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Defining adaptive capacity in healthcare: A new framework for researching resilient performance

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Abstract

Resilience principles show promise for improving the quality of healthcare, but there is a need for further theoretical development to include all levels and scales of activity across the whole healthcare system. Many existing models based on engineering concepts do not adequately address the prominence of social, cultural and organisational factors in healthcare work. Promising theoretical developments include the four resilience potentials, the CARE model and the Moments of Resilience Model, but they are all under specified and in need of further elaboration. This paper presents the Integrated Resilience Attributes Framework in which these three theoretical perspectives are integrated to provide examples of anticipating, responding, monitoring and learning at different scales of time and space. The framework is intended to guide researchers in researching resilience, especially the linkages between resilience at different scales of time and space across the whole healthcare system.

Highlights

- Theoretical development of resilient healthcare principles is needed to take account of activity across the whole healthcare system
- The four resilience potentials, the CARE model and the Moments of Resilience model are promising but under specified theoretical frameworks
- The Integrated Resilience Attributes Framework was developed to define resilience concepts across the whole healthcare system
- The framework can guide researchers in focusing research questions and in investigating linkages between resilience at different scales of time and space.

Keywords

Resilience potentials; resilience framework; multi-level resilience, resilient healthcare

Declaration of interest

Declarations of interest: None

1 Introduction

The quality and safety of healthcare are priorities for policy makers and regulators in many countries worldwide. Quality and safety are related concepts. The Institute of Medicine has defined quality as having six dimensions; safety, effectiveness, patient centredness, timeliness, efficiency and equity. Despite efforts to improve quality the rate of change is slow. Approximately 10% of patients in many countries continue to be harmed by their care, and there is now growing realisation that a new approach to improvement is needed to achieve a step change in the quality of care. Resilient healthcare is a new approach based on understanding and increasing adaptive capacity that may inform quality improvement efforts, but there is a need to develop a knowledge base of how it can be used and its effectiveness. This paper presents a new framework for defining adaptive capacity to facilitate research in this field.

Drawing from ideas in complexity and systems theory, Resilient Health Care (RHC) for organizational improvement generates insights into how care quality arises out of multiple interacting factors (Patterson et al., 2006). It provides a rich framework for deep understanding of technical work (Barley & Orr, 1997; Nemeth, Cook & Wears, 2007), which in turn can inform the development of interventions to improve quality (Nemeth et al., 2008). However, there is a need to increase the development of the evidence base for RHC research and practice, which, despite progress, is still grappling with fundamental definitional questions and how to define resilience in research designs. This is particularly challenging for RHC research because resilience is not directly observable and cannot be assumed to exist whenever acceptable outcomes are achieved. The definition of RHC has evolved from early ideas that focused on stability during and after disturbances or recovery

from crises to focus on the ability to sustain everyday operations under anticipated and unanticipated conditions (Hollnagel 2018), which is the definition that we use in this paper. Logically, we infer that this ability is required for high quality care and therefore strengthening this ability may lead to quality improvements, but more research is needed to investigate the relationship between quality of care and resilience. Many studies describing healthcare work have documented how adaptive actions taken by clinicians solved problems and prevented harm (Berg et al 2018;2019, Ellis et al 2019), but it is possible that adaptability could have negative consequences (Wears & Hettinger, 2013; Wiig & Fahlbruch, 2019; Anderson et al, 2016). The framework presented in this paper is intended to assist researchers in investigating these relationships.

Conceptual understanding of what constitutes a resilient organisation, and how resilience can be supported at an organisational level is well developed but there is still a lack of empirical evidence testing the concepts, and the theoretical concepts are in general under-specified. For example, to date there has been little consideration of how resilience can be increased, how this is linked to the quality of care, or the multi level system influences on adaptive capacity (Ellis et al 2019; Righi et al 2015). In a new scientific field this is understandable, but we argue that iterative cycles of theorising and data collection are now needed to build the knowledge base. In this paper we focus on the four resilience potentials (anticipation, monitoring, responding, learning) that have been proposed to underpin organisational performance (Hollnagel, 2018) and consider how two recent theoretical developments could help to define these constructs in research.

We integrate two theoretical perspectives to define the activities that reflect the resilience potentials: Anderson et al's Concepts for Applying Resilience (CARE) model (Anderson et al,

2016), and Macrae's (2019) Moments of Resