring fluid output and measuring lactate. The reasons those were so contentious, and keeping in mind I was on the national group and having these conversations, various groups were trying to propose if you're septic, you get catheterised. I'm saying, 'I am not taking that back to [my health board]. That goes against everything we're trying to do for [another patient safety initiative]." (NHS Scotland policy advisor)*

Thus, agreeing and aligning the evidence-based materials was done in negotiation between the policy-based SPSP leadership, the clinical lead experts, and practice-based clinicians.

In an interview, Hannah, a training and development officer at Aurora, explained the alignment of the SPSP's and existing NHS Scotland's data systems this way:

> *"The Patient Safety Programme came along and suddenly we have a huge data burden because we have measures on both sides of the camp…it was on two systems at one point. We then managed to get it onto one system. Because it felt like there were two camps in the government that weren't talking to each other…so we were campaigning to Jason Leitch every time I saw him. It would be much more helpful if this was united. Eventually that came on board, and they heard us." (Hannah)*

Moreover, the Sepsis Collaborative gathered together not only practitioners engaged in the same work elsewhere in the country, but also provided a point of contact with high-profile policy-level staff. Jason Leitch heard them, and the burdensome data collection system requirements were modified.

Another example of contact between practitioners and policymakers was noted in the same interview with Hannah, she said,

> *"She [Nicola Sturgeon] was the link for IHI and actively supported implementation across Scotland. I think that has been a very helpful thing for coordinating Scotland to be driving improvement at every health board. From that perspective, the government funded a national facilitators network." (Hannah)*

NHS Scotland policymakers and leaders, such as Nicola Sturgeon and Jason Leitch, were available and accessible to the health boards. And more than being accessible, they were responsive to the needs of local practitioners. Furthermore, the SPSP brought together a geographically dispersed practitioner workforce alongside policy leaders.

*Sepsis Collaborative*

The Sepsis Collaborative addressed all aspects of the health boards' knowledge systems, the arrangement and organisation of actors, the processes, and the materials. Professor Kevin Rooney was the Sepsis Collaborative lead clinical expert. Each of Scotland's 14 regional health boards formed a team of key stakeholders. The teams included physicians, nurses, relevant allied health professionals, training and development, as well as members of the clinical governance staff. All boards sent team members to Collaborative learning sessions to meet face-to-face with their colleagues from around the country, the expert clinical faculty, and quality improvement experts.

The Sepsis Collaborative held five learning sessions over two years, supplemented by monthly WebEx-based meetings. At Collaborative meetings they set evidence based goals, talked with other practitioners and exchanged ideas. In between meetings they applied the agreed-upon improvement methods and compiled their performance measurement data for further discussion at the next joint learning session. Additional communication channels were established using a newly developed web portal, email and WebEx conferences. And the collaborative faculty made site visits to each board once a year.

Within the Collaborative processes and materials there were mixed expectations of conformity and allowance for local variation. For example, the Collaborative agreed upon the performance measures, such as Sepsis 6 compliance. Each board was expected to collect and report compliance with the Sepsis 6 bundle on a monthly basis to the NHS Scotland audit body. Yet the policymakers did not mandate the early warning systems or charts that each board used. The Collaborative promoted the benefits of NEWS at learning sessions, but allowed each board to make the decision of what scoring system they would use. Field notes from a meeting in November 2014 reported that "two of the boards recently transitioned to using NEWS." A half hour of the meeting was given to these boards describing their "success stories." Hannah, from Aurora, explained it this way: *"So there is a whole galvanization from the government perspective, but you're very much as a board left to work out how you're going to do things yourself" (Hannah).*

The leadership of the Collaborative encouraged, but did not dictate, that all boards use the NEWS early warning system and chart. With some materials, there was a mandated standardisation, whereas with other materials, the national policies were flexible.

An evaluation of the Sepsis Collaborative reported,

> The collaborative provided multiple routes for sharing learning, the most effective of which seemed to be providing time for interactions between teams from different boards at learning sessions. Participants highly valued learning from others' successes and having an opportunity to discuss challenges. They also valued access to expert faculty at learning sessions (Tarrant et al., 2015, p. 10).

In addition to learning from other boards and clinical experts, the evaluation stated that, "Participants also felt the learning sessions were useful in that they enabled those involved…within the board to get together, away from the demands of clinical duties, and take time to discuss progress and plan for future activities" (Tarrant et al., 2015, p. 10). Hannah agreed: *"You all get together and share the learning and the tools. And share stories, case studies of how things are going and how you've made improvement or not" (Hannah).*

The Collaborative enabled time amongst co-workers to exclusively focus and reflect upon their sepsis work. The space for sustained, face-to-face contact was seen as important. The other points of contact, such as the WebEx calls and web portal, "while more convenient, the mediated nature of IT-based learning and sharing opportunities meant that they were not always as effective as face-to-face forums" (Tarrant et al., 2015, p. 10).

Furthermore, the evaluation report stated that the site visits from expert faculty were not universally well-received.

> Participants described ambiguity around the purpose of site visits. They could be effective in raising the profile of local collaborative work, provide an opportunity for celebration, and act to re-enthuse and motivate people. But they were also sometimes seen as a means through which the faculty held site teams to account for their progress, potentially creating tension with other purposes – for example, inhibiting frankness in discussing problems and deciding how they might be remedied (Tarrant et al., 2015, p. 10).

From practitioners' perspective, not all contact between actors from different communities was helpful. The critical tone by policy-level faculty erected walls and inhibited communication between these actors.

A contrast to perceived heavy-handed engagement with Collaborative faculty was observed at a face-to-face meeting in May 2016. This meeting involved approximately 100 people from health boards around the country. A new sepsis definition (i.e. Sepsis-3, see Singer et al., 2016) had been recently released by the Society of Critical Care Medicine and European Society of Intensive Care Medicine. The publication endorsed the SOFA score. This new material from the research community was unsettling for the Collaborative. Over the prior few years a great deal of effort had been poured into encouraging each of Scotland's health boards to use the NEWS early warning scoring system. Field notes from the meeting recorded that the clinical lead said, “he, only somewhat jokingly, considered closing himself in a dark closet for days.” The primary reason, Professor Rooney said, for the meeting “was to take the temperature of those responsible for sepsis care in their areas and come to consensus for a Scotland-based perspective.”

Professor Rooney wanted a response to Singer et al.’s (2016) proposed definitions that all present in the room would sign. Over the course of the day a Scotland-based “Sepsis Position Statement” was constructed. To reach full consensus, a first iteration statement crafted by policy-based actors was projected on the large screen at the front of the room. Attendees were asked to consider the content. Then Professor Rooney read the statement line by line. After each line, he stopped and requested feedback and suggested edits. Many different people proposed adjustments. Throughout the process, the clinical lead pressed for views, gave time for each person present to speak, and when concerns were raised that could potentially derail the consensus building process, he often did not take the response himself. Instead, he asked for others in the room to provide their views of agreement or disagreement. They negotiated and rewrote the statement sentence by sentence. After each rewritten paragraph, Professor Rooney asked the room to raise their hands if they could support the content. The voting continued until a final statement was agreed. SPSP released the statement on 24 May 2016.

The field journal notations indicated what was at stake. Many believed that the research community content (published in *JAMA*) must be reckoned with. One person stated that the registrars and junior doctors would be aware of it, and to remain credible, they must “keep up with the evidence,” while others expressed what was described as a “wait and see” perspective. They did not want to hastily shift to what they considered as yet unproven. Rather they wanted other health systems to test it out, and determine whether the new definition and assessment tool held up under wider scrutiny. There was a tension between being up to date with the research and not being unduly hasty.

In these discussions the clinical lead clearly stated his views but invited alternative perspectives. He listened to and managed the interactions between attendees. This observed example comports with the evaluation document, which said:

> The expertise and skills of the faculty, and the personalities and commitment of the national clinical leads, were also seen as key by participants and stakeholders alike. Participants felt that working as part of a national collaborative…provided recognition for local efforts. ...The learning sessions were used as opportunities for senior leaders to present accounts of their own failures and their learning, and participants were encouraged to share their failures with others (Tarrant et al., 2015, p. 9).

The policy leaders shared in the experiences of the hospital communities. These policy actors related to practitioners and treated their knowledge as important in the national knowledge system.

### 5.2.3. Mobilising Knowledge in the Policy Network

This account shows that the Collaborative tied together actors from the policy, practice and even the research community via IHI and the Singer et al. (2016) publication. Furthermore, the Sepsis Collaborative established professionally diverse work teams within each board. They required the health boards to construct local teams made up of a variety of specialisations, professions, and roles, where every actor's knowledge, i.e. clinical mindline, would be included. Intensive care doctors and nurses were teamed up with Emergency Department staff, microbiology, and administrative staff, such as clinical governance and training and development personnel. In this way, normally occurring social and epistemic separations were addressed, at least to the degree that they were expected to meet together and devise a local action plan.

Policymakers appear to have been flexible and allowed each region to organise processes and use materials that suited them. NHS Scotland led but did not dictate all aspects of the knowledge system. NHS Scotland proposed strategies (e.g. early warning systems) but allowed for variation. An early example is explained in the next chapter, when Aurora chose to take advantage of national funding for specialist staff and the creation of a critical care outreach team. Each board was allowed to decide if and when to adopt the NEWS system.

The policy community explicitly facilitated building consensus. Thus, resulting materials came from collective input that integrated the judgement of individual participants. And consensus was developed via regular contact, including face-to-face meetings. The moderate size of Scotland assisted national organising efforts. Most health boards were able to meet together face-to-face. This contributes to a geographic advantage in the Scottish context, as the health community knows one another. This also facilitates tighter practice-based knowledge networks that have direct access to policymakers. Furthermore, there were indications that the qualities of relationships between policymakers and health board practitioners (and between health boards) helped to support higher performing sepsis practices throughout the country. In other words, the Collaborative leadership did not often demand or shame, but tried to woo the boards. They applied careful social pressure to encourage the shift to NEWS tool.

### 5.2.4. Conclusion

In conclusion, there were commonalities between the Surviving Sepsis Campaign and the SPSP Sepsis Collaborative. Firstly, key individual actors initiated an active effort to organise stakeholders to improve sepsis practice. To do so, they were inclusive and gathered and collected actors from a variety of professional and disciplinary roles. Secondly, both the SSC and Sepsis Collaborative devised processes and materials to build and share their knowledge within their networks. They listened and responded to contrasting points of view. And by doing so, they addressed the social boundaries that separate actors in a knowledge network. Thus, shepherding practices were evident in the policy community as well. Furthermore, the consensus building process brought together actors’ formal, informal, tacit and experiential ways of knowing (their individual mindlines) in order to shape their collective mindlines.

These data reveal the knowledge systems that these communities put in place to mobilise their knowledge. And yet, these accounts also provide indicators that *how* these actors interacted, the relationships between actors, also played a role in overcoming boundaries and mobilising knowledge. These interactions are explored more fully in the hospital context in Chapter 6.

## 5.3. Sepsis Specific Terminology

By way of summarising, the following section provides in table format the outputs found in the preceding research and policy networks data. There are sets of recommendations, early warning schemas, etc., and this information once agreed upon within the SSC and the Sepsis Collaborative networks, was then distributed to ‘research-users’ in hospital contexts. These explicit forms of knowledge about sepsis can be segmented into three main areas: what defines, identifies, and treats the condition. Table 5-1 summarises the clinical content introduced in this chapter and provides the key terms needed moving forward to the practice-based context in the next chapter.

**Table 5-1, Summary of Sepsis-Related Terms and Acronyms**

| **Defining Sepsis** | |
|---|---|
| **SIRS** | Systemic Inflammatory Response Syndrome that focuses on 4 physical criteria (temperature, heart rate, respiratory rate and white blood cell count) of the patient. |
| **Sepsis-1** | Based upon a systemic inflammatory response to infection (SIRS) when 2 or more SIRS measurements fall outside of desired parameters AND a confirmed or suspected infection, a diagnosis of sepsis is given. Published in 1992. |
| (Severe sepsis) | In addition to above, signs of organ dysfunction are present or a marked shift in mental status. |
| (Septic shock) | Persistent, life-threatening organ dysfunction despite initial treatment. |
| **Sepsis-2** | A revision of Sepsis-1 based on SIRS criteria but includes an expanded list of signs and symptoms. Published in 2003. |
| (Severe sepsis)<br>(Septic shock) | Definitions of severe sepsis and septic shock remain largely the same as Sepsis-1 above. (E.g. Added elevated lactate reading to indicate severe sepsis and severely elevated lactate reading for shock.) |
| **Sepsis-3** | Life-threatening organ dysfunction caused by the body's response to a confirmed infection. Sepsis-3 discards SIRS-based criteria and instead requires signs of organ dysfunction based on SOFA criteria in order to be considered sepsis. Published in 2016. |
| ~~Sepsis 3 (Severe sepsis~~) | Category of severe sepsis eliminated in Sepsis-3. Signs of organ dysfunction now required for initial sepsis diagnosis. |
| Sepsis 3 (Septic shock) | Those unresponsive to initial treatment, whose organs continue to malfunction and require continuous treatment to maintain sufficient blood pressure. |
| **Identifying Sepsis** | |
| Patient Observation Charts | Bedside monitoring tool used to record patient data, such as blood pressure, temperature, etc. |
| Early Warning Scores | Quantitative risk calculation scores based on measurements routinely collected via patient observation charts. Also called 'track and trigger tools'. |
| SIRS score | An early warning score based on patient observation measures drawn from Systemic Inflammatory Response Syndrome-based definition of sepsis. |

| | |
|---|---|
| NEWS | National Early Warning Score developed by the Royal College of Physicians for the NHS |
| SOFA | Sepsis-related Organ Failure Assessment score developed by the European Society for Intensive Care Medicine |
| qSOFA | “Quick” SOFA score for use outside of the critical care setting |
| **Treating Sepsis** | |
| SSC International Guidelines | International consensus-based guidelines for the treatment and management of sepsis patients. Produced in 2004, 2008, 2012 and 2016. |
| Sepsis bundles | A distillation of Surviving Sepsis Campaign treatment guidelines to a small set of practices to be completed together. For critical care settings. |
| Sepsis 6 | A bundle of six treatments to be completed in 1 hour. For non-specialist clinicians used outside the critical care setting. Developed and presently used primarily in the UK. |
| Sepsis sticker | Documentation within patient record that verifies Sepsis 6 was completed |

# 6. Chapter 6—The Practice Network

Heart failure is a common way that a person dies from sepsis. In 2000 Aurora General Hospital had 465 cardiac arrest alerts. By 2012 that number had dropped to 22. The purpose of this chapter is to explore how Aurora mobilised their knowledge to achieve this decline. To do so this chapter has three sections. The first describes the story of sepsis care at Aurora over the last three decades drawn from participant interviews, documentation provided to me, as well as my own observations over the year I spent at Aurora. The next section expands and analyses these data using the Soft Knowledge Systems and Clinical Mindlines theories as lenses to explore the ways that actors organised within their knowledge network and the knowledges they drew upon that facilitated the mobilisation of sepsis knowledge. Lastly, the conclusion focuses on the interactions between actors that enabled knowledge to mobilise within this community.

In keeping with the practices of the community (and how I addressed staff members), Table 6-1 identifies key actors within Aurora, listing the senior medical staff with titles, while the rest of the staff are represented using a first name pseudonym.

**Table 6-1 Key Actors at Aurora General Hospital**

| Name | Position | Role |
|---|---|---|
| David | ICU Outreach Team nurse | Team lead |
| Kelly | ICU Outreach Team nurse | |
| Jackie | ICU Outreach Team nurse | |
| Leann | ICU Outreach Team nurse | |
| Martha | Clinical Governance | |
| Sue | Clinical Governance | Team lead |
| Dr Lewis | ICU doctor | Retired medical lead |
| Dr Adams | ICU doctor | Present medical lead |
| Dr Jones | Microbiologist | |
| Mr King | A&E doctor | Medical lead |
| Hannah | Training and Development | |

## 6.1. Aurora’s Sepsis Story

This first section provides a narrative account of how Aurora organised and became a high-performing hospital with respect to sepsis care. As in the last chapter, the story is crafted to introduce the key actors and share the events that shaped this community’s sepsis care provision.

Aurora General Hospital was a forerunner within Scotland in addressing the problem of deteriorating patients. In the 1980s and 1990s, Dr Lewis (then the medical lead over Aurora’s ICU) witnessed patient after patient being rushed from a medical or surgical ward into the ICU due to multi-organ failure after days of unnoticed deterioration in a hospital bed. From observations made by multiple participants, it was deemed that the patients were too far along the sepsis pathway for the critical care specialists to help. Consequently, it was their belief that had the patient’s decline been recognised earlier, and brought to the ICU for treatment, the ICU team might have had a chance to save their life.

Dr Lewis began to devise strategies to solve the problem of recognising a deteriorating patient and reasoned that the strategic use of the bedside observation chart was key to saving patients’ lives. In this era, standard practice was to have a collection of charts attached to a clipboard for each patient: one for tracking respiratory activity, one for bowel, another for fluid administration, etc. Dr Lewis suspected that the fragmentation of information inhibited the ward staff’s ability to monitor and properly see the holistic picture of a patient, and this slowed their recognition of a patient in decline. To address the problem, he sought to simplify and reduce the quantity of charts.

In the late 1980s, in conjunction with his medical and nurse colleagues in the ICU, Dr Lewis devised and trialled a consolidated chart within their unit. When patients were moved from the ICU to other wards within Aurora not under his medical authority, the new chart went with them. Eventually, most patients throughout the hospital were monitored using Dr Lewis’s chart, unless the patient’s consultant requested otherwise. However, despite the use of a combined chart, patients were still arriving at the ICU too late to help: *"But it wasn't doing what it should do. You would still get people that had [not passed urine] for two or three days coming through the system" (Dr Lewis).*

In response the ICU team revised the consolidated chart by adding a simple colour component. In this way, under Dr Lewis's direction, they devised a visual trigger tool with a view to help ward staff more clearly see a patient at risk. For example, if a patient's temperature was above or below a normal range, the number was recorded in a yellow box as opposed to the normal white box. Trigger tools such as this were not yet commonplace. Dr Lewis explained in an interview that his ideas stemmed from Shoemaker's research publications in the late 1970's that advocated focusing on patients that met high risk parameters. Dr Lewis found Shoemaker's views convincing. And yet, despite the incorporation of a visual trigger, patients continued to arrive to the ICU too late to help.

In an interview, Dr Lewis recalled discovering Bone et al.'s (1992) paper defining SIRS, and the progression from SIRS to organ dysfunction, to organ failure, and finally to death. In the mid 1990s he once again worked with his ICU staff to incorporate the SIRS criteria into the colour coded chart and expected that would finally ensure the early identification of deteriorating patients. However, to the ICU's surprise, the problem continued:

> *"Getting people to use it the way it was supposed to be used, i.e. go through the whole lot, do the charting, recognise it was an abnormal result, call the right people, and enact the right resuscitation, was difficult and very sporadic." (Dr Lewis)*

The ICU staff decided the problem must be a knowledge deficit (*"an educational issue"*). To address this, members of the ICU provided training throughout the hospital on how to use the chart and what to do in response. *"It should have worked. [The timely identification of sepsis] showed an uplift, and then faded off again...we were scratching our head" (Dr Lewis).*

As noted in the last chapter, in 2000 two UK critical care reports, one for Scotland and one for England, observed this was a widespread problem. The independent reports both showed that across the country, patients were often not faring well in wards and arriving too late to the ICU to recover. In response, NHS England funded the roll out of Critical Care Outreach teams, whereas NHS Scotland chose a chart-based early recognition system. However, Aurora already had a chart-dependent system in place for nearly a decade and there were still 465 cardiac arrest alerts that year. Early recognition based on charts had not sufficiently addressed the problem. Aurora decided instead to utilise funding by the Scottish Chief Nursing Office for specialist nurses, and put in place a Critical Care Outreach service.

In 2001 David was selected to start an Outreach service. As an ICU senior charge nurse he had been a trusted part of the ICU for many years and had been involved in earlier efforts of trialling the charts and training Aurora's staff on their usage. David sought out well-regarded Outreach programmes in England to model and learn from, and visited to *"collect intelligence…to see what was working and use it"* (David). Initially, as the solitary member of the Outreach service, he covered Monday to Friday from 9 am until 5 pm where his responsibilities were fourfold. Firstly, he provided an additional layer of monitoring for patients discharged from the ICU to a ward. David explained in an interview that this was a manageable workload and these patients were at higher risk of rapid deterioration.

Secondly, a referral process was put in place. When a hospitalised patient registered a SIRS score of two or higher, the ward staff were instructed to page the Outreach service who would come and conduct an immediate assessment. For example, nurses on the wards regularly record a patient's vital information on the bedside chart. If a patient's heart rate was above 90 or below 60 beats per minute, that counted as one point on the SIRS scale. If the patient also appeared confused, that brought the SIRS score up to two. Before the Outreach referral system, *"they may not see the importance of that, so [the nurse] may not report it* up" *(David)* to the senior clinical staff for a more thorough assessment. The new referral system added on a specific response, paging Outreach, as a further layer to Aurora's existing track and trigger system.

Thirdly, an open invitation was offered to any hospital staff member that had patient of concern. They were encouraged to page Outreach, who would reliably respond and provide an immediate consultation. David would arrive promptly, listen to the ward staff's concerns, and assess the immediate and ongoing needs of the patient. Using his decades of critical care expertise, he would gauge whether the patient was septic or not, and as well as whether the patient warranted 'escalation'. Escalation means being moved from the regular ward to a higher level unit such as the High Dependency Unit or ICU where staff ratios are higher and monitoring is more aggressive than can be done on a regular medical or surgical ward.

Lastly, David established a quarterly Study Day set within the hospital for all nursing staff. The stated purpose was to provide training on how to identify and rescue a deteriorating patient. To encourage wide ownership, David sought out specialists from various areas in the hospital to teach on the course. "I had [respiratory therapy] do a respiratory assessment, a physician doing pneumonia, and anaesthetist doing therapeutic fluids, another anaesthetist doing blood gas analysis, and I did sepsis" (David). David explained that the Study Day was well received and he was encouraged to expand the training to include students, doctors, and physical therapists. "It grew and grew" and now is multi-professional as well as multidisciplinary.

Despite the limited availability of resources, Aurora chose to expand the Outreach service. Kelly joined David in 2005, and two years later, Jackie and Leann were added. The Outreach team extended their cover to 12 hour shifts each day of the week. The reason was that once the Outreach service was in place to support the SIRS-based early warning system, Aurora's audit data saw marked improvement. There was a decline of all forms of organ support provision (e.g. fewer patients requiring ventilation or kidney dialysis), fewer emergency ICU admissions during the night shift, patients' overall length of stay in the ICU went down, and, most importantly, patient mortality decreased. Furthermore, the team grew because the consultants in particular saw the value of it: "They had someone to go to, and say, 'Can you keep an eye on this one?'…They knew they had a safety net. And they really appreciated it" (Dr

Lewis). Each team member independently noted that the consultant staff sought Outreach out when they had a patient of concern. The consultants depended upon them.

> *"They [the consultants] see the benefits of the service. I mean, who wouldn't like somebody experienced coming around to see their patients that aren't as well? We're keeping an eye on them." (Kelly)*

With the increase of Outreach staff hours, their responsibilities expanded to include rounds through all inpatient wards three times per day. Each team member commented (and I observed) that while walking through the hallways and bays, in addition to checking on patients that had previously been referred and those recently discharged from the ICU, they chatted to nurses, doctors and porters, whilst looking attentively through windows and into side rooms to see who occupied each bed. And if, for example, a patient's posture did not seem right, they investigated further.

When the Scottish Patient Safety Programme began in 2008, Aurora had an early warning system supported by the Outreach team in place. The continued decrease of cardiac arrest calls within the hospital signalled, along with other indicators, that this approach provided consistently positive outcomes for their patients. Moreover, 90% of patients with sepsis were able to remain on the ward, managed by the ward staff with support from the Outreach team, reversing the last minute, and often deadly, rush to the ICU.

> *"Just having a tracking system didn't work. We had tried it. It didn't work. We put in education around it, and it still didn't work. Not until we put in the Outreach team, which was the person support to the ward staff, the juniors and nurses in particular, on the ward, in real time, who could actually be the first port of call to go to, the friendly face, plus the educator. That's when it worked." (Dr Lewis)*

In 2012, some 20 years after Dr Lewis's initial efforts, the Scottish Patient Safety Programme turned to focus on improving preventable deaths from sepsis by establishing the Sepsis/VTE Collaborative. This nationwide effort, described in Chapter 5, drew attention to Aurora's accomplishments in preventing and treating sepsis.

Drawing on the Institute for Healthcare Improvement's Breakthrough Series Model (described in the last chapter), a wider range of Aurora's staff augmented the Outreach Team with formal responsibilities for the deteriorating patient. A wider range of people took on an active role and the Deteriorating Patient Group was formed. Members of the Deteriorating Patient Group included (see Table 6-2) those with clinical responsibilities (such as the Outreach Team, the clinical lead from the ICU [Dr Lewis and, later, Dr Adams] and the Emergency Department [Mr King], microbiology [Dr Jones], and every unit's senior charge nurse) and hospital administration (such as the Associate Director of Nursing, members of the Clinical Governance department, Aurora's medical director, training and development, and, periodically, Aurora's Chief Executive). The group met fortnightly and attendance varied from meeting to meeting. For example, when the Chief Executive attended, notice was sent ahead of time, and as a result the senior charge nurses would come as well, but otherwise, the Outreach team and the Clinical Governance staff were the mainstays of the meetings.

**Table 6-2, Deteriorating Patient Group Members**

| **Clinical Members:** | **Hospital Administration Members:** |
|---|---|
| Critical Care Outreach Team | Clinical Governance |
| Intensive Care Unit Medical Lead | Assistant Director of Nursing |
| Emergency Department Medical Lead | Training & Development |
| Senior Charge Nurses, All Wards | Chief Executive (occasionally) |
| Microbiology | |

At the national level, the Sepsis Collaborative initiative coalesced around bringing the Sepsis 6 bundle (the treatment response for those diagnosed with sepsis) into all hospitals across Scotland. At Aurora, members of the Deteriorating Patient Group used the meetings to revise the patient observation chart to include Sepsis 6. A wide range of hospital training activities were organised to integrate Sepsis 6 throughout the hospital's protocols, provide clinical support for accomplishing all six steps (including the support of Outreach) and track all documentation that demonstrated compliance for national records (by Clinical Governance). Sue, the lead for the Clinical Governance team, focused on converting the chart, while Martha, Clinical

Governance's patient safety coordinator, provided continuous reminders to all relevant clinical units to complete documentation on the sepsis sticker.

In 2014, the senior hospital management of Aurora transitioned to a new Chief Executive and Associate Director of Nursing. Both the Chief Executive and nursing director came from other health boards within Scotland and with them came different perspectives on and priorities about Aurora's existing SIRS-based chart. As noted in the last chapter, NHS Scotland's leadership strongly advocated but did not mandate using the National Early Warning System (NEWS) over SIRS. However, the new executives determined that Aurora would change their chart to conform with the nationally standardised NEWS-based format.

A further transition within this time was that Dr Lewis retired from full-time work (though he continued to provide locum shifts). He handed his clinical lead responsibilities over to Dr Adams. Dr Adams trained at Aurora and was a part of the ICU when they incorporated the SIRS criteria into the patient observation chart and later when the Outreach team was put in place. *"The reason I came here was because Dr Lewis was doing it differently than anybody else"* (Dr Adams). Dr Adams explained that if hospital systems *"are not well-designed, well-conceived and well-managed, then the ICU becomes nothing more than expensive palliative care units".* He sought to continue the systems Dr Lewis had put in place where the chart triggered the early identification of a patient at risk of decline, and the Outreach team provided specialist support to ensure proper care was administered in a timely manner. *"It's all about early intervention, early action, to prevent deterioration…that's the philosophy I inherited. That's the philosophy we continue to use."*

Throughout 2015 the bimonthly Deteriorating Patient Group meeting was primarily dedicated to the design and implementation of a NEWS chart and system for Aurora (as recorded in my field notes and accumulated meeting agendas). Administrative members of the group advocated and supported the change. Those holding clinical roles, however, questioned the move to a new early warning system and related chart. Many of the clinical members had been centrally involved in the progress achieved of preventing and treating sepsis within Aurora over the prior 20 years. Thus, these members expressed uneasiness and concern about changing from a SIRS chart that was accepted and effective in their context. The transition to a NEWS-based chart *“scares us…it will be an enormous transition for the guys in the wards” (Kelly).* Both Drs Lewis and Adams, as the former and existing clinical lead of critical care, commented that this was a potentially dangerous decision to shift from a system they knew worked well to an unknown. *“There has been a huge anxiety from us in critical care with the change from SIRS to NEWS scoring” (Dr Adams).*

> *“[The change] appears just to tick a box when it actually might mean that patients don’t get recognised as quick or will be put at risk in the changeover is more a problem for me...it’s been working well since 2000 [when the Outreach service was incorporated]. And we’ve shown year on year improvements.” (Dr Lewis)*

Jackie observed that within the existing nursing and medical staff “*there’s going to be some resistance”*. *“Some of the [clinical staff] are questioning why we are changing something that’s working for us” (Leann).* The SIRS-based system was established, known, and trusted. Yet, despite their concerns, the responsibility fell heavily upon the Outreach team to ensure that the transition went smoothly and *“to make sure that patients don’t suffer”* (Kelly). Dr Adams affirmed Kelly’s view in a separate interview saying, *“Now we’re trusting the Critical Care Outreach Team system to cover the potential gaps that NEWS creates. It’s about the culture. It’s about when you call for help, help arrives.”* The chart had to change but the response and support by Outreach would not.

Although the purpose of changing to the NEWS chart was to align with the national standard, some leeway was granted to tailor the chart to local needs. By the beginning of 2015, the Deteriorating Patient Group meeting was largely dedicated to negotiating the content of their new observation chart. Field notes from one meeting observed the differing and, at times, conflicting priorities by members of the Deteriorating Patient Group. *“It appears to be a difficult process of re-crafting their [observation] chart. Everyone has their own priorities and are advocating for their needs.”*

After extended deliberations over many months, a chart was agreed upon. Two nurses were seconded to provide shift-by-shift training throughout the hospital. A ‘go live’ date was set for early November. At the last minute, the changeover was delayed for a few weeks at what was later described as a tense and difficult Deteriorating Patient Group meeting. Some of the medical staff were not satisfied that the staff had received sufficient instruction.

The long-awaited and often feared transition elicited a sense of fatigue regarding the extended change process. A field journal notation from late in November observed that:

> The nurses [on the wards] are now saying that they just want to get the shift to the new observation chart over with. They’ve had a bit more time to get used to it, have heard from transitory staff that the chart is doable and useable at other hospitals, and they just want to get on with it. They’re feeling less anxious and more comfortable, as well as weary of the process.

In early December the move was made. Alison, a High Dependency Unit nurse, described the first night they switched to the NEWS score and chart. She calculated the NEWS score but *“I had no idea what that meant…It was just a number with no meaning attached to it.”* To accommodate, Alison shared that she calculated the NEWS score and then converted that to the familiar SIRS score. And after a few weeks of using a two-step interpretive process, she no longer needed to use SIRS in order to understand NEWS.

Overall, many stated the chart transition had gone well and was not nearly as bad as they had feared. They had, however, found the chart did not include some important information for detecting sepsis (e.g. urine output and periphery perfusion). Also, in their opinion, the NEWS score was both far more complicated to calculate than SIRS and did not capture a relative scale of importance well. For example, a patient given oxygen was allocated a set score regardless of whether the amount of oxygen being delivered was minimal or high. During the rounds, I witnessed Outreach completing the NEWS calculations on more than one chart (*“that’s not been done” Jackie).* As a result, the Outreach team said that they had to draw more extensively on their clinical judgement to determine whether a high NEWS score was ‘really’ sick or not.

By early 2016, with the new chart in place for three months, revisions were underway once again within the Deteriorating Patient Group meetings. The clinical staff were insisting that urine output be put back on the chart. Sue pointed out that this deviated from the primary objective of establishing a Scotland-wide observation tool and potentially negated all of their effort. Kelly and Leann said that they had tried the chart, but *“I’m afraid we’re firm on this” (Kelly)*. To further their point, Leann and Kelly pointed out that another board had put urine output back on their chart. *“I’m afraid she shot herself in the foot when she showed me the Highlands’ chart, and they were recording urine.”* In the end, they were modifying the tool to meet their clinical needs, and despite Sue’s protestations, the observation chart was changing. A compromise was struck: they would be using NEWS, but additional data would be routinely collected moving forward.

In summary, what we see in Aurora’s account can be characterised in three pivotal movements. To begin, the problem of sepsis was primarily of concern to the ICU staff. With Dr Lewis leading the effort, the ICU devised and employed various early warning type strategies to enhance the hospital staff’s knowledge around patients at risk of deterioration. However, the document-based systems did not bring about the sought after results. In the second movement, experienced actors shared their knowledge via human contact using the outreach strategy. Rather than sequester sepsis expertise in the ICU, David, and later Kelly, Jackie and Leann, linked directly with those engaged at the point of care. In this way the responsibility for sepsis moves beyond the ICU, through the Outreach team, to the wards. The Outreach staff members worked alongside clinicians in the wards, and by connecting actors and their knowledge brought a relational systems-based connection that effectively reduced the burden of sepsis at Aurora. In the final movement, responding to a Scotland-wide initiative, additional actors within the hospital took on direct responsibility for aspects of sepsis care. Clinical governance, training and development, and others joined the ICU and

Outreach staff in the Deteriorating Patient Group and further widened responsibility for sepsis within the hospital. Each movement represents a widening locus of responsibility and thus a broadening of inclusion in the sepsis knowledge network.

## 6.2. Understanding Knowledge Systems

### 6.2.1. Section Introduction

To further develop Aurora's knowledge network content using Soft Knowledge Systems, this section now turns to examine three parts of the knowledge system: 1) how the actors were organised and arranged; 2) the processes; and 3) the materials they used to accomplish their shared task. Additionally, using Clinical Mindlines, the section displays the many sources and ways of knowing that played a part in mobilising sepsis knowledge.

In so doing, this section answers the research questions following the three time frames identified above. As a reminder, the research questions are:

RQ: How is knowledge mobilised within and between the research, policy and practice communities for clinical practice?

> Sub-RQ 1: What are the sources, forms and ways of knowing involved in mobilising research-based knowledge in practice?
>
> Sub-RQ 2: How are knowledge systems (actors, processes, and materials) organised for mobilising knowledge?

### 6.2.2. Early ICU Efforts—Creating Early Warning Alerts

There was unanimous agreement amongst the participants that the central actors credited with first raising the problem and spearheading Aurora's sepsis effort were the ICU staff and Dr Lewis in particular. The ICU staff in the 1980s and 1990s included those who later emerge as important individual actors. David and Kelly were part of the nursing team, and Dr Adams, eventually a consultant and then clinical lead, trained as a Senior House Officer under Dr Lewis.

The physical distribution of actors in Aurora's knowledge network was set according to their specialist knowledge and subsequent function and was therefore a form of epistemic segmentation as well. For example, the critical care staff were located in the ICU. At times, this physical divide of knowledge resulted in suffering for patients and families. For many years, Dr Lewis, Kelly, and David explained, they were regularly frustrated that the ward staff did not identify septic patients until they were in multi-organ failure and their critical care skills were rendered useless. Because the patients arrived too late, they were unable to use their knowledge and save them.

As ICU staff they had the specialist training and experience and thus held primary responsibility for critically ill patients. The ICU was set apart behind access-only barriers separated from the medical and surgical wards. Other than patient hand-offs to or from the ICU, there was minimal contact between the units. The ICU had its own coffee break room within the ward that kept the staff close to their patients. When patients throughout the hospital became extremely unwell and required urgent treatment, they were transferred to the ICU where the hospital's critical care specialists were located to receive care. In traversing the physical space from a ward to the ICU, the patients also entered a different epistemic area. The multiplicity of charts in place for monitoring pulmonary, cardiac, gastrointestinal, etc. systems, was yet a further indicator of the fragmentation of knowledge-based responsibilities.

Furthermore, the ICU staff's centralised location provided the ability to observe that sepsis was a hospital-wide problem. More than that, these practitioners had the ability and the knowledge to see that a last minute rush to the ICU could have been avoided.

> *"I was fed up seeing patients arrive into ITU too late. I mean, why didn't we know about this patient 2 days ago?" (Kelly)*

The implicit protocol for identifying sepsis was left to the generalist ward staff to comprehend that a problem was mounting based on their contact with patients and the recorded observations. The next step in the process depended on the professional level and role of the staff person. Nurses were to contact either the junior doctor or registrar responsible for the patient. Similarly, junior doctors were to contact the registrar or consultant. If the medic in charge agreed with their concerned assessment, they could then reach then out to the ICU for help.

> *"Whereas consultants are happy to ring up ITU, it took a LOT for the juniors and the nurses to jump ship and not just go to their normal pathway but to come to ITU and say 'I have a patient who's triggering your chart'." (Dr Lewis)*

Often the actors with the least authority in the hospital's knowledge network were the ones most often in contact with patients. Others also pointed out that there were challenges for junior staff to act on their concerns.

> *"I think is all about remit. The nurses don't feel that they can go above the ward doctor. They feel that they can't phone the consultant. I think that's just a historical thing." (Kelly)*

> *"You speak to most nurses and they'll have an anecdote, a story where they felt not enough was being done." (David)*

In this time frame, the tool went through three increasingly refined efforts at the instigation of Dr Lewis and the ICU staff: first compiling and streamlining many charts into one; second adding coloured zones to further underscore an abnormal, and potentially problematic, reading; and third, incorporating the SIRS criteria. Each iteration was done to help the ward staff focus on the patient observation data that the ICU believed were most important.

The third tool modification integrated Bone et al.'s (1992) SIRS criteria in the chart. The criteria provided a numerical score that indicated a level of illness. In the ICU staff view, the early warning score gave the ward nurses *"some data power"* (David). David continued to explain in an interview:

> *"If you want a doctor's attention, give them numbers. They grew up with numbers, you need to get them a number, so they can process. And if they're really, really busy, and they've got 5 phone calls saying I'm concerned about this patient, the person that phones and says, they look like they have severe sepsis, that one will get their attention. So we need to speak the same language." (David)*

However, even after the SIRS score was introduced, the protocols depended on the ward staff contacting the ICU.

> *"Actually getting people to use it the way it was supposed to be used, i.e. go through the whole lot, do the charting, recognise it was an abnormal result, call the right people, and enact the right resuscitation, was difficult and very sporadic and we went through a few formats and changes to the chart." (Dr Lewis)*

> *"We know that things don't happen because people are a bit scared to act sometimes." (Dr Jones)*

The patient observation chart was a communal document and information conduit between units. It provided the relevant patient indicators that all staff, no matter the unit, depended upon. And yet *"recognising an abnormal result"* required the ability to interpret the data. Calling *"the right people*" entailed communication between actors across professions, specialisations, geography, and tenure. The use of the patient observation chart was liable to failure at multiple points.

In this time frame the problem was framed as a knowledge deficit where the 'knowledge' deficit was actually an 'information' deficit resulting from the inefficient presentation of patient data. As a result, Aurora did not address the system's arrangement of actors or the protocols for mobilising knowledge between actors. Instead, they recrafted the information tracking and sharing tool.

The ICU believed that their ward colleagues held the knowledge they needed but required assistance seeing the information. The underlying belief was that ward staff would be able to understand and interpret the potential implications of the patient information captured on the chart in the same way those in the ICU could. Thus, the knowledge mobilisation strategy to help others know and change their behaviours focused exclusively on adjusting the materials for clearer information transmission.

Similarly, the protocol in place for sepsis was predicated upon the assumption that communication between various health professionals and units was a simple and unproblematic interactional process. Instead, medical staff were at times difficult to reach and dismissed the concerns of nurses.

> *"You would have the nurse saying, 'I was concerned about the blood pressure,' but the doctor said 'Just watch it.' And that happened all the time. That junior doctor maybe doesn't want to call their senior, because there is still a bit of that culture. But they're not really sure what to do about it." (David)*

> *"The junior doctors are very busy and don't always appreciate how sick patients are." (Kelly)*

There was limited mention of connection to the research and practice communities over this time period. Dr Lewis and Dr Adams referred to specialist focused professional meetings they attended. David and Leann both commented in interviews that Dr Lewis regularly read medical journals. Through one of these channels, Dr Lewis discovered Bone et al.'s article (1992) and SIRS.

> *"The Surviving Sepsis Campaign (which came from America, not IHI) started in 2000. They were the first ones to say this is how we define sepsis...**They were using the same criteria that Bone had used for my SIRS.** It was exactly the same. I was there already, fortuitously, whatever, but the Surviving Sepsis, I already had a chart which ideally could identify sepsis, severe sepsis, septic shock. It was already there. It affirmed what I was already doing." (Dr Lewis)*

Dr Lewis not only found Bone et al.'s (1992) piece, but he integrated it into Aurora's system to guide their practice. A publication of the collective actor (that later developed into the Surviving Sepsis Campaign) had a significant impact on this practice community. Similarly, the UK policy community's sepsis-related publications in 2000 heightened awareness and resulted in key government funding for specialist nurses. They were aware that Outreach services were in place elsewhere in the UK and that some were reporting good outcomes. SIRS and the nurse Outreach service (explored below in detail) made up fundamental parts of Aurora's sepsis knowledge systems. These originated from the research and policy-related communities.

The knowledge in practice problem represented in this time period centres around the differences of specialisation between the ICU and ward staff. The critical care specialists believed they knew how to identify the precursors to severe sepsis whilst their non-specialist colleagues did not.

> *"I'm sure people, like nurses on the ward, just didn't know how big a killer it was to start with, how many people died from sepsis." (Kelly)*

> *"Our system was broken. You would see patients and they had been hypotensive and unwell for maybe 48 hours…[The ward staff] may not see the importance of [a patient's temperature and heart rate], so they may not report it up…they'll think, 'we'll just watch it'." (David)*

Initially the ICU staff reasoned that those with monitoring responsibilities were both unaware of the serious risk of sepsis and unable to properly track key indicators of concern because the disjointed information on multiple charts obscured their ability to identify a deteriorating patient. However, even when the information was accentuated and they had a SIRS score to assist, too often the ward staff were unable to interpret the data with appropriate urgency.

> *"Sometimes you would see a chart where for hours they had beautifully documented someone's demise. The [blood pressure] comes down and down and down, urine output disappears, but they just kept on documenting it." (David)*

Despite the first consensus definition of sepsis and the accordingly refined materials *"getting them to do all the right things all the time didn't work. Left scratching our heads"* (Dr Lewis).

Dr Lewis eventually came to realise that the disciplinary/specialist differences were not readily overcome. In an interview Dr Lewis pointed out that:

> *"Intensivists are often working according to different diagnostic criteria than other physicians…We have a very immediate mind set. We are not neurologists. We are not GPs. We are not dealing in a different time frame. We are not the best people to want to look at long, slowly developing illnesses. You know, our attention span might not be long*

> *enough… We have the ability to act on less than sufficient data. We are having to play the odds all the time." (Dr Lewis)*

Each discipline's perspective is driven by background, educational emphasis, and perhaps even temperament that attracted them to their specialisation. In a separate interview, Dr Jones agreed and explained that different specialties conceptualise illness differently, based on their training and function. As a microbiologist, he said that he:

> *"thinks in terms of specific conditions and specific germs. Whereas critical care come at it from more of an angle of sepsis is a physiological response and dealing with that rather than sepsis is an infection that needs to be treated." (Dr Jones)*

The depth of experience and professional role also played an important role. Each actor's knowledge was further linked to their profession and level of seniority in that role. Martha explained in an interview that it was often the student nurses who took the patient observations. This division of labour enabled the more experienced nurses to focus on the less routine work. The result was a division of both the types of specialised knowledge and levels of proficiency. In this way, the sepsis protocol was misaligned because the staff carrying out the observations tasks were those with the least amount of experience as well as those least heeded in the knowledge network.

By contrast, Dr Lewis credited his years of critical care experience as a major contributor to his knowledgeability. *"All I have is experience and outcomes on my side*." He laughs and continues,

> *"I've been doing it longer and I've been getting the success. Actually, there's always a time when you can say, 'The data isn't helping me make this decision, but deep down I know this is the right decision." (Dr Lewis)*

Because Dr Lewis's career began when critical care as a discipline was in its infancy (see Reynolds & Tansey, 2011) he did not have an extensive scientific literature to build upon.

> *"We didn't have the protocols, we didn't have the textbooks, we had nothing. We just had basic physiology and some knowledge about how agents acted and we had to plot our course for the patient." (Dr Lewis)*

He continued his explanation of how his specialist knowledge developed using a commonly used analogy.

> *"Anaesthetics and critical care are often familiarised to flying an aeroplane. Bush pilots in uncharted territory would plot their way by the stars, by the weather, by familiarity, whatever, how the air felt to him…and he had a better chance than a less experienced person…It goes with the old adage of the inter-war pilots navigating by the seat of our pants and the stars. And because our intrinsic knowledge and feel for things, we're getting the right answers much quicker. But it's not something you can export easily." (Dr Lewis)*

Dr Lewis attributed his expertise to years of work and trial and error, which resulted in an *"intrinsic knowledge and feel for things,"* a well-developed clinical intuition that guided his work.

However, beyond developing complex clinically-focused knowledge, Dr Lewis was adept at advancing the knowledge-based systems within Aurora. He was determined that he and his staff get patients in time to use their knowledge. They viewed the chart as the key to unlocking ward staff's awareness and set about retooling the form. Dr Adams and David reported that Dr Lewis involved the ICU team to help their non-critical care colleagues be able to identify a patient developing sepsis. Dr Adams commented in an interview that as a registrar under Dr Lewis, he helped to devise and test the SIRS-based chart. David also noted in an interview that he helped revise charts and trained the non-ICU staff in their use. Dr Lewis drew not just on his fellow consultant's expertise, but those with less experience and from a different profession by involving junior medics and skilful nursing staff as well. Tool development was an inclusive process.

While Dr Lewis had the structural authority to direct the staff, protocols and materials within the parameters of ICU, his responsibility did not extend outside the walls of the ICU. In order to reach beyond his own specialist area and coordinate elsewhere in

Aurora’s knowledge network, he had to negotiate with and obtain the agreement from his medical colleagues and hospital management. As Dr Lewis explained in an interview:

> *“Because I was the head of the ICU, they understood where I was coming from. I didn’t actually say you need to get rid of your other charts. I just said, any sick patient coming into the hospital, they go on this chart until their consultant says this chart is not a requirement. Once the consultant body realised they had control of it, then it became the standard chart for the whole hospital.” (Dr Lewis)*

In this way, Dr Lewis did not infringe upon his colleagues’ professional autonomy. Instead he worked around it. Based on his institutional position and authority, as well as what he perceived as his colleagues’ mutual value of providing good care for their patients, he provided a new tool. Furthermore, Dr Lewis was patient by allowing time for staff to adjust and see the benefits of the new chart. He gave other units the opportunity to become familiar with the chart and allowed for its incremental acceptance.

In addition to being patient, Dr Lewis was inclusive. He welcomed the input of many staff (not just doctors) during the chart’s development. Similarly, the earlier quote regarding intra-professional variation showed that Dr Lewis acknowledged that the other units in the hospital system held expertise needed for a hospital to fulfil its service mandate. He said that just as critically ill patients would not get the care they needed in the wards, less urgent patients would not get the care they needed in the ICU. This mutual respect was held by others on the ICU staff as well.

Kelly said,

> *“It’s just what you’re used to. In [the High Dependency Unit] they’re used to certain procedures, traches, vents, etc, but if they [with their specialised knowledge] went to the stroke unit, they’d be like, ‘whoa’. But then the opposite would happen. The stroke unit have their expertise in stroke, so it depends on what you do with regularity. It works both ways.” (Kelly)*

Similarly, Leann said,

> *"If we don't know something, we don't claim to know it. We would get back up. And we utilise all the other sort of specialist practitioners, nurses, whatever they would be." (Leann)*

These ICU practitioners understood the limitations of their own expertise, respected that other actors' knowledges and roles were outside of their own realm of expertise, and accepted the inevitable division of knowledge that results from specialisation. Furthermore, they expressed that whilst they held knowledge relevant to sepsis, the other units held knowledge they did not. They valued the differences in knowledge within an interdependent health system.

Nevertheless, there were times when Dr Lewis applied pressure. In an interview Dr Lewis gave an example from a meeting of the hospital's consultants. He said if another patient arrived to the ICU when *"all the information is right there in front of you"* he would report them for substandard care.

> *"A little bit of hardball had to be played, especially to my consultant colleagues. Even when they'd accepted the chart, and it was out there. And we still got people that were [not passing urine] for 3 days. And there it was, beautifully documented and not done. I must say… we had the system then that the hospital was small enough all consultants could attend a meeting on the Wednesday afternoon. We were all there. I had it on the agenda. Yet again. I have two patients. Look at these charts. I've photocopied them. The charts show they were [not passing urine] for well over 48 hours and then we get called when they're in their terminal decline from renal failure and cardiac failure. I said, 'You all know this is wrong. You've all got the charts there. The next one of these I get, I'm going to say to the GMC, 'This was incompetent care.' And they said, 'You can't say that!' And I said, 'You tell me why it isn't. You have the knowledge. You have the data. You are looking at the patient and didn't act on it. What is competent about that?' (*He snaps*) Next time, no problem. Masses of interest!!…Now whether or not I actually would have done is another matter, but the fact is, I was pointing out to them, how can I as a doctor say this person died for reasons other than medical incompetence?" (Dr Lewis)*

While Dr Lewis critically prodded a group in public, correcting individuals was done in private. He gave two examples in an interview.

> *"'Actually, you missed the boat. What do you expect me to do 24 hours too late? I mean, you had all the markers here.' You sometimes have to be robust with that, in a private environment where they're not losing face to colleagues." (Dr Lewis)*

> *"The SHO, early registrar will say, 'Oh, I did this and this and this'. You have to very gently say, 'Why do you think I'm going to say up to ITU now? 'What were you thinking of? Why were you thinking that? How do you interpret that?' Look at the whole picture. What am I seeing that you're not seeing? You have to educate them without humiliation." (Dr Lewis)*

In summary, over this time frame the knowledge system-based strategies to help others know and change their behaviours focused primarily on adjusting the communally shared tools. The central individual actor in the knowledge network was Dr Lewis. The collective actor was the ICU. To develop the patient observation chart, they used their reasoning abilities to devise a shared tool. They drew on their specialist knowledge from a combination of their training, years of experience, and research publications. *How* the knowledge network assembled these forms of knowledge, *how* they went about connecting these domains, and, importantly, *how* they mobilised their knowledges for use within Aurora, was embedded in the social interactions between the system actors. To develop and revise the charts, Dr Lewis was inclusive, drawing on a range of actors' knowledges and experiences. To share their knowledge with others entailed a bold yet gentle course. And to get the charts into wide use required they be alert to issues such as professional autonomy, as well as carefully building and releasing tension.

### 6.2.3. Incorporating Outreach on the Wards

Aurora had reworked their system's patient information document and yet the tool did not contain or share the knowledge necessary for improving sepsis care. In this second movement they turned to reassemble actors in the network structure and put in place new processes. The key actors expanded beyond the confines of the ICU. The Outreach service and ward staff became active parts of Aurora's sepsis knowledge network as well.

The establishment of an Outreach service reconfigured the contact between actors. Former charge nurses were now largely outside of the ICU, providing one-on-one help, training courses, and looking after patients elsewhere in the hospital. And yet Outreach maintained their structural ties with the ICU. Their office space was located in and shared with senior ICU clinicians. Equally important, when elsewhere they had the *"back-up of the senior critical care clinicians, which they know they always do. They are… doing it in our stead, and that we know that they're doing it in our stead" (Dr Lewis).* David said in an interview that he rarely needed to draw on their authority, but at times it proved helpful. *"If someone challenges this, 'Why do we need potassium checked daily?' 'Because we do. It's important.' 'I don't see the point.' 'Well, the consultant in anaesthesia wants it checked daily.' I can use that as support" (David).*

Relatedly, the link between Outreach and the ICU consultants was important not only for addressing resistance from other medics. The Outreach specialists' direct access to ICU consultants established a new, direct communication conduit for ward nurses that stepped past the traditional professional and specialisation boundaries.

> *"A nurse in the ward who is concerned about a patient, their first point of contact is a [Foundation Year 1] doctor. They're turning to a doctor who it's maybe their first day in the ward as a doctor. When I'm concerned…my first point of contact is a consultant anaesthetist. And that is an important, a crucial difference." (David)*

Kelly also noted that the traditional chain of communication dictated that nurses talk first to the junior doctors.

> *"They wouldn't think they had the authority to pick up the phone and call the registrar. But we're not scared to pick up the phone and call the consultant. I mean we, I suppose it's just the relationship we have with them. We know that if someone's sick and we're not getting what we would like to get from it, a decision, or someone to see the patient, then we go higher until you get to the top." (Kelly)*

In this way Outreach had both the authority of the ICU as well as a direct line of communication that side-stepped and rewired some of the boundaries between professions and specialist units. Outreach had the relationships that allowed them to bring their knowledge to bear and work around the hierarchies that slowed the early identification and treatment of septic patients.

In an interview Leann said that for these very reasons she thought the consultant body was initially reluctant to put in place an Outreach service. *"[Outreach] would belong to [ICU] and why was [the ICU] thinking their nurses needed to come down and interfere in their role" (Leann).* Dr Adams agreed that there was some resistance. *"The cynics would say it's a bit of a back door into the ITU…a bit undermining…Why are Outreach involved?...But that is by far and away the exception rather than the rule" (Dr Adams)*.

Putting Outreach in the wards was perceived by some as the ICU overstepping their remit, while others were concerned about the implication of the service and their own competence. Overcoming these concerns with the structural rearrangement was borne by David. From his recollection, while most wards welcomed his presence, some senior nurses raised questions, *"'Why do we need you to come in? We didn't have you before, why do we need you now?'"* David reported that he responded by saying, *"You're experienced…maybe you don't [need help], but another nurse would actually welcome a bit of support."*

And yet as the Outreach team grew, acceptance from the hospital staff was an individual process that had to be earned by each new member. Leann said,

> *"I found when I started this role that David was a hard act to follow. Everybody knew David, he'd been there for years and he'd proved his wealth of knowledge and his right to be there. But even when I started in the post, you have to build up those relationships for yourself…I did have to prove my worth." (Leann)*

As new staff joined the hospital these relationships had to be built person by person.

> *"Once they get to know us, I suppose you don't trust someone as soon as you meet them. But I think as soon as we've built up that relationship with them, and maybe after we've helped them once. After we've had a difficult situation, and we've helped them once then the next time,*

> *they'll say, 'Oh.' They recognise that you can help. I suppose that trust does build up pretty quickly." (Jackie)*

> *"New consultants that come, you need to build up that relationship with them before they use you as such. They're not really sure of your role and what you're actually, how useful you can be." (Leann)*

I asked Dr Adams if his perception was that his medical colleagues throughout the hospital trusted the expertise of the Outreach team. He replied that *"The way around [reservations of Outreach by medical staff] is the vast majority of the nurses find help from the Outreach team, and so whatever happens, Outreach still get called, Outreach still get involved."* Leann agreed saying, *"Only with the very experienced nurses were we viewed as a threat. Most of them are very, very, their resources are so pushed that they're so glad there is someone there to help."*

Further affirmation was documented in a print publication. A consultant head of service stated that *"Critical Outreach means that if any of my patients are showing significant signs of deterioration…there is a reliable way of being identified, assessed and treated by the expert team of Nurses...Critical Care Outreach is a way of putting into practice all the recommendations that have come from studying unnecessary mortality and morbidity in hospital patients, the ability to rapidly assess people who are deteriorating and the ability to stabilise them as quickly as possible and if necessary transfer them to an intensive care setting."*

However, the Outreach team's relationship with registrar level doctors was more variable.

> *"I think resistance, I've seen much more resistance from probably registrars, the dual grade doctors. Junior doctors really appreciate our help and advice. They become our friends. David has a good relationship with all the junior doctors. He quite often takes them under his wing, does a lot of teaching. They become our friends. The consultants know who we are, know our experience trust us completely. And sometimes will quite often phone on a Friday afternoon and say 'I'm just a tiny bit worried about this patient could you just have a look over the weekend' and they'll be home thinking, that's fine, they'll have a look. But the registrars I think, they're at a level where they think, I*

> *don't need you. I find that mostly. David, Kelly, Leann and I have all spoken about this, and we agree that it's the middle grade of registrar. They'll argue with you a bit, that they don't agree, or they don't think whatever you say, they'll say, no, just leave it. I don't want that just now. I think they're maybe that's all part of building their own confidence, and clinical ability. I would say we get most resistance from them." (Jackie)*

In a recorded conversation after an interview Leann and Kelly affirmed this view. They stated that *"You'll often get that with a registrar, 'Well, I don't need a nurse as a backup."* They continued to explain how, eventually, they overcome the view that Outreach is not a useful support.

> *"We get a registrar that comes from [a major medical centre] and they're not particularly keen on Outreach. We can all sort of judge, we can all say, they won't utilise us. They don't need us. And, again, then they get the one case where they weren't able to come, and we've dealt with it. And they're eternally grateful, and then they will utilise us." (Leann and Kelly)*

As noted earlier, with Outreach's new functional position in the knowledge network came four new processes. Firstly, they monitored patients that had been discharged from the ICU. In addition to having a higher risk of deterioration, because the ICU had already been responsible for these patients' care they reasoned that there would be fewer concerns about the ongoing involvement of an ICU-related staff member.

Secondly, they instituted a referral process for patients who triggered an early warning score. Dr Lewis reflected that formalising the Outreach service's support within Aurora's protocols enabled the ward nurse or junior doctor *"to come to us…and not be told it doesn't matter by a trainee…Whereas consultants are happy to ring up ICU, it took a lot for the juniors and the nurses to jump ship."* Furthermore, Dr Lewis believed that nurses felt more comfortable going to another nurse, and *"that's why [a nurse-based] Outreach made sense" (Dr Lewis).*

Thirdly, in addition to the formal referral system, Dr Lewis sought the agreement of his senior medical colleagues to offer an open invitation for staff to call for a patient assessment by Outreach.

> *"One of the key points that I got established with the consultants at the beginning was that it was acceptable if their team wasn't responding appropriately, either negatively or just didn't, then it was acceptable that Outreach would be informed as well so that the patient didn't suffer. And they were highly delighted with that…It's never been, 'let's exclude the team', it's always been 'let's take away the barriers from the people who can make the decisions finding out about it. And some of the barriers are nurses, because they just don't feel empowered. We empower them. The Outreach team has empowered nurses, especially experienced nurses, but all nurses to ring up." (Dr Lewis)*

The intent was that Outreach would be reliable and willing to listen to every person's concerns. Dr Lewis explained that, *"If you're not getting what you need from one team, there is another team that will always respond and support you."* And to the Outreach staff he said, *"Make sure it's a positive experience. Always thank them. If you turn them off, they will never call you again" (Dr Lewis).*

In this way, the new protocol relied upon the mutuality between staff. And, together, these three new system protocols helped address regular communication challenges. As Jackie explained in an interview:

> *"It's lovely to be able to go and help. You can tell, the nurse in the ward, they don't know what to do. Someone's urine output's dreadful, and they've told the doctor, and nothing's been done. You know as a junior staff nurse I would have loved to have Outreach. I remember what that was like…We had nobody else to tell apart from a junior doctor as a junior staff nurse. So, I would have loved to have, to be able to phone Outreach and somebody comes and helps me, and you know it's going to get sorted out." (Jackie)*

The worth of the Outreach service to nurses was evident during my observations as well. Many times whilst I was on the ward nurses approached me to explain their gratitude for Outreach, saying how much they valued their help and support. And while the original idea of Outreach was to support the ward nurses the service helped the less experienced medics as well.

> *"Surprisingly one of the groups we've supported as much and sometimes more than nursing colleagues is the junior doctors. It releases the pressure. I hadn't predicted that…In the early days, especially those on their first ever wards it's an immense responsibility and we really should do everything we possibly can to support them." (David)*

Leann agreed saying, *"Our workload increases phenomenally in August when the doctors change. We're called all the time."*

Outreach not only provided expert help and access for less experienced staff, but, as Leann explained in an interview, a charge nurse had recently commented that the Outreach service was helpful to her because *"there's quite often patients I'm worried about, and I just need a review, and I can't get one, but if you come along you seem to get a senior review straight away."*

The Outreach mechanism put in place a safe, knowledgeable source to call when uncertain. But more than that, the medical staff paid attention when Outreach was involved. Jackie and Kelly both identified this phenomenon. Jackie relayed that the nurses on the ward tell her that, "*'When you come, I know it's going to be sorted out because the doctors listen to you'" (Jackie).*

Similarly, Kelly said,

> *"It actually still happens, we occasionally get people phoning up saying, 'The doctors aren't listening to me. Would you come along and see this patient because I'm not happy with them.' And I'm not sure why the doctors don't listen…but when we go to the ward and say, so-and-so's not well, then they pay attention…They think that if I'm involved, then the patient must be sick. But why they didn't believe the nurse in the first place, I don't know." (Kelly)*

Each of the Outreach staff separately shared that consultants rely on them to provide another layer of protective care. For example, David explained (documented in the field notes) that many consultants use the Outreach team as a *"safety net, a safety* *mechanism*." *"At 5:00pm on a Friday when consultants from various wards are going home they'll call up [Outreach] and say keep an eye on these patients over the weekend. They understand the valuable resource that Outreach can be."* Leann shared in an interview that, *"It's not that [the patient] needed specific treatment. It's a safety net. They have potential to deteriorate, and please ensure should they deteriorate that you intervene."* The safety net for both the medics and patients is that with Outreach being aware of patients of particular concern, time will be saved if the patient does begin to deteriorate. Continuing her explanation, Leann said,

> *"That's through a trust and relationship thing. That's not a formal…there's nothing formal saying, saying CCOT should keep track of at-risk patients. There are medical staff there taking care of the patients. But they value us as a safety net. And I suppose they know we're here, we're skilled in the wards. You could have a locum doctors on who haven't known the patient, haven't been involved in their care. That relationship, it's taken time to develop that relationship with consultants." (Leann)*

Dr Lewis was aware that consultants depended on the Outreach staff as well. He said they were *"delighted with…the security they got from being able to ring up someone like David, 'Can you keep an eye on them. If they deteriorate can you let me know'" (Dr Lewis).*

Late into the evening during one site visit, Kelly was called to the Renal Outpatient ward to assess a patient. After talking with the patient, the renal nurse on duty, and reviewing the patient's chart, Kelly decided to page the consultant even though they had left for the day. Later, during a recorded conversation I asked about the extra step of communication. She responded saying,

> *"We actually have a quite good relationship with the renal physicians because they know we're here, looking out for their patients and if there's anybody with an [Acute Kidney Injury] on the ward, or any of their dialysis patients that arrived on the ward, we make sure they're contacted, because that's not the first thing the medics think about…They like [knowing about] their patients in their own specialty." (Kelly)*

This illustrates that Outreach activities provide a further information-sharing link that holds the actors within the system together. There was wide agreement that the Outreach provided a safety net for nurses, junior doctors, consultants. But they helped patients and carers as well. In a pamphlet describing the Outreach team, an Emergency Department staff nurse is quoted saying *"the team provide…good continuity of care for patients and their families when patients are transferred from the Emergency Department to the ward."*

Further patient testimonials about the Outreach service had been collected and said:

> The term Critical Care Outreach was unfamiliar to me but the reality of the care we received at [Aurora] made a huge difference to our overall experience.
>
> With the advice I was given by the Critical Care Team I felt confident to go home to recover and to prepare myself for my operation seven weeks later.
>
> We may not have been aware of what the Critical Care Outreach programme involved, but the impact of this innovative programme was absolutely vital to us. It is the little things that can make all the difference to patients and close family which is why the structured approach to CCO works so well.

What these comments demonstrate is that Outreach nurses also provided a reassuring stability of care for patients and their families as they moved through various units in the hospital. Ultimately, patients were safer. Compared to when patients would come to the ICU days after their organs were showing signs of distress, *"If we find someone that's been unwell for 3 hours now, we're getting annoyed" (David).*

Finally, the Outreach-run Study Day was a high dependency skills course that was open for all staff to attend. This was a traditional information sharing event, but brought nursing and medical staff from throughout the hospital together. Moreover, the day built relationships and trust. As the primary trainers, Outreach could meet new staff and demonstrate their willingness to help and support. The hospital-wide training headlined the service's knowledgeability. The day also provided an even wider point of contact and introduced newcomers as most new staff attended. The training events established their credibility in the knowledgeable teaching and coaching role, and provided the opportunity to be in contact, get familiar and build comfort as they heard first-hand Outreach's goal to support all staff before they are in a position to call Outreach and ask for help. This familiarity, David stated in an interview, assisted with supporting the referral system. This was because most staff knew him and had to opportunity to interact with him before asking for help. Furthermore, David reflected that over the last 15 years he had trained many of the nurses that now hold charge and senior charge nurse positions within the hospital.

Furthermore, David used the Study Days curriculum to build goodwill. He would invite many different clinicians, from a variety of disciplines. *"I had [respiratory therapy] do respiratory assessment, a physician doing pneumonia, an anaesthetist doing therapeutic fluids, anaesthetist doing blood gas analysis, I did sepsis, we did neurological assessment."* More than bringing together actors from different areas, he sought out ways to address their needs. David gave an example of the gastrointestinal doctors. They wanted to promote their scoring tool to ward staff in order to screen for bleeds. *"But the message wasn't getting out for people to use this score."* He included a section in the programme covering their tool. He explained that *"it's also good if there's something in it for them as well" (David).*

The new protocols further addressed the boundaries between actors for knowledge mobilisation. As the Outreach team expanded, the open invitation was augmented by thrice daily ward rounds. They were able to spend time walking the wards and the casual contact helped provide yet deeper familiarity. The formal protocols combined with the ward rounds continued to enhance Outreach's ability to share their specialist knowledge, but also opened the opportunity for learning from their colleagues about concerning patients. *"There's a lot of corridor consultations. There's a lot of meeting someone 'I'm just going to tell you about a patient'." (David).*

Knowledge was more than information located on a tool. Aurora implicitly reframed the knowledge in practice problem and provided a knowledge-filled human resource to help the least experienced and those whose concerns were sometimes dismissed. And in the exchange processes, Outreach developed to become a resource for all professions, specialisations, and at all levels of experience.

*Links to the Knowledge Network*

Mention of connection to the research and practice communities remained fairly limited in this timeframe with three exceptions. Firstly, Dr Lewis and Dr Adams explained separately that they were aware of various specialist team configuration possibilities. In addition to Critical Care Outreach, there were Medical Emergency or Rapid Response Team structures. *"Such as in New South Wales. I've spoken to people that have worked there,"* said Dr Adams. *"They go in, provide treatment, make the decisions, talk with the family, and go away again. It is a complete waste of time and resource and it took years to show a difference in outcome."* Instead, he said, *"Outreach is a nursing resource that goes and facilitates, and allows the right thing to happen using the resources that are there. And allows the right, the additional resources to be applied to the problem."*

Secondly, the governmental reports highlighted that many patients were dying unnecessarily from sepsis throughout the UK health system. These catalysed a response at the national level in both NHS England and Scotland. Additional financial resources from policymakers were allocated to address the problem. And while these documents raised awareness for much of the country, they legitimised the work that Aurora, Dr Lewis and the ICU staff in particular, had been doing for many years. Furthermore, the funding and political validation enabled Aurora to reorganise their local knowledge network forming an Outreach service.

Thirdly, in addition to the SIRS criteria the Surviving Sepsis Campaign continued to publish guidelines formulated from research. *"They came out and gave some good ideas around what end organ system dysfunction, how you could categorise those, and we've used those and incorporated those into our severe sepsis things" (Dr Lewis).*

However, the research content on its own was not sufficient, especially for diagnosing sepsis. For example, in an interview Jackie recalled a time she was asked to review a patient with an infected leg from an orthopaedic ward who had triggered a high SIRS score.

> *"I saw him. His face was red. He was sweating. He was kind of a little bit out of it. He was confused. He was only a man in his sort of 50s and he was really unwell. His BP was low. At first glance you thought, gosh he's really septic. But when I opened his drug cardex, I knew his kidneys were struggling and his kidneys had been knocked off a bit. Weren't working that well. When I opened his cardex he'd had opiate after opiate after opiate. It wasn't sepsis, he was completely opiate toxic, but nobody had really looked." (Jackie)*

She was taking in far more details than SIRS categories. Her knowledge included knowing what sepsis looked like, but also how to evaluate and see it was not sepsis. Relatedly, Kelly pointed out that sometimes *"the patient looks really unwell even though the data isn't capturing it. The bottom of the bed tells us they're going to crash and burn. And 99.9% of the time we're right" (Kelly).* When asked where this sense comes from, Kelly replied,

> *"I think time. I suppose once you've seen one person having a condition, you remember, oh, that's like so-and-so, I wonder if this is what's going on here. It looks the same, the same things seem to be happening. Over time you definitely draw on your experiences." (Kelly)*

Another example of various forms of knowledge working in concert, to provide a mindline 'check', was when Kelly called the renal consultant. She was aware that she was not a specialist trained in renal care, and was cautious that her lack of specialist knowledge might have ramifications of which she was unaware. Documented in my field notes, she said that her *"gut"* told her everything was okay, but that she still needed further confirmation from the clinician with ultimate responsibility.

Another reflection recorded in my research journal further substantiates that the harmonising of different forms of knowledge is important for high-performing care. After my first interview with David. I wrote, *"[I] observed to him that he is working* *from intuition, knowing the people involved, knowing the place, the organisation, resources outside organisation, and is proactive in finding those resources to continue to nurture their success. He agreed."*

Clinical acumen was indeed essential for Outreach nurses. *"We have always gone for ICU sisters, because the key thing for Outreach is you've got to be able to spot at 20 yards a sick patient" (Dr Lewis). But he also* stressed that a more holistic knowledge was required. *"Clinical expertise and inbuilt confidence. They must be able to overrule an aggressive middle grader. Or even a consultant to say I'm backing my own clinical experience. Doctors are trained to stand up for their clinical judgement, but nurses are not trained to do it."*

Kelly agreed saying,

> *"From a critical care background we're maybe astute at recognising when patients are sick even when they don't look sick. There are certain physiological things that we know aren't right. I suppose that's our specialist knowledge from our critical care background that makes it good to go out to the wards and share our skills." (Kelly)*

*"You also need to use your judgement. Sometimes the SIRS score is masked by something, beta blockers, steroids, and even paracetamol can mask a patient's real temperature. SIRS data helps, but you still have to have clinical judgement."* (Leann)

Jackie gave an example of gaining confidence to speak based on her judgement that came as a result of a very difficult situation:

> *"I was called to see a patient who was quite sick"* and was about to be transferred to a nearby major medical centre*. "The nurse came up to me and said, 'Jackie, the ambulance crew is here to take her…but she looks terrible'."* Jackie agreed and thought the patient should be closely monitored. But the ICU registrar who provided the consultation disagreed. The registrar was *"just kind of snippy. She said, 'She looks the same as what she's looked. Looking at her chart, nothing much has really changed. Just let us get her to [the specialist hospital].'"* Jackie responded, *"'Her [oxygen saturation has] dropped, you know, she looks terrible.'"* The registrar called the consultant. To the registrar *"he said, 'I trust your judgement, 'just*

> *get her to [the specialist hospital].' And the junior doctor said, 'yeah, let's just get her to [the specialist hospital]'. The ambulance crew said, 'It'll take us 40 minutes on a blue light.'… I was standing there thinking, 'I don't think this is right'…They got a really junior staff nurse to go with her. I don't really think she picked up she was deteriorating on the way there. As they went into the renal unit, she died…It all sort of blew up. Do you know? It really affected me, because I was thinking I don't think this is right. I should just have said 'this is not right'...Because of that case, I have no hesitation. I suppose that's made me more so sort of determined to sort of pass that message along to other nurses. It's human factors isn't it. It's part of human factors. Speak up." (Jackie)*

The tragic result taught her to have confidence in her intuition that something was amiss.

Thus far we have seen that choosing the 'right' personnel for Outreach involves being a highly experienced, confident critical care specialist nurse. But more than epistemic-related aptitudes, skilful interpersonal abilities were also necessary. Dr Adams pointed out in an interview, *"There has been a history of taking critical care, charge nurses, senior nurses out into Outreach. But you have to be careful which ones do it. David is a fantastic politician. He can communicate exceptionally well. And because of that [Outreach is] a success"* (Dr Adams).

The individual's productive relational skills were proved necessary when a nurse was brought in to provide maternity care cover within Outreach. In a conversation with Kelly and Leann they explained,

> *"Even though she was a [local] girl, she'd been trained into a different way of relating that did not work here…She rubbed everybody's back up because of the way she behaved. She had the city attitude to things, I don't have to talk to you in the corridor. In fact, that's exactly what we do. We say hello to everybody." (Kelly and Leann)*

They went on to explain,

> *"I think there was a lot of…she didn't have the relationship that she was there to help. She had the old Rapid Response Cardiac Arrest team go in and shout, 'Why hasn't this, and this and this been done?', which led to a lot of complaints coming back as to why did [the ICU] think that*

> *sending someone to check up or, which is not at all what we want to do. We're a safety net to assist and make sure things are happening. I don't think people perceive, they like people checking up on them. You get very defensive, don't you?" (Kelly and Leann)*

They summed up, *"She just didn't fit. She was a nice girl, but she just didn't fit."*

The primary reason the highly experienced maternity cover nurse did not fit was because she kept herself separate and functioned using blame. At Aurora, the Outreach staff depended on building and maintaining good professional relationships. She was less personable, which hampered her ability to share and use her knowledge.

Yet, remaining even-keeled and amiable was not always easy. The Outreach team members did feel very frustrated at times.

> *"You need to really be careful, and not fall out with people, or be too stroppy, because then they're not going to phone you or they're going to be scared to approach you again. I mean, David has always promoted that as well. There's a way of saying things gently, 'Oh you may have done their [observations] more often' without being overly judgemental, and damaging relationships… because that wouldn't be productive for anybody, for the patient or the staff relationships." (Jackie)*

From David's perspective, diplomacy skills were of utmost importance for the Outreach role.

*"Diplomacy is second only to clinical competence"* (David). This section has already described times where David diplomatically soothed senior nurses' concerns around perceived professional insult. He was attentive to the social dynamics, pressures, and tensions and sought ways to alleviate them. In this way, more than being a nurse, having specialist critical care training, and extensive experience, the qualities of the individual were important. They needed to have clinical competence as well as political, negotiating, and communication skills.

And while Outreach staff were largely non-confrontational, they would have difficult conversations when necessary. When a critical incident occurred, they would talk with the ward sister. *"We would take it to them, not as an accusing, but as a learning thing. This happened, how can we stop it happening again?" (Kelly).* Thus, the Outreach team did give uncomfortable feedback and tell a nurse or the supervisor that something was missed, but they sought not to be harsh or criticise.

Indeed, Leann gave an example where pursuing a tension-filled conversation established further credibility. She said that early in her Outreach position she came across a patient that she believed needed to be moved to the ICU. She spoke with the patient's consultant who made it clear that he was not interested in hearing her view.

> *"He left the room. And I thought actually I can't let this go. I really think this patient should be in ICU. So, I went out to the corridor behind him and pleaded my case, excuse me, I just wonder if we could discuss this further. I really think, and I gave my case. And he apologised. That's fine. I didn't realise that…Ever since then, we've had a completely different relationship. It was almost like I proved myself and my ability. And one time I phoned because I felt a locum registrar wasn't doing what we normally have done in this hospital. He said, put the registrar on. And he said 'Do whatever it is Leann from Outreach tells you.'" (Leann)*

And yet, while Outreach had confidence in their own views, they also deferred to other specialties.

> *"I don't go into the [cardiac ward] and claim to be able to treat any of their cardiac patients as well as they can. They're all cardiac nurses. I would think nothing of phoning them and saying, 'Look, can I get a wee hand. I've got somebody's whose…It's knowing your limitations and your area of expertise" (Leann).*

Leann went on to point out the central role of professional relationships bringing together their variety and diversity of skills. *"If we don't know something, we don't claim to know it. We would get back up. We utilise all the other specialist practitioners, nurses, whatever they might be."* She had an awareness of her own knowledge-based limitations and found that extending requests for help to other actors built good will and appreciation. Furthermore, these actions built trust, which enabled knowledge to flow both ways.

The Outreach staff also deferred to the consultant body. *"The consultant, you kind of think, they're much more experienced, it's their patient, and they have the final say in what happens" (Kelly).* Even when they disagreed, in the final analysis the consultant was responsible. As seen in Kelly's interchange with the renal consultant, it was ultimately the consultant's patient, their credibility, and their responsibility. I later observed a conversation where Jackie asked Kelly what she did when a medic did not listen. I recorded in my field notes that Kelly responded that you do your best, you document your concerns, but as nurses they had to remember that with the medics' responsibility they had the authority to provide the final say. At times she disagreed and tried to dissuade the doctor in charge, but ultimately recognised and accepted the limitations of her professional role.

But the Outreach team's deference was not just for highly knowledgeable colleagues. In a later recorded exchange with Kelly, she explained how she tailors her advice depending on the experience and role of the recipient.

> *"If a student nurse was referring a patient to me, I wouldn't necessarily expect her to know as much detail. I'd want her to know the basic details but not about the processes that are going on that's making this patient sick. Whereas a staff nurse I would hope that she would. And then the FY1 I would think, hopefully thinking on the same par as me. And then..." (Kelly)*

She paused. I interjected asking how a foundational year doctor could be on par with a nurse of 25 years. She laughed, *"Okay, they're a little bit below me. But I don't like to make them think I know more than them. They're a doctor."* I restated asking, "They're growing in ability and confidence?" *"Absolutely!"* she replied.

My field notes noted:

> Again, [Kelly's] careful and sensitive in her stepping. Not using her experience and knowledge as a status/power tool. And views it as her part of her responsibility to build up [junior doctors'] confidence and to

> treat them as their capabilities will (hopefully) one day deserve.” Later in reference to another foundational year doctor she said, “‘You would think, I mean he’s an FY1, he is going to be an excellent doctor. He is an excellent doctor’.

Kelly saw it as part of her job to help the junior medics develop their skills. It was part of her role to help them become doctors.

In order to help all staff develop their knowledge, Outreach emphasised a learning rather than a shame culture. Leann explained in an interview that after many years as an ICU nurse, she had forgotten the pressures and demands that nurses faced on the ward. When a treatment had not been completed for a patient in a timely manner, *“I was going in all guns blazing: ‘Why on earth has this not been given? That’s not appropriate. And this needs to happen.’ A few times David had to pull me aside and say, ‘That’s not helpful’ (Leann).* David reminded her that care needed to be taken in dealing with problems such that the communication channel between the Outreach team and the ward staff was intact.

David worked diligently to help his team establish and maintain productive professional relationships.

> *“It’s working together. If a nurse refers a patient and they come to Intensive Care, it’s always good just to say, ‘Thanks very much for that referral. You were on that really, really quickly.’ That means a referral again. We are non-punitive non-judgemental, and even though you want to have a moan sometimes, it’s a golden rule. I’ve said that to each team member that’s come. Never, ever criticise someone for a referral, or they’ll never refer again. It’s back to just having good working relationships.” (David)*

During ward rounds, the ward nurses were often alert when Outreach entered their area. The nurses would walk over and ask if they had overlooked a patient in distress. Outreach worked to reassure them. But more than providing reassurance, the Outreach staff frequently took the opportunity to converse (have a work-related ‘blether’) with the ward staff. In just one example drawn from the field notes: *“[A ward nurse] stopped me when Kelly and Jackie were in a room checking on patients.*

*She wanted to explain how much she values having Outreach as a resource. If she's concerned that 'something isn't right', she'll pull Outreach aside and talk through her concerns and have them check on the patient."*

In summary, in contrast with the last time frame, over this period the system changes involved new and shifting actors and processes for providing sepsis care. The knowledge network expanded to include more individual and collective actors. Whilst Dr Lewis and the ICU staff remained important players, the Outreach team took on the central role for mobilising sepsis knowledge. The ward staff became *part of* the active knowledge system rather than the recipients. And by involving a fuller range of actors, a richer array of knowledge was engaged as well. In addition to Dr Lewis's tacit knowledge, those with less authority, but more patient contact, were able to develop, share, and use their knowledge. Furthermore, reorganising the actors in the knowledge network and establishing new care processes that crossed specialty, geographic, professional, and epistemic boundaries was accomplished by social means. Outreach, in particular, but various actors tended to and nurtured professional relationships that crossed boundaries. They worked to neutralise, minimise, and manoeuver around tensions. The vital interdependency between actors in the system helped support positive interactions and helped a wider range of knowledge to be heard. But also the determination of various individuals to cultivate and maintain goodwill enabled Aurora's knowledge network to flourish in mobilising their knowledge.

### 6.2.4. Expanding Hospital-Wide: Deteriorating Patient Group

The inception of the Sepsis Collaborative in 2012 marked a substantive expansion of Aurora's knowledge network. Once again Aurora, this time along with the other 13 territorial health boards, recalibrated their sepsis structures. The nationwide effort brought changes to the organisation of actors, processes, and materials in Aurora's system.

While the Outreach team and ICU remained central stakeholders, staff holding official responsibilities for sepsis expanded beyond clinical practitioners to those with administrative roles. Because the Scottish Patient Safety Programme placed an emphasis on data collection at least two members of the Clinical Governance team (Sue and Martha) were hired to manage patient safety performance measures. They joined the Training and Development department, and senior hospital executives alongside additional clinical areas such as the Emergency Department, Microbiology, and senior charge nurses from each ward to make up the Deteriorating Patient Group (see earlier Table 6-2).

The Deteriorating Patient Group expanded the actors holding sepsis responsibilities to include those in non-clinical roles. But many began as health practitioners. Sue, Martha (from the Clinical Governance unit) and Hannah (from the Training and Development unit) were formerly nurses. In separate interviews each explained that their background training and experience informed their present roles. Alternatively, the new Chief Executive did not have a clinical background but was *"a finance person" (Hannah)* who depended on the senior medical staff for clinical insight.

Further key personnel changes occurred over this time period as well. Actors in senior positions, who had been in place for decades, departed. Dr Lewis retired from full-time work and handed his lead role in the ICU over to Dr Adams. A new Chief Executive and Assistant Director of Nursing also took up posts in Aurora.

In addition to new senior management staff in the hospital, the Sepsis Collaborative brought a new makeup of the knowledge network. In a shift from primarily ICU-held responsibility, the Deteriorating Patient Group reviewed, devised, agreed and implemented all formal policies, protocols, and tools related to sepsis. The group met between one and two hours every two weeks in order to coordinate their local efforts. Martha, the patient safety coordinator, explained the work of the Deteriorating Patient Group in an interview:

> *"This is huge. We've had to arrange meetings for every fortnight…It's quite a structured meeting…Initially, it was how we would introduce the sepsis program. And how we were progressing, and how we would spread it. We had to discuss successes and discuss why we were having difficulties." (Martha)*

The Deteriorating Patient Group meetings became the place where actors discussed plans, considered alternatives, sorted consensus and held one another accountable for accomplishing the goals of the Sepsis Collaborative. Furthermore, the Collaborative necessitated new processes and materials that reshaped Aurora's high-performing knowledge system. The Outreach team and referral process remained in place, however, new treatment, audit, training, and diagnostic processes were introduced. The integration of the Sepsis 6 treatment bundle into the hospital's systems was a priority. As explained in the last chapter, the six bundle steps needed to be completed within one hour of suspecting sepsis.

Kelly explained that the new treatment bundle was sometimes difficult for staff on the wards.

> *"I think [Sepsis 6] was a big ask, because if you've found someone who was septic, I think they felt they had to drop everything and concentrate on that person. Whereas they had another seven people that were still need a commode and drips are going. There are other things going, and to then dedicate an hour to this one patient was actually a bit frightening. You know exactly what you need to do. Yes, I think it was a daunting job for them." (Kelly)*

Outreach was able to provide support for the ward staff to complete Sepsis 6 within the required time frame.

Dr Jones' view was that the benefits of the Collaborative and bundle at Aurora were two-fold. Firstly, they brought additional support for the Outreach team's efforts.

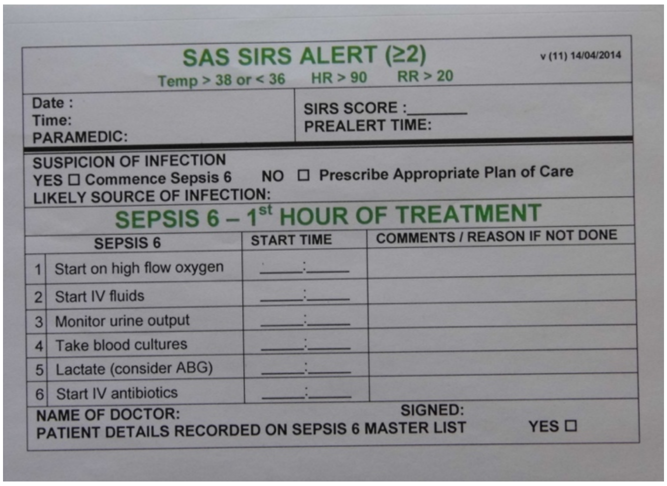
> *"When the [Sepsis Collaborative] and the sepsis bundle came along it was great because it gave the Outreach and critical care people, they could then go to the rest of the hospital and say, look, this is what we've been doing and now this is what we should all be doing. It gave them an easy way to get other people, gave an excuse to corner other people into doing it." (Dr Jones)*

Secondly, the bundle provided specific steps for all clinical staff to concentrate on.

> *"Teams like to perform well…having a target, having a set of sort of specific goals, is a lot easier to follow than some more complicated*

> *algorithm or weighing up different sorts of things. I think if you've got some things where it's reasonable to think that doing them will make a difference if you can put them into something that makes a simple target for people to do, then there's a fair chance of getting them done." (Dr Jones)*

A Sepsis Sticker documented whether or not Sepsis 6 was completed and in a timely manner (see Figure 6-1). Martha referred to herself as "*the Sepsis Lady*". It was her job to ensure the Sepsis Sticker was used by all units in the hospital. From these recordings materials she produced consolidated run charts that demonstrated compliance (or the lack thereof). Achieving 95% of the target equated success. "*Because the SPSP programme stipulates [95%] to achieve excellence…The Model for Improvement says that if something's been done [successfully] for nine consecutive points, it is embedded*" *(Martha).*



SAS SIRS ALERT (≥2)

v (11) 14/04/2014

Temp > 38 or < 36 HR > 90 RR > 20

Date :
Time:
PARAMEDIC:

SIRS SCORE :_______
PREALERT TIME:

SUSPICION OF INFECTION
YES ☐ Commence Sepsis 6 NO ☐ Prescribe Appropriate Plan of Care
LIKELY SOURCE OF INFECTION:

SEPSIS 6 – $1^{st}$ HOUR OF TREATMENT

| | SEPSIS 6 | START TIME | COMMENTS / REASON IF NOT DONE |
|---|---|---|---|
| 1 | Start on high flow oxygen | _____:_____ | |
| 2 | Start IV fluids | _____:_____ | |
| 3 | Monitor urine output | _____:_____ | |
| 4 | Take blood cultures | _____:_____ | |
| 5 | Lactate (consider ABG) | _____:_____ | |
| 6 | Start IV antibiotics | _____:_____ | |

NAME OF DOCTOR: SIGNED:
PATIENT DETAILS RECORDED ON SEPSIS 6 MASTER LIST YES ☐

*Figure 6-1 Sepsis Sticker*

The run charts provided a visible sign of success. During an interview with Dr King (clinical lead of A&E), he drew attention to the A&E charts posted on the wall of their main corridor. He was proud of the unit's regular 100% success rate and said that displaying the audit data helped to keep his staff motivated.

However, the new Sepsis Collaboration documentation processes also proved challenging. Martha said she spent significant amounts of time reminding staff to complete the Sepsis 6 sticker. Even (later) when the tool was integrated into the patient observation chart, *"some staff ignore it even though it is on the back of the chart. They don't look there at all" (Martha).*

The most substantive change in this time frame for Aurora centred on the patient chart. Whereas incorporating the Sepsis 6 treatment protocol fit neatly into Aurora's existing systems, the new Chief Executive decided that the hospital would move to the National Early Warning Score diagnostic charting system. No longer would Aurora use the SIRS scoring system that had worked so well for them. Instead, he charged the Deteriorating Patient Group with bringing the hospital into alignment with other boards in Scotland. The chart redesign, staff retraining, and rollout occurred over the year of data collection, and was the principal focus of the Deteriorating Patient Group meetings.

> *"There's a new chart they want us to use nationally in Scotland. And while I'm hanging on to [SIRS] for the moment because it's worked for us, you've got to look to the future. And with another hat on, I know that standardisation and reducing variation is the best thing. Doctors and nurses in [a nearby board] will use one chart and come here and use a different system. So we will cross over." (David)*

Perspectives on the new chart amongst Deteriorating Patient Group members appeared divided. Those with outward, health system focused roles supported the change. In addition to the Chief Executive and Assistant Director of Nursing, Hannah in the training and development unit said that the shift was *"a helpful thing from the government to move to the NEWS."* While crediting Dr Lewis for Aurora's well-known success around sepsis care, she went on to say that, *"We were kind of an island of excellence…Things can feel like, 'we're okay'."* As a result, Hannah said the change to a NEWS-based chart had been difficult for the clinical staff to accept. She said that they needed *"a culture shift, from the 'we're fine' mentality for [the clinicians] to agree that we need to be in line with everybody else."* She explained that they were concerned about the (then pending) shift to NEWS *"because they don't think it's broken at the moment, but there is recognition* [due to the SPSP] *that we can't do this on our own, and it will be helpful. Because the doctors rotate, and Scotland's a very small country."*

Moreover, Sue, the team leader for clinical governance, had a different view of SIRS and Aurora's sepsis success from every clinician I spoke with. *"I would debate whether [sepsis care] has been successful here. We haven't got utopia. I'm a lone voice saying that, but I just don't believe we have utopia."* At Deteriorating Patient Group meetings, Sue regularly provided contrasting perspectives. One reason for her differing perspectives was that her role and responsibilities were geared toward NHS-system wide compatibility. *"My role has been to gather information from other health boards, nationally, to provide [those with direct treatment responsibilities] with ideas."*

Meanwhile, Leann expressed the worries of clinical staff saying,

> *"The NEWS score just looks very, very busy and very complex [in comparison to SIRS]. You just wonder how well it's going to be filled out. That's why particular are very, very twitchy about changing to the NEWS. Why are we changing something that's working for us. But nationally, obviously, they're saying we need to standardise." (Leann)*

More succinctly, Dr Adams said, *"The national efforts have been welcomed and feared, because if it's not broken, don't fix it."*

Despite their reservations, the Outreach team dedicated their efforts to help the changeover. Kelly, in an interview said, *"Unfortunately, well not unfortunately, it's about to change, our chart system, which will be a big challenge. But we're up for it…because we've got to go national."* Later that day in my field notes I observed that *"It seemed like she caught herself. It's clear she disagreed with the decision to shift from SIRS to NEWS, but is now trying to be supportive and move forward."* Almost a year later Kelly was more definitive. In a conversation described in the field notes: *"She's having to use NEWS despite not trusting the trigger to work as well as SIRS. I said that you didn't have a choice, but had to make the best out of it. She replied, 'That's exactly the case.'"*

This period saw a robust connection between Aurora and the wider knowledge network. The Sepsis Collaborative meetings increased the interconnectedness between practitioners in Scotland. Between 2012 and 2014 most members of the Deteriorating Patient Group attended the face to face meetings, and participated in the monthly WebEx calls. The Collaborative website provided a place to share research, policy and practice information with one another.

Sue gave an example of how the SPSP built a community of peers with her Clinical Governance counterparts.

> *"I have networks. There's one of me at every health board, so we're always chatting. 'Has anybody got this, anybody got that?' So, we're always kind of sharing ideas…we have quarterly meetings face-to-face, but we email each other all the time." (Sue)*

The NHS's Scottish Patient Safety Programme (SPSP) was guided by the Institute for Healthcare Improvement (IHI). And IHI's formal link with the Surviving Sepsis Campaign (SSC) meant their research was highlighted as a resource for boards. *"SPSP was the real driver of [Sepsis 6], and the SSC" (Kelly).* Leann agreed. *"The SSC…they were sort of the first people that gave you a sort of diagnosis. So they were up there pioneering. There was no diagnosis for sepsis. There was nothing. So what we did was things that SSC advocated."*

Kumar and colleagues' (2006) work was a key example. David explained, *"We always knew that the earlier you give antibiotics the better. We've always known this. We weren't calling it Sepsis 6 but we knew if someone was septic and hypertensive, that was bad. The sooner you started treating that the better."* But the resonance of Kumar et al.'s (2006) work was, at least in part, due to the visible simplicity contained in a widely presented chart:

> *"Kumar brought out a paper in last few years, there's a lovely graph on it, which shows, it's almost linear, that survival from antibiotics, and as it comes, as the survival goes down, and he actually worked out that for every hour you delay antibiotics, mortality goes up 7.6%. It's a beautiful wee graph." (David)*

Kumar et al.'s graph was the single most referred to piece of research literature throughout all interviews, presentations, and conversations. It was mentioned by every doctor I interviewed as well as each member of the Outreach team. However, when probed about the reason for the one-hour time frame in the Sepsis 6 bundle, no one linked Kumar's graph as the supporting evidence. When asked, Martha instead spoke of her reliance upon knowledgeable figures in the knowledge network.

*"Professor Rooney…they've done all the research. It's actually evidence based stuff. And it has been proven to work…even WHO is involved with it."* However, Dr Jones and Kelly gave pragmatic reasons for supporting Sepsis 6:

> *"Getting the antibiotics in probably is the most evidence based for improving the outcome…People think they're all reasonable things to do. You're getting everything done that might reasonably have a chance to help the patient." (Dr Jones)*

> *"The evidence for this being a good bundle, I think, it's fairly basic stuff. When you think that that's what you would do…It's logical. There kind of is solid science behind it. And the number of times it doesn't actually fit that that's the thing you should do, is very, very rare, because you won't do your patient any harm in doing these things in the first instance. It's more likely that you'll do them a power of good." (Kelly)*

Leann was more emphatic about the value of Sepsis 6. *"The most important thing is that early recognition saves lives and implementation of Sepsis 6. It's the gold standard treatment and saves lives."* Her explanation for why she saw Sepsis 6 as the gold standard was based on Aurora's performance outcomes. *"It's the data isn't it. You need to know reducing mortality, reducing length of stay. There's lots of studies that prove the earlier you get antibiotic delivery, you're reducing mortality" (Leann).*

Only Dr Jones revealed that he had heard murmurs at a conference that Kumar et al.'s research might not be as authoritative as it seemed.

> *"The graph that gets shown…is possibly a bit dubious…it's possibly not as squeaky clean as you might think. But it's almost too good to be true, isn't it? It's a very powerful kind of image, isn't it? We haven't got that kind of graph for giving oxygen or giving fluids." (Dr Jones)*

Indeed, Dr Lewis was aware that the bundle concept was not based on research findings but rather their own local outcomes.

> *"Bundles work. We know bundles work. If you apply bundles rigidly, you will show an improvement. What no one can tell me is whether it's actually the elements of the bundle or the fact that you've just applied a bundle and therefore everyone is working in as much team harmony as you can manage. Because we all know it, before the bundle, yes we*

> *thought we did that, but when we actually measured it, you got those 4 [steps] 80% of the time, we never got the whole bundle right. So you do the whole 100% and all of a sudden your infection rates fall. But we know that if you then take bits out of that bundle, the infection rates don't rise again." (Dr Lewis)*

During this time frame both the policy and research communities were actively delivering their knowledge-based resources (in the form of updated guidelines, revised bundles, and the SPSP initiatives) to the practice communities. And yet the nursing Outreach staff looked to the consultant body to take the lead on discovery and assessment of the materials. During an interview when I asked the source of the scientific research material they used, Kelly replied,

> *"Probably just whoever has the biggest brain in ICU [and] thinks here's this paper, 'They say this, I think we should try this.' They normally would take it to the [Deteriorating Patient] meeting. And if nobody shouts and says, 'Oh no, we're not doing that!' then they would have the consensus." (Kelly)*

Aurora was a high-performing, research evidence-using organisation as a collective, not as individuals. Based on their professional role and position of authority, the medical staff were expected to remain current in their disciplinary area. When new material was provided to the Deteriorating Patient Group, the other professions were able to provide their perspectives. And the Outreach staff were aware of some of the controversies existing in the research network. For example, Kelly called Activated Protein C *"the very expensive wonder drug"* that later was withdrawn. And Leann pointed to *"all those studies by that German that said colloid this, colloid that, and then it transpires it was all fabricated and biased."* But not every member of the Deteriorating Patient Group needed to be reading the specialist literature and able to assess and critique the methodology. Nevertheless, the group decided together in consultation if and how their systems would be adjusted. In this way, they relied on one another to bring their areas of expertise to bear.

None of the ward nurses I spoke with queried the evidence for Sepsis 6 (or SIRS). They said that the knowledge they drew on was based on their training, the perspectives of their immediate work colleagues, and their prior experience. One example came from Alison, a High Dependency Unit nurse. On a visit soon after the chart transition took place, she described the first night they switched to the NEWS score and chart. She said her fellow nurses on duty expressed uncertainty similar to hers. To accommodate, Alison explained that she first calculated the NEWS score and then converted that to the familiar SIRS score. And after a few weeks of using a two-step interpretive process, she no longer needed to use SIRS in order to understand NEWS. In this example, Alison correlated meaning based on her experience to build sense of the NEWS score. The knowledge needed to find her way forward was built using prior experience and creative experimentation for using the new protocol and chart.

The early warning scores provided a simple form of communication between doctors and nurses. Relatedly, Dr Lewis wondered whether the value of bundles lay in the cross-professional, multi-unit coordination required to get the bundles done. "*Is it actually what you're doing or just the way you're doing it?…Is it just that you've got everyone singing from the same hymn sheet?" (Dr Lewis).* In this way, both early warning scores and bundles established a shared language and engagement in order to overcome divides.

And yet, the deeper integration with the practice and policy communities came at a cost for Aurora. Changing Aurora's knowledge systems highlighted some tensions between units. For example, Clinical Governance's priorities were largely externally focused toward areas of concern to NHS Scotland and audit reporting bodies. The prior hospital executive structure could take credit for Aurora's sepsis success. But the new Chief Executive and Assistant Director of Nursing came from a different board and did not have ownership in the success of the SIRS- and Outreach-based system. They had experience with different processes that had been successful elsewhere, such as the AIMS Training rather than the Outreach-led Study Days. They brought different views about what systems to use, such as the national chart rather than SIRS. One staff member observed that a standardised NEWS chart might meet the needs of the workforce around Scotland, *"but not for us".* Aligning communities does not necessarily equate to aligned benefits.

In an interview, Dr Lewis predicted, based on what he had learned from efforts over the last decades, that returning to rely on an early warning protocol and revamping a knowledge sharing tool was not enough.

> *"The point is, what's happening out there is they're exporting the monitoring system. Are they exporting the education? Are they exporting the Outreach? No. We tried a lot in the early days to find other systems that aren't going down the Outreach pathway. There are other systems not called Outreach, but something similar, but didn't really have a monitoring, a trigger system but did have a call system but it was bits of the puzzle, but didn't actually put the whole puzzle together…That's my problem with the current system. The government thinks it's the NEWS chart. I know full well it's not the NEWS chart that's going to make the full difference. It won't even make a difference if you put the education into it. It will only make a difference if you put in that third element. Which is a ward based insight and resource." (Dr Lewis)*

Aurora's knowledge network knew from experience that putting knowledge-based materials in place was insufficient. A more holistic knowledge was needed. Relational connections between actors holding different roles and responsibilities is what helped knowledge to be successfully mobilised. And as Dr Adams explained, *"Now we're trusting the Outreach system to cover the potential gaps that NEWS creates."*

The interdependence of Aurora's knowledge network reveals how they addressed, minimised, and mobilised around boundaries. A variety of actors helped to nurture the processes and professional relationships, which in turn stabilised their knowledge systems in the midst of change.

For example, Sue, the Clinical Governance lead, saw her role as an organiser in the NEWS chart development, as the person standing between the standardisation and customisation process.

> *"I have been facilitating it more than making decisions on it. In this role I have to be quite careful…the Outreach team, the doctors, the nurses*

> *who are working in the ward every day, I have to let them make the decision what the chart's going to look like." (Sue)*

She was aware that the chart represented a marked shift for frontline staff. And while she was an advocate for its adoption, sensitivity was required.

Likewise, David believed that maintaining an awareness that all members of the knowledge network were engaged in a process of learning and change cultivated a productive and healthy environment.

> *"I think there's probably still some people want blood when something goes wrong. There can be a knee-jerk reaction to, right, who's at fault, who did this. But I think slowly but surely people are learning that that's, unless it's wilful, reckless behaviour, or repeated stupidity with no attempts to improve, people don't come to work to harm people. We all do our best. And when someone gets it wrong, we all get it wrong, we all get it wrong. It's about learning from it. The further you move away from blame, the quicker people will acknowledge when something goes wrong. That's the direction it's got to be. Throw up your hands and say, 'I got this wrong'. I want you to learn from this. I think we're moving in that direction…It's all about culture, it's all about culture." (David)*

Other actors provided soft nudges to encourage the completion of tedious but necessary tasks. Leann observed in an interview that Martha, the clinical governance assistant, had been instrumental in getting the ward staff to complete the required documentation. *"Martha goes into the wards every morning, 'please remember SIRS…Sepsis 6…sticker'. She's tried various different modes. Even tried taking sweeties in every Friday…pure bribery. It's constant reinforcement" (Leann).* Martha found creative and kind ways to encourage the staff to get their job done.

Sue's views on a variety of issues provided distinct and at times contrary perspectives at Deteriorating Patient Group meetings. As she was in regular contact with clinical governance staff at other boards, she relayed information about ways other hospitals in the country were managing, for example, the inclusion of pain scoring tools on their patient observation charts. While Sue provided a conduit to practices elsewhere, she also held strong views that, at times, contrasted with others in the meeting. And she was willing to support unpopular ideas. For example, whilst others were concerned and highly reticent to bring in the standardised Scotland-wide NEWS chart to Aurora, she was a strong advocate. When other members of the group proposed modifications to the standardised version, she challenged them. In this way Sue affected how ideas were discussed in meetings. Each person had to be prepared to provide well-considered reasons to support their ideas. As a result, Sue's questions minimised the risk of succumbing to agreement too easily.  Because of Sue's willingness to share alternate perspectives, any new processes and materials at the Deteriorating Patient Group underwent a refining process that might have otherwise been missed.

## 6.3. Mobilising Knowledge in the Practice Network

Over the course of these three time periods, the organisation of actors and the links between actor groups grew in size and evolved in form. Initially, Aurora relied on individual actor initiative to call the ICU. Then, in the form of the Outreach team, Aurora put in place a resource that included regular casual contact. Finally, the involvement of many more actors brought formal contact in the form of biweekly meetings and quarterly participation in the national Sepsis Collaborative.

The organisational assumptions about who held the necessary knowledge and the strategies for mobilising necessary knowledge resources also evolved. To begin, Aurora assumed that all health professionals had the requisite knowledge for identifying and treating sepsis. Each health care professional held the epistemic resources on their own. In later years, Aurora drew on the interdependency tied to the distribution of knowledge between actors in the network.

Yet these data show that it was difficult to cross social boundaries (professionally from nurse to doctor, geographically/proximally from unit to unit) even when there was an epistemic need. In an interview, Craig, a ward nurse of 19 years, explained that when he was an inexperienced nurse he was apprehensive about talking with medics. *"Now I can approach doctors, though I used to be afraid to ask for help."* This unease was not reserved to nursing staff. Dr Jones said that in *"my own personal experience of* *things taking a while to sink in because you were a bit reluctant to make that call in the first place."* Dr Jones's view was that the referral system and the Outreach team helped provide confidence in times of uncertainty.

A level of harmony between actors and their knowledge was necessary, and still their collaboration did not come easily. The various boundaries between actors were addressed by both individual and collective actors. *"Now let's be totally honest, we might not have achieved anything like what we've achieved if it hadn't been for someone like David. Very, very person dependent. We might not have achieved if we hadn't had someone like me. I mean, I think the whole system is very extremely person dependent" (Dr Lewis).* In other words, every ICU has a medical lead and charge nurses. Many hospitals in NHS England have Outreach Services. But very few have accomplished what Aurora has. Individual and collective actors worked together in this context to construct high performing sepsis care context.

The interactional practices by various actors in the knowledge network enabled the whole community to mobilise their knowledge. Furthermore, the interactions that helped facilitate knowledge mobilisation were distributed throughout the knowledge network. While some of the actors were in positions of authority, such as Dr Lewis, others, such as Martha, were not.

The moderate size of the hospital helped address geographic boundaries and the lack of contact with others. *"In a small hospital everyone knows each other. And that's got a lot of benefits. There's a lot of corridor consultations, there's a lot of meeting someone 'I'm just going to tell you about a patient'" (David).* Knowing one another helped minimise the social boundaries between actors. *"Everybody knows everybody and that definitely helps the job that we do. Because they're not scared to contact us about anything. They don't feel embarrassed or silly about phoning"* (Kelly). While a closer proximity made contact easier, the Outreach team established a sense of safety for all staff in asking for help. More than merely knowing the staff, the Outreach staff were attentive. Even when they faced difficult circumstances or personalities, they made a continuous effort to listen.

The referral system put in place a structural dependence, a mutual reliance, between the ward staff and Outreach, to share their knowledge. Rather than relying on the inherent kindness of Outreach staff, the Outreach staff *needed* the ward nurses. The Outreach team did not know if a patient was unwell unless the ward staff told them. Even their ward rounds depended on nurses completing the charts and calculating the early warning score. "*They're the starter. They need to be doing their job properly before we can" (Kelly)*. As a result, even when difficulties arose, it was understood that tending the long-term relationship with the ward staff was paramount and needed to be maintained. Providing ready, affirming feedback for the ward nurses was based on more than goodwill, the referral system hinged on nurses' willingness to call Outreach.

And nurturing the relationships in the knowledge systems required a continual effort. As David explained,

> *"It's working together. If a nurse refers a patient and they come to Intensive Care, it's always good just to say, 'Thanks very much for that referral. You were on that really, really quickly.' That means a referral again. We are non-punitive non-judgemental, and even though you want to have a moan sometimes, it's a golden rule. I've said that to each team member that's come. Never, ever criticise someone for a referral, or they'll never refer again. It's back to just having good working relationships." (David)*

The geographic, professional, social and epistemic boundaries resulted from necessary segmentation in training, expertise, and function. Indeed, boundaries were the by-product of important differentiation in training processes and functions. And yet the actors in Aurora's knowledge network did not eradicate the boundaries in order to mobilise knowledge for sepsis care, rather they respected the divisions whilst shepherding the relational connections that facilitated the establishment and coordination of different knowledge-based protocols and materials as needed.

## 6.4. Conclusion

This chapter has presented and analysed the Aurora practice community using Soft Knowledge Systems and observed the complexities of knowledge with a Clinical

Mindlines lens. Using these theories, this chapter found that mobilising knowledge began with, but was not assured by, setting knowledge systems in place. Indeed, these knowledge systems actors, processes and materials depended on the relational practices between actors to address social and epistemic tensions.

Relational practices enabled the system to ‘work’ and mobilise knowledge. Furthermore, the professional relationships were cultivated not just by those in roles of authority, but by many actors in the knowledge network. The practices and relationships described above are demonstrative of what I have termed ‘shepherding’.

Furthermore, relationships between actors interconnect and shape their knowledge. For example, their training and years of experience influence their shared values, which in turn shape local norms and routines in the course of determining how to use explicit forms of knowledge such as guidelines. This description of knowledge and knowledge networks is informed by Clinical Mindlines theory. This is a communal, yet also individual process. In this way, individual and collective mindlines develop via relationships and within the milieu of social interactions.

This chapter has also explored the multifaceted weave of many forms of knowledge that enabled this community to use their sepsis-based knowledge to benefit patients. Just as different actors provided differing views, which both informed and shaped their collective sepsis activities, actors’ mindlines worked in tandem and tension as well. Intuition, or ‘gut feelings’, past experiences, contextual values and procedures, patient concerns, and the sepsis research evidence all worked together for interpreting the most beneficial way to apply their *knowledge*-in-this-*practice*-in-this-*context*-for-this-patient. In other words, the tensions between many sources of knowledge contributed to, rather than impeded, high performing care.

The next chapter will explore how these three overlapping, intersecting networks mobilised their knowledge for sepsis care provision. The chapter will then discuss how these findings contribute to the academic conversation around the knowing in practice dilemma.

# 7. Chapter 7—Discussion

*Human interaction is the engine that drives research into practice*
*(Jonathan Lomas)*

## 7.1. Introduction

Chapters 5 and 6 presented and analysed data from a sepsis knowledge network made up of interconnected actors from across research, policy, and practice contexts. The purpose of this chapter is to bring together these findings, discuss the contributions of this thesis, and provide reflections on the work. This chapter is organised in three sections. Firstly, the chapter summarises the study aims and methods, and connects the key findings from Chapters 5 and 6 in order to answer the overarching research question. Secondly, the chapter discusses the empirical and theoretical contributions of this study in relation to the healthcare knowledge, knowledge systems and knowledge mobilisation literatures. Finally, the chapter reflects on the implications, methods, limitations and potential avenues for future research.

## 7.2. Summary of the Study Aims, Methods and Findings

This thesis focuses on the development and connection of knowledge within and across the healthcare research, policy and practice communities. This study is important because when knowledge is not mobilised, or is not mobilised rapidly enough, care that could prevent or alleviate unnecessary suffering is not provided. In addition, ineffective medical practices remain in use and result in wasted resources and unnecessarily poor outcomes for patients.

Using knowledge mobilisation to frame the study, the aim of this thesis was to enrich our understanding of how knowledge was developed, shared and used by and between researchers, policymakers and practitioners. The exploration was then guided by an overarching question drawn from the research problem: *How is knowledge mobilised within and between the research, policy and practice communities for clinical practice?* After considering the knowledge and knowledge mobilisation literature, the overarching question was refined by two further sub-questions: (1) What are the sources, forms and ways of knowing involved in mobilising research-based knowledge in practice? (2) How are knowledge systems (actors, processes, and materials) organised for mobilising knowledge? These questions addressed issues of complex epistemic and social dynamics that appeared in the literature to inhibit the mobilisation of knowledge. A qualitative case study was selected as a productive way to explore the knowledge-driven interconnections within a 'whole network'. Specifically, this meant that the project examined the knowledge systems of an interconnected research network (the Surviving Sepsis Campaign), a policy network (NHS Scotland's Sepsis Collaborative) and a practice network (Aurora General Hospital).

This study found that there were inter-relational practices that addressed the social and epistemic boundaries within and between networks. I argue that the term 'shepherding' combines these inter-relational practices together and renders them visible. 'Shepherding' then is a collection of practices that describes the nurturing of social and epistemic boundaries at the micro-interaction level. Shepherding practices cultivate the development, sharing and use of knowledge, for it is interactions at the actor-to-actor level that influence the harmonisation (or damage) of social and epistemic boundaries. The development and mobilisation of knowledge are intertwined social processes. These social processes involve binding together different forms of knowing (tending knowledge) as well as relevant actors and communities (tending the knowers).

An analysis of the Surviving Sepsis Campaign network suggested that shepherding practices accompanied their structural organising efforts. The purpose of the SSC was two-fold: firstly, to raise awareness, challenge and prod existing sepsis practices; and secondly, to actively build an inter-organisational structure to facilitate and coordinate the widely spread domains of sepsis knowledge. Signs of shepherding were detected in the inclusive nature of the network. The 1991 meeting brought together a range of disciplinary specialists from one continent. As the network evolved, they sought out specialist societies representing every part of the world to be involved and provide input. Nursing professional societies joined the effort. Publications spanning the last

25 years bear witness to a stable set of individual actors, whilst also welcoming the involvement of new participants, some of whom took on leadership responsibilities. The European Society of Intensive Care Medicine (ESICM) and Society for Critical Care Medicine (SCCM) provided a platform for bringing international professional bodies together. In addition, their facilitation of effective collaboration evidenced in simultaneous SSC journal outputs was a sign of shepherding.

Further indicators of shepherding can also be seen in the ways that the SSC responded to concerns as disagreement and conflict arose. Some parts of the network believed it was inappropriate to include commercial partners in their collective work based on the view that the actors involved shape their collective knowledge and thereby their outputs. To address this concern, the SSC parted ways with the International Sepsis Forum (an original partner). They eliminated industry-related funding. And they sought to reassure the wider knowledge network of their ‘objectivity’ by increasing the transparency of evidence assessment and consensus-building processes.

The SSC had to mediate disagreement. There has been considerable debate over the best parameters for defining (SIRS or SOFA), diagnosing (early warning scores), and treating (bundles) sepsis. To address their differing views, they regularly met together in person, which was supplemented by other channels of contact. Care was taken to ensure that softer voices were not drowned out by powerful personalities as seen in the adoption of a Delphi process and nominal group technique. Even the Infectious Diseases Society of America’s rejection of the most recent 2016 guidelines highlighted “numerous amicable discussions” (IDSA, 2017, p. 2) and the hope to be able to continue to collaborate in the future. Thus the SSC tended to the reception of materials by other researchers, policymakers and practitioners. At times the SSC responded with a vigorous response to epistemic challenges. Other times, they modified and adjusted to accommodate diverse views.

While the documentary sources from the Surviving Sepsis Campaign could not provide direct observation of their interactions such as was available in the other networks, these data nevertheless provided hints that shepherding practices supported actor engagement. The longevity of the SSC further attests to relational work supporting their ongoing knowledge mobilisation efforts. Furthermore, the SSC story showed that ‘evidence’ (in the form of guidelines) was created, formed, interpreted and moulded into material outputs emerging from a process of ongoing social interactions between actors.

The Sepsis Collaborative findings provided additional glimpses of shepherding practices in the policy community. The Collaborative sought to actively coordinate sepsis care throughout Scotland. While disagreement was less apparent in these data than with the SSC, the Collaborative involved aligning separate actors that had overlapping responsibilities for quality improvement within governmental bodies in addition to all regional health boards in the country. Given a similar lack of consensus in the research network, the Sepsis Collaborative also had different clinical definitions and related measures. They recognised the discontinuity, and to find common ground, they had to “work closely” (Haraden & Leitch, 2011, p. 756) together.

The Collaborative showed a blend of fixed and flexible stances. They mandated that each board include a mix of professional disciplines. And they required regular collection and reporting of performance data. Yet, they were also responsive to concerns regarding the duplication and burden of data collection. They strongly encouraged (and at meetings tried to entice) boards to adopt the National Early Warning Score-based chart and tool, but did not demand it. In this way, they respected a measure of regional autonomy.

Furthermore, the boards reported that Collaborative leaders were accessible and approachable. Leitch and Rooney were named as policy leaders who were safe to air different perspectives with and share concerns. The five learning sessions were intended to encourage, motivate and build connections between actors. Additional methods of contact (e.g. an online hub) were provided to help sustain further exchanges. As Hannah explained, NHS Scotland funded and facilitated a network that linked sepsis practitioners from across the country together with clinical experts. And the network structure was used to seek out the views of Scotland’s sepsis practitioners when the new Sepsis-3 definition was released. Care was taken to hear many actors' opinions and disagreement was acceptable. Through a careful, stepwise negotiation process, they produced a consensus-based statement. In these actions, the Sepsis Collaborative also showed that their knowledge systems were nurtured by shepherding practices.

The findings from Aurora General Hospital were replete with examples of shepherding practices. In the practice context there were many social and epistemic boundaries. Some examples include boundaries between general and specialist units (e.g. the ICU, renal unit and general wards), between doctors and nurses, between doctors (and nurses) of differing seniority and responsibility (e.g. junior and consultant doctors), and between position-related responsibilities (e.g. clinical governance, hospital management and practicing clinicians). Rather than accept ongoing patient harm, this network was proactive and experimental in seeking out ways to organise their sepsis knowledge systems. In the process, Dr Lewis, and later David, found ways to draw on many actors' knowledge to (re)create charts and provide training. They bent toward inclusivity rather than exclusivity.

Moreover, shepherding practices included seeking out and emphasising common values to establish a shared basis of understanding between different groups. Putting in place such agreements set the stage for cohesiveness later when challenges arose. One example was when Dr Lewis obtained his senior medical colleagues' agreement that a lack of medical response to patient suffering was not to be tolerated. Thus when a ward nurse contacted Outreach for help, they were not chastised.

The inbuilt dependence between the ward nurses and Outreach staff also helped to encourage positive interactions. Outreach team members knew that dependably responding to calls, and reassuring and supporting ward staff would build and maintain trust between them. This also entailed tolerating a measure of 'imperfection'. Outreach were highly skilled and experienced nurses. Unless there was an urgent reason, they did not draw attention to skills less than their own. Outreach tried to remember the many challenges the ward nurses faced and provide help rather than criticism. Building trust was a person-by-person process that could not be taken for granted. Trust required active maintenance.

And yet, if a patient was at risk, they did not retreat from engaging in uncomfortable conversations. Dr Lewis corrected individuals privately and challenged inadequate care provision. The Outreach staff pursued and prodded medical staff even after being dismissed. Martha coaxed. Sue questioned. However, these actors also recognised that different knowledge, abilities and priorities were required by various actors carrying different roles in the network. Respect accompanied negotiation. Indeed, shepherding in this context most often worked by accepting and (often) deferring to existing boundaries between actors. For example, Dr Lewis provided a consolidated chart but did not challenge his colleagues' autonomy, leaving them to decide what was needed for their patient. Kelly sought to build junior medics' professional confidence rather than undermine it by pointing to her superior skills. These kinds of interactions supported and strengthened the knowledge systems within Aurora and were particularly relevant at the points of tension.

Tending epistemic and social boundaries included both buffering and easing tensions between actors but also involved creating productive tensions as well. There were commonalities between these three networks. Each had areas of friction. There were strongly held and diverse views where building consensus entailed adjustments and compromises. At various points, the SSC, Sepsis Collaborative and Aurora each took the initiative to establish a plan and build ties between actors. And yet, within each network, there was also an element of serendipity, trial and error, and experimentation.

Face-to-face contact provided the opportunity for deepening professional relationships that could be supported by less direct means away from meetings. For NHS Scotland and Aurora, their smaller size relative to their health system peers aided the ability to know one another personally, pointing to the importance of relational interactions for strengthening knowledge systems.

Contact between the research, policy and practice networks had elements of intentionality and chance. Broad research dissemination methods, namely journal publications and continuing professional development meetings, in this case filtered down to and influenced their sepsis practices, for example, Bone et al.'s (1992) article and Critical Care Outreach Team information. However, only a few of Aurora's actors were specifically attuned to research network materials. All practitioners within Aurora did not keep abreast of the latest developments. Dr Lewis, or whomever was "the biggest brain," said Kelly, provided the conduit. In this way, the Aurora was 'evidence-based' not on an individual basis, but together as a collective.

While Clinical Mindlines and Soft Knowledge Systems theories do not explicitly focus on leadership, these data indicate that the shepherding of knowledge was intertwined within the leadership structures and activities in each of the research, policy and practice networks. The longevity of actors in executive roles, the inclusive leadership practices that embraced wide participation, and the cultivation of environments that provided a safe place for engagement all contributed to the development of contexts where knowledge could successfully mobilise. And yet, shepherding was not solely a leadership practice. These data have shown that during times of disagreement members of the Outreach team helped to mediate between actors, including those at a more senior level within the hospital. Indeed, David worked to repair relationships with nurses that were damaged by his medical supervisors. Another example was seen in Martha's sustained efforts to ease communication flows between different units. Aurora's knowledge mobilisation success can be attributed to actions by members throughout the organisation's network.

In sum, the term 'shepherding' is intended to capture and describe a set of practices rather than a role. Shepherding practices cultivated, challenged, influenced, negotiated and shaped knowledge between actors. Boundaries were addressed, tensions were managed (to either build up tensions or to soothe them), and resistance was (sometimes) abated. Connections between actors were sought out, built, tended, nurtured, negotiated, and, when necessary, mended. Shepherding practices challenged existing views, provided the opportunity to modify their understanding, and allowed the re-binding of different forms of knowledge. Additionally, shepherding practices encouraged and nurtured an interconnected network of actors for mobilising their knowledge.

In this thesis I showed that knowledge mobilisation was a boundary-tending process, and that individual and collective knowing were continually emerging social processes. Furthermore, in this thesis I contend that these social processes were aided by structural knowledge systems and yet these structures were not sufficient. Namely, knowledge was shepherded in the muddle of human interactions (Greenhalgh & Papoutsi, 2018).

## 7.3. Study Contributions

The key contributions of this study are threefold. *Empirically* it provides a rich and detailed account of interconnected knowledge and the social interactions that contribute to the mobilisation of that knowledge in sepsis care in Scotland. *Theoretically*, the study demonstrates the successful use of Soft Knowledge Systems (SKS) and Clinical Mindlines (CM) as a combined 'relational knowledge systems' lens to better understand knowledge mobilisation processes. Furthermore, this work extends the academic literature that explores the diversity, complexity, and interconnectivity of knowledge for practice by emphasising the role of social interactions in supporting knowledge networks. These areas of contribution are discussed in turn.

### 7.3.1. Empirical Contributions

The empirical contributions of this thesis are covered according to, firstly, the nature of knowledge and knowledge use literature from Chapter 2, secondly, the organising knowledge systems literature from Chapter 3, and finally, the reconsideration of the research problem (and overarching question) identified in Chapter 1 in light of this work.

*Nature of Knowledge Literature*

The complex nature of knowledge was borne out in this research study and was particularly evident in the hospital setting. The Outreach staff depended on many forms of knowledge including explicit and tacit forms (Polanyi, 1966) of their own and of others (i.e. individual and collective forms of knowledge, Cook & Brown, 1999) to assess patient well-being. Their own observations (for example, ‘the slump’ or the ‘end of the bed’ test), their years of experience (‘I’ve seen this before’), their ability to touch a patient’s ankle and discern if blood circulation was adequate, concerns of ward nurses (‘something isn’t right’) were used in combination with the data recorded on the patient chart to decide what actions on behalf of a patient should be taken. They could envision various possibilities. They knew where to go and whom to contact to get further information if these various streams of knowledge ‘felt’ unaligned. They had confidence in their skills and professional judgement. Their medical and nursing colleagues had confidence in their clinical competence and professional judgement. If one source of input appeared to contradict another, the Outreach person continued to reach for more ways of knowing until they were satisfied there was an answer for their ‘whole’ knowledge, or their ‘whole’ mindline (Gabbay & le May). In this way, their different forms of knowledge did not function in isolation but rather in cooperation with the others. And the tensions between different forms of knowledge were useful.

Such dualities and tensions between different forms of knowledge were prevalent in the healthcare knowledge literature (Crilly et al., 2010; Ferlie et al., 2012a; Greenhalgh 2002; 2010). By contrast, this study illustrates that these tensions between different forms of knowledge play a useful and productive role in professional practice. When tensions between explicit and tacit forms of knowing emerge, a closer examination could be warranted.

As such, the importance of tensions between different forms of knowledge affirms the literature that problematizes reductionistic perspectives on knowledge, and those scholars that consider explicit forms alone as ‘trustworthy’ and sufficient for professional practice (Dopson et al., 2003; Gabbay & le May, 2011; Miles et al., 2007). To the contrary, an array of sources (e.g. prior training, experience, context-based values, early warning scores) drawing from various kinds of knowledge (explicit, tacit, individual and collective) function in productive tension and thus serve as protective and beneficial forms of checks and balances.

And yet, these data also show that there are risks with an easy alignment of differing forms of knowledge. For example, Kumar et al.'s (2006) graph (in Chapter 5) established a research-informed urgency for 1-hour treatment that joined neatly with practitioners' experiences of observing the benefits of providing antibiotics. Even after subsequent attempts to replicate Kumar's work were not successful, policy-driven requirements held hospitals in Scotland accountable for meeting a 1-hour time frame. And practitioners at Aurora worked diligently to deliver the Sepsis 6 bundle (that includes antibiotic administration) in less than one hour.

Tending and responding to tensions between forms of knowledge can be explained as a kind of self-shepherding. However, tuning out or setting aside potential incongruities (or, conversely, overly simplistic congruities) without consideration carries risks, especially in providing patient care. Similarly, listening to and exploring (rather than ignoring) the epistemic tensions in group settings (such as multidisciplinary teams) recognises the importance of many perspectives for averting unneeded problems.

In addition to highlighting the value of many forms of knowledge, this study also raises to prominence the developmental nature of knowledge. Individuals influence collective knowledge and, reciprocally, collective knowledge shapes an individual's knowledge. Examples of individuals who affected collective forms of knowledge were WA Knaus, who brought scoring systems to the first set of sepsis guidelines, and J-L Vincent, who advocated for discarding the SIRS score in favour of the European Society for Intensive Care Medicine's preference, the SOFA score. Their research redirected not just the SSC's materials, but reached the policy and practice settings as well. The new SOFA-based definition of sepsis left every sepsis-related researcher, policymaker, and practitioner with a decision of how to respond. The Sepsis Collaborative weighed and considered their collective response and agreed to maintain existing knowledge systems until further evidence was available.

This view of knowledge as ‘continually under development’ raises an alternative perspective regarding Nonaka et al.’s (2008) view that tacit forms of knowing can be made explicit in the process of knowing. Perhaps rather than defy Polanyi’s definition of ‘tacit’ (that which cannot be articulated as it is situated within and belongs to the knower), Nonaka’s work speaks more to the developmental, ever-changing nature of knowledge.

There are conflicting views about the objective nature of evidence (Gabbay & le May, 2011). The SSC’s guidelines process presented in this work provides empirical support for the view that evidence, and especially evidence consolidated into guidelines, are socially constructed interpretations that are influenced by the actors involved. ‘Expert opinions’ could also be entitled ‘epistemically informed interpretations’.

The new Sepsis-3 definition provides an example of how explicit forms of information are interpreted differently in different contexts. In other words, the SSC’s new definition challenged the Sepsis Collaborative’s epistemic boundary. In response, the Collaborative determined not to adjust, but keep existing knowledge systems in place for now. The interactions between individual and collective forms of knowledge reveals a dynamic interplay between the two. Knowledge is always in flux, growing, and reforming. Knowledge in this example did not ‘transfer’ intact from one network to another. The research-based information did provoke the policy context, and yet for a myriad of socially-situated reasons, they determined to retain the NEWS score (Cook & Brown, 1999; Brown & Duguid, 2001).

### *Knowledge Use Literature*

In relation to the knowledge use literature, this study highlights the unpredictability of linear, relational and systems-based strategies for encouraging knowledge use (Best & Holmes, 2010). Even as linear and rational models neglect the complexities of both knowledge and the complexity of social contexts, surprisingly, sometimes the simplistic distribution model proves effective. These data have shown that academic publications and guidelines can indeed ‘reach’ practitioners at times through traditional means of dissemination. Similar to Olson and Tooman’s (2012) study of the role of didactic education and behaviour change, Dr Lewis found the Bone et al. (1992) publication and drew on the content to begin Aurora's trial and error process of experimentation for addressing sepsis care in their hospital. The article, while only one input, nevertheless provided timely illumination and inspiration, and contributed a key part of knowledge to Aurora's sepsis story.

Graham et al.'s (2006) Knowledge to Action model depicts an active, multi-step cyclical process built upon a relational model that shapes knowledge use. However, connectivity alone did not ensure that knowledge was put into action. Because the Outreach team members were in regular contact with ward staff, the Outreach nurse who provided maternity cover was present in the wards. But despite the contact, the nature of her interactions inhibited her ability to share her knowledge and support the development and use of sepsis knowledge on the wards. Finally, these findings suggest that, for systems-based knowledge use strategies, building alignment between different actors' epistemic goals in the health system will rely upon establishing mutual respect and genuine reciprocity. These qualities are worked out in interactions between network actors and highlight the importance of shepherding practices.

### *Knowledge Systems*

The literature on teams and networks revealed underlying assumptions about how these structures support knowledge mobilisation. Furthermore, the empirical literature showed that even when spatial and geographic divides were addressed, social boundaries continued to inhibit the development and sharing of knowledge between actors. Boundaries were prevalent within as well as between communities.

Where this literature highlights the challenges resulting from professional and disciplinary collaboration (Ferlie et al., 2005; Powell & Davies, 2012), this study showed that shepherding practices address these tensions. Furthermore, whilst interactions between actors within networks (Stein-Parbury & Liaschenko, 2007; Zwarenstein et al., 2013) and between networks (Currie et al., 2013; Fitzgerald & Harvey, 2015) were often messy and difficult, as a point of contrast, my research emphasises that boundaries (the differentiation between actors) play an important role in teams and networks. Shared training, experiences, spaces and roles can and do cultivate connectivity, shared values, and belonging. Within the diverse knowledge ecology encompassed by researchers, policymakers, practitioners, doctors, nurses, allied health professionals, ancillary staff, managers and patients, each provide a partial knowledge. Boundaries often arise out of necessary segmentation. Thus, boundaries are only problematic where and when they inhibit, rather than strengthen, the development and flow of knowledge for use.

This study observed that nurses often provide the helpful linchpin between stakeholder groups. The experience and disciplinary expertise of Outreach nurses helped support interactions with some medics, and yet their nursing role kept them part of their own ‘tribe’. This allowed for a certain level of fluidity between groups that the Outreach team was able to capitalise upon, in part, by their shepherding practices. As corroborated by findings from Ferlie et al. (2005) and Olson et al. (2010), shifting primary responsibility to professions other than physicians better supported the spread of innovation. In this study, physician initiation was helpful, and physician support was essential. However, for mobilising and embedding sepsis-based knowledge with stakeholders throughout Aurora, the non-medical staff orchestrated the work by engaging with all professions.

Success in this case did not appear to be the result of one or even several parts of the knowledge system in isolation. For example, it was a combination of the patient monitoring chart, the Outreach team structure, the early warning scoring system, how they were used, the interactions they prompted and the qualities of these interactions that contributed to success in their practice. In turn, these knowledge systems were enabled by various other factors, such as the relatively small size of the hospital and the stability of key actors at Aurora. Moderate group size appears to help mobilise knowledge. The smaller sized health system within Scotland also appeared to aid the building of relationships in the wider context. Geographic boundaries were more easily crossed. Actors saw one another in corridors and lunchrooms, perhaps overlapped in their training, and attended specialist meetings of a moderate size. These contacts provided opportunities for connecting and getting to know one another (Bailie et al., 2018).

However, building trust is the result of more than mere contact. Following Edmondson (2012), shepherding includes creating psychologically safe environments for all actors to develop, grow and share their knowledge. These data provide empirical examples that depict building and maintaining a safe space as an ongoing, regularly nurtured process, especially as new actors join the network. Edmondson equated psychological safety as a willingness to speak up. This study extends the psychological safety concept. Part of building safe contexts also involves knowing when to be quiet and bide your time, knowing when to push for what your experience and knowledge say is needed, and when to wait. One example was the regular intake of new registrars. The Outreach team learned not to threaten the registrars' professional standing, but wait until their clinical acumen saved the registrars from professional harm (not to mention the patient). They waited until their actions could prove they were on the registrars' 'side', and not a threat.

### *Knowledge Mobilisation Literature*

The knowledge mobilisation literature points to trust as a necessity for knowledge sharing (Bailie et al., 2018; Fitzgerald & Harvey, 2015; Scarbrough et al., 2014). This thesis provides a range of empirical descriptions depicting how shepherding practices build trust between actors for mobilising knowledge.

Returning to the overall question, how was knowledge mobilised between different actor groups, here are several observations for consideration. Firstly, 'success', as presented in this study, cannot be explained without acknowledging the role of key individual and collective actors. Their shepherding of knowledge and practice over time included responding to opportunities, addressing conflicting priorities, applying epistemic tension and soothing social tensions. Shepherding involved actively working to maintain relationships (Ferlie et al., 2005) and "continuous joint work" (Kislov, 2014, p. 310).

This thesis exposed the insufficiency of relying on knowledge systems alone to mobilise knowledge. The qualities of engagement between actors within the networks played an important role in whether knowledge was mobilised or not. Similarly, relying on explicit forms of knowledge alone was insufficient for realising knowledge use in practice. The different forms and domains of knowledge were intertwined rather than segmented and detached.

Knowledge mobilisation involves both the structural organisation of knowledge systems and the relational activities between actors. In other words, knowledge is mobilised within systems-based structures (teams and networks and the processes and the materials they use). However, to understand *how* knowledge is mobilised within these structures we must look to the muddle of human interactions.

### 7.3.2. Theoretical Contributions

This work employed a two theoretical lenses, Clinical Mindlines (Gabbay & le May, 2011) and Soft Knowledge Systems (SKS) (Engel, 1997). As explained earlier in Chapter 4, the two theories were well suited to a study of knowledge mobilisation because they adhere to an interpretive understanding of knowing and because both are concerned with how knowledge develops and spreads for professional practice. Furthermore, each theory complements the other. Clinical Mindlines provided a rich explanation of what knowledge 'is', whilst Soft Knowledge Systems provided a way to operationalise a study about knowledge in practice. In other words, SKS focused on the links between knowledge sources and mindlines focused on the content of those sources. As a result, this research benefitted from using both as a 'dual lens'. Additionally, Clinical Mindlines drew attention to the epistemic tensions within the study, and SKS highlighted the social tensions between actors in the knowledge network.

Various scholars have called for better ways to conceptualise, analyse and address the knowledge in practice problem (Greenhalgh & Papoutsi, 2018; Holmes et al., 2017). While complexity is clearly challenging to operationalise, Soft Knowledge Systems provided a useful tool for two reasons. SKS was able to capture established and emergent ties between actors, as well as the knowledge-laden processes and materials they used. Furthermore, the knowledge network concept in SKS was flexible in that it could include actors from research, policy and practice. Thus one theoretical contribution of this work was the ability to explore a ‘whole’ network as opposed to a reduced subset of actors. Using SKS allowed for the study of an array of actors ‘in situ’ as opposed to constructed networks (such as CLAHRCs in Chapter 3). And, in this way, Soft Knowledge Systems aligned well with Clinical Mindlines because a wider reservoir of knowledge sources could be included.

A central part of theorising is observing patterns and developing a concept (Llewellyn, 2003). Shepherding-type practices are frequently mentioned in the knowledge mobilisation literature, but as yet, no unifying construct has been offered. ‘Shepherding’ renders these interactions visible, and provides a starting point for more careful theoretical scrutiny and conceptual development.

In this vein, Clinical Mindlines (Gabbay & le May, 2011) and Soft Knowledge Systems (Engel, 1997) were put under the microscope. This study further strengthens Clinical Mindlines as a robust explanatory theory of professional knowledge. Far more than ‘consulting colleagues’, mindlines metaphorically represents the multifaceted and ‘living’ dynamic of human knowledge (Wieringa & Greenhalgh, 2015). Many different forms and sources of knowledge are involved in mobilising research-based forms for practice. This study further reinforces mindlines theory in not only the acute care setting, but offers glimpses of mindlines at work in the policy and research settings as well.

Furthermore, this work suggests that knowledge outputs, such as guidelines and patient observation charts, are momentary and static expressions of a collective mindline. The negotiating and consensus building processes result in a snapshot of collective knowledge. And as each of the knowledge outputs underwent continuous revision, each new publication momentarily codified a collective mindline. As products are explicit, they cannot represent the whole of a collective mindline, but even what it cannot express influences what can be expressed, even as a mindline cannot be fully documented and transferred.

## 7.4. Study Reflections

To conclude, the following sections reflect on the study's implications, methods, and limitations and addresses potential avenues for future research.

### 7.4.1. Implications

This study elicits various considerations that are relevant for research, policy and practice contexts. First, it is worth noting that in this case of successful knowledge mobilisation, each network *did* something. They observed a problem; they had aspirations for change; and they deployed resources for action. And yet, while there was planning involved, there was also an element of serendipity.

Second, knowledge mobilisation initiatives need to consider the epistemic and social boundaries involved. Consider the knowledge systems – what kinds of boundaries do these systems hope to overcome? Anticipate the spatial, professional, intra-professional, organisational and inter-organisational boundaries. And consider the social lubrication mechanisms, in other words, the interactions between actors that either help or hinder the functioning of those knowledge systems. What are ways that might soften or manoeuvre around problematic boundaries? More consideration tends to focus on the architecture of the knowledge system, but relational architecture needs tending as well. Do not underestimate the importance of informal engagement. Focus on creating conditions for relationships to grow and support long-term connections. Similarly, actively facilitate formal *and informal* contact between actors. Tea, coffee, and lunch breaks build the bonds of trust that can help relieve tensions in the workplace. Good will cannot be forced, but it can be nurtured.

Third, exclusive reliance on explicit forms of knowledge is not an advancement of knowledge. It simply misunderstands how our 'whole' knowledge mobilises for research use. Relatedly, as Dopson et al. (2008) argue, the context for mobilising knowledge cannot be viewed as a separate 'variable' for examination, but rather a dynamically interconnected and multidimensional part of the 'whole' network. Fourth, mobilising knowledge is not a one-time achievement but rather an ongoing and long-term process of regular experimentation. An experimental and developmental perspective is essential given the complexity of knowledge and of social contexts.

Finally, in situations where the desired direction of change is contested or as of yet unclear, concentrate on facilitating meaningful and shared dialogue between actors. Periodic face-to-face contact appears to help.

### 7.4.2. Methodological Reflections

Over the course of carrying out the study, I adapted the study in two significant ways. Firstly, I made adjustments to the case study design. I initially envisioned a comparative case study of multiple practice sites as the most reliable way to build a richer understanding of complex and interconnected knowing. Then, early during data collection, one hospital, Aurora, offered increasingly extensive access as trust developed quickly with the participants at this site. I began to regularly shadow their workdays. This provided a degree of engagement within the case that I had not thought possible as I was able to walk alongside key practitioners in their work. I was able to witness how sepsis care was provided throughout the hospital. Furthermore, I was able to get to know staff, hear both their formal views and informal reflections, and witness the social interactions between staff of numerous units at Aurora in real time. Therefore, I took advantage of this unanticipated level of access and availed myself of the open invitation to spend time at this hospital.

Second, I began to understand that 'research use' was not a narrow practice-based knowledge problem, but rather a process that unfolds *within* and between the research, policy and practice communities. This recognition reshaped the boundaries of the case. Sepsis researchers, and especially the research community represented by the Surviving Sepsis Campaign, as well as the NHS Scotland policy community and the national Sepsis Collaborative were key actors alongside the clinical practitioners at Aurora.

There were different theories available as lenses, for example, Communities of Practice (Wenger, 1998) and Promoting Action on Research Implementation in Health

Services (PARIHS) framework (Kitson et al., 1998). Both theories focus on knowledge and knowledge use and could have been suitable choices. However, these theories have an existing body of work, and heeding the call from Best and Holmes (2010) to consider systems-based strategies for mobilising knowledge, I chose Soft Knowledge Systems instead, in part because it employs a systems-based view of actors and how they organise for sharing and using their knowledge.

### *Positionality*

My positionality as researcher was integral to this qualitative study. I was engaged on a learning journey *alongside* a willing group of people, not conducting research *on* them (Stake, 2000; Wolcott, 2009). Wolcott emphatically states that, "Recognizing the critical nature of the observer role and the influence of his or her subjective assessments in qualitative work makes it all the more important to have readers remain aware of that role…for qualitative research, it should be the rule rather than the exception" (2009, p. 17).

I experienced various challenges around potentially 'going native'. I have spent well over a decade as a health services researcher, and in the past when visiting sites, I was part of a research team. In this project I was a solo researcher. By temperament, I enjoy engaging with people and learning about their work. Furthermore, Aurora had been identified by policy experts as a high-performing hospital around sepsis care. This was a form of appreciative inquiry and I knew I was there to learn. Indeed, not having clinical training meant I was not in a position to assess Aurora's clinical practices as an 'insider' of the health professional world. Thus, in the course of data collection, I listened and watched the staff at Aurora go about their duties, and I found it very difficult not to be impressed. I did not have a research partner to review and analyse the data collection process alongside me to help temper my positive (or negative) views.

However, the physical, social, and (eventual) temporal distance enabled me to develop a more dispassionate and critical perspective alongside my appreciative mindset. While the relationships that formed over my time in the field remain important to me, I had to engage fully with my responsibilities as an academic. As a result, examples of resisting the urge to ‘go native’ are seen in my descriptions of conflict between actors and less than perfect practice.

There were further challenges along the way. For example, one difficulty that I had not anticipated (as my prior experience was situated in a different country) was the difficulty of preserving the anonymity of actors in the course of conducting qualitative research in Scotland. In the comparatively smaller world of healthcare in the UK, and especially in the patient safety community of Scotland, the actors know or know of one another. At Scottish Patient Safety meetings, for example, when I would explain that I was talking with high-performing hospitals in relation to sepsis care, the most common response was to name Aurora. Once I realised this, I asked my primary contact if he felt comfortable if I did not conceal that their hospital was part of my data set. He agreed. However, to protect the individual identity of participants as much as possible, my materials include a pseudonym for the hospital as well as participants.

Furthermore, because the Institute for Healthcare Improvement is an American company and was a key partner in the Scottish Patient Safety Programme, I was concerned that my nationality might pose a problem and inhibit candid explanations about IHI’s involvement in NHS Scotland. While I remain uncertain about whether or not this was a problem, the IHI organisation’s part in the research findings proved largely supplemental.

Another concern was the imbalance of data from each network. Because the knowledge mobilisation framing came later after the primary data collection in the analysis process, I had less data from the NHS Scotland policy context than either Aurora or the Surviving Sepsis Campaign and related organisations. Had I realised that I would frame the knowledge network as bringing together the ‘separate communities’, I would have sought more direct access at the policy-level.

### 7.4.3. Future Research

This section identifies two opportunities for future research. The first involves further work employing Clinical Mindlines (Gabbay & le May). I would like to explore the possibility of identifying a more detailed schematic of collective mindline. To do so, I would use the Surviving Sepsis Campaign-related guideline documents beginning with Bone et al. (1992) until the most recent Rhodes et al. (2017) alongside named author publications for a longitudinal review and comparison. Based on my work to date in this literature, it might be possible to identify the influencing mark of individual actors in a collective output. Thus, it might be possible to trace the influence of actors in collective knowledge outputs over time.

A second piece of work would explore the relationship between shepherding and structural authority. Within this case, shepherding practices were a distributed activity. Are there different kinds and categories of shepherding that align with an actor's professional role? In this study, mid-level managers were often key intermediaries. It would be interesting to consider shepherding in light of the literature on knowledge intermediaries and middle management. Are intermediaries useful because of their place in an organisational structure or because of how they interact with other actors? Is shepherding related to power-sharing? Further work would try and tease out the intersection of relational capabilities alongside different structural positions.

## 7.5. Conclusion

Sepsis presents a difficult puzzle for mobilising knowledge within and between the research, policy and practice communities. And yet sepsis is not unique in medicine. The nature of scientific study means that explicit research-based information is continually advancing, pruning and refining what is known. These data have shown that this state of constant emergence (incubation) is relevant to other contexts of knowledge as well. Individuals and collectives have new, informing experiences. Actors in the knowledge network develop and change. As a result, the whole of the knowledge system is under continual development. Furthermore, harmonising these ever-changing sources of knowing is not easy.

This work found that knowledge is carefully curated (through social interactions) in order to connect knowledge from different domains and to support the mobilisation of new actionable understandings for care. Tensions regarding both what knowledge 'is', as well as the social system in which knowledge is employed, are negotiated and nurtured by social practices that I have termed 'shepherding'. Shepherding practices are those that tend to the social interactions that support the mobilisation of knowledge, and they are in evidence throughout the distributed areas of research, policy and practice. In concluding, this thesis argues that – because knowledge is complex and emergent, and because mobilising knowledge is an ongoing social process – a developmental perspective needs to be taken as the normative frame for the 'knowing in practice' problem.

Main Contributions:

- *empirically* it provides a rich and detailed account of interconnected knowledge and the social interactions that contribute to the mobilisation of that knowledge in sepsis care in Scotland;
- *theoretically*, this work extends the academic literature that explores the diversity, complexity, and interconnectivity of knowledge for practice by emphasising the role of social interactions in supporting knowledge networks; and the study demonstrates the successful use of Soft Knowledge Systems (SKS) and Clinical Mindlines (CM) as a combined 'relational knowledge systems' lens to better understand knowledge mobilisation processes.

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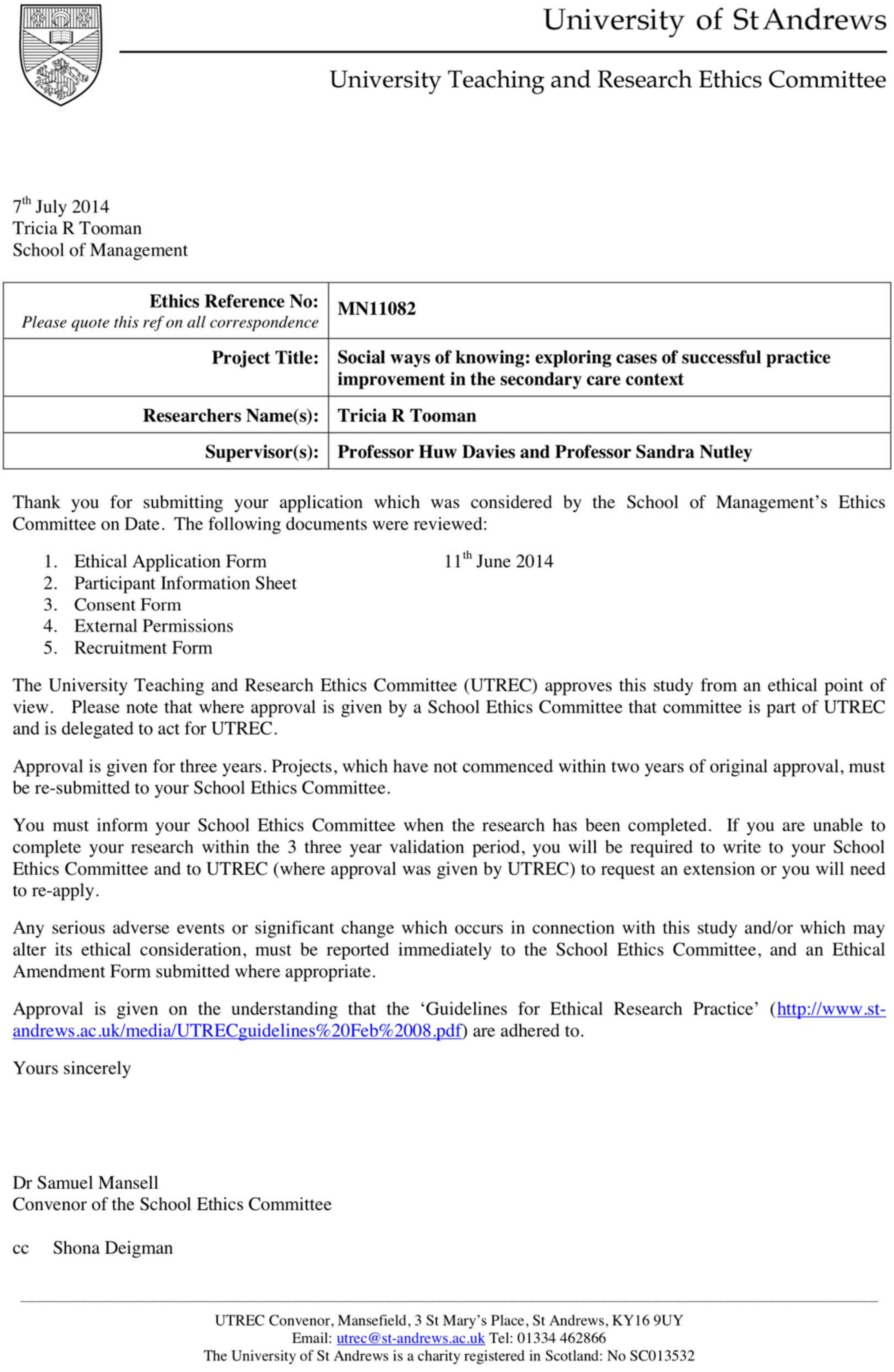
# Appendix A—Ethics Approval Letter



University of St Andrews

University Teaching and Research Ethics Committee

7th July 2014
Tricia R Tooman
School of Management

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|---|---|
| **Ethics Reference No:**<br>*Please quote this ref on all correspondence* | **MN11082** |
| **Project Title:** | **Social ways of knowing: exploring cases of successful practice improvement in the secondary care context** |
| **Researchers Name(s):** | **Tricia R Tooman** |
| **Supervisor(s):** | **Professor Huw Davies and Professor Sandra Nutley** |

Thank you for submitting your application which was considered by the School of Management's Ethics Committee on Date. The following documents were reviewed:

1. Ethical Application Form 11th June 2014
2. Participant Information Sheet
3. Consent Form
4. External Permissions
5. Recruitment Form

The University Teaching and Research Ethics Committee (UTREC) approves this study from an ethical point of view. Please note that where approval is given by a School Ethics Committee that committee is part of UTREC and is delegated to act for UTREC.

Approval is given for three years. Projects, which have not commenced within two years of original approval, must be re-submitted to your School Ethics Committee.

You must inform your School Ethics Committee when the research has been completed. If you are unable to complete your research within the 3 three year validation period, you will be required to write to your School Ethics Committee and to UTREC (where approval was given by UTREC) to request an extension or you will need to re-apply.

Any serious adverse events or significant change which occurs in connection with this study and/or which may alter its ethical consideration, must be reported immediately to the School Ethics Committee, and an Ethical Amendment Form submitted where appropriate.

Approval is given on the understanding that the 'Guidelines for Ethical Research Practice' (http://www.st-andrews.ac.uk/media/UTRECguidelines%20Feb%2008.pdf) are adhered to.

Yours sincerely

Dr Samuel Mansell
Convenor of the School Ethics Committee

cc Shona Deigman

UTREC Convenor, Mansefield, 3 St Mary's Place, St Andrews, KY16 9UY
Email: utrec@st-andrews.ac.uk Tel: 01334 462866
The University of St Andrews is a charity registered in Scotland: No SC013532

# Appendix B—In-depth Interview Guide

| | |
|---|---|
| **Introduction** | • Summary of the study; purpose and format of interview<br>• Consent form |
| **Demographic and background information** | • Profession? E.g. Nurse, doctor, etc.<br>• Specialisation? E.g. Critical care<br>• How long have you been practicing?<br>• How long in this organisation?<br>• Current position? How long? |
| **Explore the process/history of the improvement project** | • Can you describe how this project got started? Why did it start?<br>• Why focus on this particular problem? How did you know there was a problem?<br>• Problem definition--<br>• What did you do? When? Describe the process and stages of implementation that? |
| **Explore roles—division of tasks** | • Who did what?<br>• When? |
| **Explore how the actors organised to achieve success** | • Can you describe the various formal coordination efforts?<br>• Were there formal project groups?<br>• If yes, who was involved? Did the project team evolve?<br>• When did they begin to meet? |
| **Who was involved and when? Explore relationships inside and outside the organisation.**<br>**[Collaboration]** | • Who was on the team? Who were the central people involved in this project's success?<br>• Who were other key colleagues involved in this effort?<br>• External colleagues?<br>• Internal groups?<br>• External collaborations? Organisations? Regulatory bodies? |

| | |
|---|---|
| **Explore relational flow of information and ideas [Collaboration]** | • Do these various people and groups interconnect? If so, how? |
| **Explore the sources and kinds of knowledge they drew upon in various stages of the project implementation**<br>**[Acquiring]** | • Internal data?<br>• External sources?<br>• Research-based "EB" material?<br>• Context-based knowing?<br>• Prior experience?<br>• Clinical judgement/intuition?<br>• Reasoning?<br>• Any surprising contributions come along? |
| **Explore social context** | • Hospital culture<br>• Longevity of people involved in intervention?<br>• Leadership (of varying types): formal structure. Who is your supervisor? Organisational reporting structure—how did your supervisor and the org structure support/not support this effort? |
| **Explore social and contextual barriers and facilitating strategies** | • Were there barriers that had to be overcome?<br>• Were there people within the organisation less inclined to make these changes (even if they have later come around)?<br>• How did you/others go about obtaining buy-in?<br>• What strategies and resources did you draw upon? |

| | |
|---|---|
| **Explore communication channels—formal and informal**<br>**[Sharing]**<br>**[Connectivity]** | • Who do you generally go to for advice? Did you go to different people for different aspects of advice?<br>• Were there internal/organisational meetings? Of what frequency?<br>• Important conversations that took place outside of meetings?<br>• Were there important connections/communications that helped overcome barriers?<br>• Outside meetings, conferences, collaborations, workshops?<br>• Are there work and/or personal friendships that have affected the flow of information?<br>• Role models? |
| **What formative learning accumulated through the practical experience** | • What advice/tips would you give to a colleague in another hospital?<br>• What was essential to make this work? |
| **Other issues** | • **Why do you think this projected succeeded?**<br>• Any additional comments?<br>• Is there anyone else from this organisation or from another organisation that we should be talking to? |
| **Closing remarks** | • Thank participant and advise them of the timescale for the study |

## Appendix C—Follow Up Interview Guide

CCOT:

1. CCOT staff meetings?
2. The CCOT team log—purpose, when did it begin? How is it used?
3. How do you know how well you're doing around sepsis? Internal tracking? Outside audit bodies?
4. Interpreting data:
    a. How do you have to interpret data differently with NEWS than you did with SIRS?
    b. Patient information—labs, etc., what do you do with these pieces of information?
5. Seeing—being able "to see" a sick patient (or not) isn't the same for all nurses. Can you describe this kind of knowledge? What sources (internally, externally) are you drawing on?
6. If you are stuck/uncertain, what do you do? Where do you go? To whom do you go?
7. How do you know what sources of information to trust?
    a. Of the many kinds of information you hear and see regularly—do you trust it? Eg Run reports? Kumar article? Audit data? Other?
8. Are there some sources you don't trust, but have to "use" anyway? How do you do that? Do you use it differently?
9. How is information that you trust affected if it's coming from a sources you don't trust? (Whether an inexperienced nurse, or FY1? Or governmental body? Others?)
10. Do you use National Education Scotland (NES)? They have a Knowledge into Action Knowledge Network. (Policies, guidelines, apps, journals, tools)
11. What are the social pressures you deal with (related to sepsis care)?
12. Are there political pressures?

Nurses: [What do you have to know and take into account to provide sepsis care for your patients?]

1. How did you learn about the sepsis protocol here at this hospital?
    a. Break it down for me: what is simple in terms of recognizing and treating sepsis? When does it get complicated?
2. Seeing—being able "to see" a sick patient (or not) isn't the same from person to person. Can you describe this kind of knowledge? What sources (internally, externally) are you drawing on? (Experience seems to play a role—you've observed it before.)

3. If you are stuck/uncertain, what do you do? Where do you go? To whom do you go?
4. How do you handle at risk patients when CCOT is not on duty? What's the difference in terms of how you manage when CCOT is on versus off? Do you have to draw on different resources?

Clinical governance:

1. New/updated reports?
2. Any other reports or documents related to sepsis care?
3. How are we doing after bringing in the new chart?
4. What materials are for internal use only? What goes to the national auditing body?
5. Are there other reporting places/bodies?

# Appendix D—Key Documents for Definitions and Guidelines

| Year | Names of people involved | Article |
|---|---|---|
| 1992 | Bone, *Balk*, Cerra, *Dellinger*, Fein, Knaus, Schein, *Sibbald*, Abrams, *Bernard*, Biondi, Calvin, Demling, Fahey, Fisher, Franklin, Gorelick, Kelley, *Maki*, *Marshall*, Merrill, Pribble, Rackow, Rodell, Sheagren, Silver, *Sprung*, Straube, Tobin, Trenholme, Wagner, Webb, Wherry, Wiedemann, Wortel | Definitions for Sepsis and Organ Failure and Guidelines for the Use of Innovative Therapies: American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference in Sepsis published simultaneously in *Critical Care Medicine* and *Chest* |
| 2001 | Sprung, Bernard, Dellinger; Pérez, Arndt, *Abraham*, *Carlet*, *Vincent*, Martin, Jimenez, Marshall, *Bochud*, Glauser, *Calandra*, Llewelyn, *Cohen*, Matot | Supplement of *Intensive Care Medicine* containing the ISF recommendations for the management of patients with severe sepsis and septic shock |
| 2003 | *Levy*, Fink, Marshall, Abraham, *Angus*, Cook, Cohen, *Opal*, Vincent, *Ramsay*; Balk, Bernard, *Bion*, *Carcillo*, Carlet, *Dhainaut*, Evans, Fry, *Gerlach*, Lowry, Malangoni, Matuschak, *Parillo**, *Reinhart*, Sibbald, Sprung, Weil | 2001 SCCM/ESICM/ACCP/ATS/SIS International Sepsis Definitions Conference, (joint publication) in *Critical Care Medicine* and *Intensive Care Medicine* |
| 2004 | RP Dellinger, Carlet, *Masur*, Gerlach, Calandra, Cohen, Gea-Banacloche, Keh, Marshall, *Parker*, Ramsay, *Zimmerman*, Vincent, Levy; *Beale*, Bennett, Bochud, *Brun-Buisson*, Cordonnier, EP Dellinger, Finch, Fourrier, Hazelzet, Jorgensen, Maki, Murphy, Opal, Parrillo, *Rhodes*, Sprung, Torres, Trzeciak, Vender, Bonten, Carcillo, Cariou, Dhainaut, Finfer, *Harvey*, Hollenberg, Maier, *Marini*, Nitsun, *Sevransky*, Szokol, Vinsonneau | Surviving Sepsis Campaign guidelines for management of severe sepsis and septic shock, (joint publication) in *Critical Care Medicine* and *Intensive Care Medicine* |
| 2008 | Dellinger, Levy, Carlet, Bion, Parker, *Jaeschke*, Reinhart, Angus, Brun-Buisson, Beale, Calandra, Dhainaut, Gerlach, Harvey, Marini, Marshall, Ranieri, Ramsay, Sevransky, | Surviving Sepsis Campaign: International guidelines for management of severe sepsis and septic shock: 2008 |

| | | |
|---|---|---|
| | *Thompson*, *Townsend*, Vender, Zimmerman, Vincent | |
| 2013 | Dellinger, Levy, Rhodes, *Annane*, Gerlach, Opal, Sevransky, Sprung, Douglas, Jaeschke, *Osborn*, *Nunnally*, Townsend, Reinhart, *Kleinpell*, Angus, *Deutschman*, *Machado Rubenfeld*, Webb, Beale, Vincent, *Moreno* | Surviving Sepsis Campaign: International guidelines for management of severe sepsis and septic shock, 2012<br>Simultaneously published in *CCM* and *ICM* (2013) |
| 2016 | *Singer*, Deutschman, *Seymour*, Shankar-Hari, Annane, Bauer, Bellomo, Bernard, *Chiche*, *Coopersmith*, Hotchkiss, Levy, Marshall, Martin, Opal, Rubenfeld, *van der Poll*, Vincent, Angus | The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) in *JAMA* |
| 2017 | Rhodes, Evans, Alhazzani, Levy, Antonelli, Ferrer, Kumar, Sevransky, Sprung, Nunnally, Rochwerg, Rubenfeld, Angus, Annane, Beale, Bellinghan, Bernard, Chiche, Coopersmith, De Backer, French, Fujishima, Gerlach, Hidalgo, Hollenberg, Jones, Karnad, Kleinpell, Koh, Costa Lisboa, Machado, Marini, Marshall, Mazuski, McIntyre, McLean, Mehta, Moreno, Myburgh, Navalesi, Nishida, Osborn, Perner, Plunkett, Ranieri, Schorr, Seckel, Seymour, Shieh, Shukri, SQ Simpson, Singer, Thompson, Townsend, van der Poll, Vincent, Wiersinga, Zimmerman, Dellinger | Surviving Sepsis Campaign: International guidelines for management of sepsis and septic shock: 2016<br>Simultaneously published in *CCM* and *ICM* (2017) |

Names listed in order given on publications and include all conference participants listed as well as authors. Names are *italicised* for their first appearance if they appear again later in the list. Thereon, names are underlined to emphasise multiple appearances. *Dr Parrillo's name was misspelled on the 2003 definitions document.

# Appendix E—SSC Actors (by SSC Publication Participation)

| **Name** | **Number of Occurrences** | **Publication Year** |
|---|---|---|
| Abraham | 2 | 2001, 2003 |
| Angus | 5 | 2003, 2008, 2013, 2016, 2017 |
| Annane | 3 | 2013, 2016, 2017 |
| Balk | 2 | 1992, 2003 |
| Beale | 4 | 2004, 2008, 2013, 2017 |
| Bernard | 5 | 1992, 2001, 2003, 2016, 2017 |
| Bion | 2 | 2003, 2008, |
| Bochud | 2 | 2001, 2004, |
| **Bone** | 1 | 1992, and extensive prior supporting clinical literature |
| Brun-Buisson | 2 | 2004, 2008, |
| Calandra | 3 | 2001, 2004, 2008 |
| Carcillo | 2 | 2003, 2004 |
| Carlet | 4 | 2001, 2003, 2004, 2008 |
| Chiche | 2 | 2016, 2017 |
| Cohen | 3 | 2001, 2003, 2004 |
| Coopersmith | 2 | 2016, 2017 |
| **Dellinger** | 6 | 1992, 2001, 2004, 2008, 2013, 2017 |
| Deutschman | 2 | 2013, 2016 |
| Dhainaut | 3 | 2003, 2004, 2008 |
| Gerlach | 5 | 2003, 2004, 2008, 2013, 2017 |
| Guyatt |  | 2008, 2013, 2017 |
| Harvey | 2 | 2004, 2008 |
| Jaeschke | 2 | 2008, 2013, 2017 |
| Kleinpell | 2 | 2013, 2017 |
| **Levy** | 6 | 2003, 2004, 2008, 2013, 2016, 2017 |
| Machado | 2 | 2013, 2017 |
| Maki | 2 | 1992, 2004 |
| Marini | 3 | 2004, 2008, 2017 |
| Marshall | 7 | 1992, 2001, 2003, 2004, 2008, 2016, 2017 |

| | | |
|---|---|---|
| Masur | 1 | 2004, 2008 (listed in acknowledgement as consultant), 2017 (IDSA statement) |
| Moreno | 2 | 2013, 2017 |
| Nunnally | 2 | 2013, 2017 |
| Opal | 4 | 2003, 2004, 2013, 2016 |
| Osborn | 2 | 2013, 2017 |
| Parker | 2 | 2004, 2008 |
| Parrillo | 2 | 2003, 2004, extensively in supp clin lit |
| Ramsay | 3 | 2003, 2004, 2008 |
| Ranieri | 2 | 2008, 2017 |
| Reinhart | 3 | 2003, 2008, 2013 |
| **Rhodes** | 3 | 2004, 2008, 2013, 2017 |
| Rubenfeld | 3 | 2013, 2016, 2017 |
| Sevransky | 4 | 2004, 2008, 2013, 2017 |
| Seymour | 2 | 2016, 2017 |
| Sibbald | 2 | 1992, 2003, supporting clinical lit |
| **Singer** | 2 | 2016, 2017 |
| **Sprung** | 6 | 1992, 2001, 2003, 2004, 2008, 2013, 2017, ext sup lit |
| Thompson | 2 | 2008, 2017 |
| Townsend | 3 | 2008, 2013, 2017 |
| Van der Poll | 2 | 2016, 2017 |
| Vincent | 7 | 2001, 2003, 2004, 2008, 2013, 2016, 2017 |
| Zimmerman | 3 | 2004, 2008, 2017 |

The lead author and corresponding year for each of the documents are bolded. (All names were checked multiple times. Parrillo was misspelled on the header for the 2003 definitions document. The names Evans and Webb appear twice, but are different people.)

The table is not intended to be exhaustive, rather the goal is to demonstrate and sketch the regularity of involvement over the last two decades by members of what became the SSC community. There is a continuity of involvement by many members, a consistent inclusion of new collaborators that then endure for future iterations of these key documents.

Bone is included as the 1991 consensus conference and 1992 publication are foundational for subsequent work. He was also a prolific author in the sepsis research literature 1980s, a driving force. See memorial dedication by John Marshall in inaugural *Sepsis* journal 1997 (Marshall, 1997b).

Masur is included on the table because it stood out to me that he was an early participant in the guideline development process. He was part of the 2016 guideline committee on behalf of the Infectious Diseases Society of America (IDSA), but due to substantive disagreement with various guidelines, he cordially decided that IDSA could not endorse the guidelines in time for publication. He, and four other Sepsis Task Force members within IDSA, penned a document for IDSA’s highly respected journal providing an explanation to readers of the specific areas of disagreement.

# Appendix F—Growth of Sponsoring and Endorsing Organisations (Guidelines)

| **Guideline publications** | |
|---|---|
| **Bone et al. (1992)** | 2 organisations; 35 committee members; 12 pages; 45 references<br>American College of Chest Physicians<br>Society of Critical Care Medicine |
| **Supplement (2001)** | 1 organisation; 17 authors; ICM Supplement of 134 pages<br>International Sepsis Forum |
| **Dellinger et al. (2004)** | 11 participating organisations; 46 faculty; 13 pages (+Supplement); 135 references<br>American Association of Critical-Care Nurses<br>American College of Chest Physicians<br>American College of Emergency Physicians<br>American Thoracic Society<br>Australian and New Zealand Intensive Care Society<br>European Respiratory Society<br>European Society of Clinical Microbiology and Infectious Diseases<br>European Society of Intensive Care Medicine<br>International Sepsis Forum<br>Society of Critical Care Medicine<br>Surgical Infection Society<br>(IDSA declined to endorse) |
| **Dellinger et al. (2008)** | 16 organisations; 55 international experts; 44 pages; 341 references<br>American Association of Critical-Care Nurses<br>American College of Chest Physicians<br>American College of Emergency Physicians<br>Canadian Critical Care Society<br>European Society of Clinical Microbiology and Infectious Diseases<br>European Society of Intensive Care Medicine<br>European Respiratory Society<br>International Sepsis Forum<br>Japanese Association for Acute Medicine<br>Japanese Society of Intensive Care Medicine<br>Society of Critical Care Medicine<br>Society of Hospital Medicine<br>Surgical Infection Society<br>World Federation of Societies of Intensive and Critical Care Medicine<br>German Sepsis Society<br>Latin American Sepsis Institute<br>(The American Thoracic Society and Australian and New Zealand Intensive Care Society withdrew their sponsorship; IDSA declined) |
| **Dellinger et al. (2012)** | 30 organisations; 69 international experts; 64 pages; 636 references<br>American Association of Critical-Care Nurses |

|  |  |
|---|---|
|  | American College of Chest Physicians<br>American College of Emergency Physicians<br>American Thoracic Society<br>Asia Pacific Association of Critical Care Medicine<br>Australian and New Zealand Intensive Care Society<br>Brazilian Society of Critical Care<br>Canadian Critical Care Society<br>Chinese Society of Critical Care Medicine<br>Chinese Society of Critical Care Medicine—China Medical Association<br>Emirates Intensive Care Society<br>European Respiratory Society<br>European Society of Clinical Microbiology and Infectious Diseases<br>European Society of Intensive Care Medicine<br>European Society of Pediatric and Neonatal Intensive Care<br>Infectious Diseases Society of America<br>Indian Society of Critical Care Medicine<br>International Pan Arabian Critical Care Medicine Society<br>Japanese Association for Acute Medicine<br>Japanese Society of Intensive Care Medicine<br>Pediatric Acute Lung Injury and Sepsis Investigators<br>Society for Academic Emergency Medicine<br>Society of Critical Care Medicine<br>Society of Hospital Medicine<br>Surgical Infection Society<br>World Federation of Critical Care Nurses<br>World Federation of Pediatric Intensive and Critical Care Societies<br>World Federation of Societies of Intensive and Critical Care Medicine<br>German Sepsis Society<br>Latin American Sepsis Institute<br>(International Sepsis Foundation no longer among the sponsoring organisations) |
| **Dellinger et al. (2017)** | 36 sponsoring and endorsing organisations; 59 international experts; 67 pages; 655 references (+ additional digital content)<br>American Association of Critical-Care Nurses<br>American College of Chest Physicians<br>American College of Emergency Physicians<br>American Thoracic Society<br>Asia Pacific Association of Critical Care Medicine<br>Associação de Medicina Intensiva Brasileira<br>Australian and New Zealand Intensive Care Society<br>Centroamericano y del Caribe de Terapia Intensiva<br>European Respiratory Society<br>European Society of Clinical Microbiology and Infectious Diseases |

| | |
|---|---|
| | German Sepsis Society<br>Indian Society of Critical Care Medicine<br>International Pan Arab Critical Care Medicine Society<br>Japanese Association for Acute Medicine<br>Japanese Society of Intensive Care Medicine<br>Latin American Sepsis Institute<br>Scandinavian Critical Care Trials Group<br>Society for Academic Emergency Medicine<br>Society of Hospital Medicine<br>Surgical Infection Society<br>World Federation of Critical Care Nurses<br>World Federation of Societies of Intensive and Critical Care Medicine<br>Academy of Medical Royal Colleges<br>Chinese Society of Critical Care Medicine<br>Asociación Colombiana de Medicina Critica y Cuidado Intensivo<br>Emirates Intensive Care Society<br>European Resuscitation Council<br>European Society of Paediatric and Neonatal Intensive Care<br>European Society for Emergency Medicine<br>Federación Panamericana e Ibérica de Medicina Crítica y Terapia Intensiva<br>Sociedad Peruana de Medicina Intensiva<br>Shock Society<br>Sociedad Argentina de Terapia Intensiva<br>World Federation of Pediatric Intensive and Critical Care Societies<br>European Society of Intensive Care Medicine<br>Society of Critical Care Medicine<br>(Infectious Diseases Society of America and Canadian Critical Care Society no longer endorsing) |

# Appendix G—Growth of Sponsoring and Endorsing Organisations (Definitions)

**Bone et al. (1992)**

**2 organisations; 35 committee members; 12 pages; 45 references**

1. American College of Chest Physicians
2. Society of Critical Care Medicine

**Levy et al. (2003)**

**5 organisations; 27 committee members; 9 pages; 41 references**

1. Society of Critical Care Medicine
2. European Society of Intensive Care Medicine
3. American College of Chest Physicians
4. American Thoracic Society
5. Surgical Infection Society

**Singer et al. (2016)**

**32 organisations; 19 Task Force Members; 10 pages; 36 references (+ additional supporting articles and references)**

1. Academy of Medical Royal Colleges (UK)
2. American Association of Critical Care Nurses
3. American Thoracic Society (endorsed August 25, 2015)
4. Australian–New Zealand Intensive Care Society (ANZICS)
5. Asia Pacific Association of Critical Care Medicine
6. Brasilian Society of Critical Care
7. Central American and Caribbean Intensive Therapy Consortium
8. Chinese Society of Critical Care Medicine
9. Chinese Society of Critical Care Medicine–China Medical Association
10. Critical Care Society of South Africa
11. Emirates Intensive Care Society
12. European Respiratory Society
13. European Resuscitation Council
14. European Society of Clinical Microbiology and Infectious Diseases (and its Study Group of Bloodstream Infections and Sepsis)
15. European Society of Emergency Medicine
16. European Society of Intensive Care Medicine
17. European Society of Paediatric and Neonatal Intensive Care
18. German Sepsis Society

19. Indian Society of Critical Care Medicine
20. International Pan Arabian Critical Care Medicine Society
21. Japanese Association for Acute Medicine
22. Japanese Society of Intensive Care Medicine
23. Pan American/Pan Iberian Congress of Intensive Care
24. Red Intensiva (Sociedad Chilena de Medicina Critica y Urgencias)
25. Sociedad Peruana de Medicina Critica
26. Shock Society
27. Sociedad Argentina de Terapia Intensiva
28. Society of Critical Care Medicine
29. Surgical Infection Society
30. World Federation of Pediatric Intensive and Critical Care Societies
31. World Federation of Critical Care Nurses
32. World Federation of Societies of Intensive and Critical Care Medicine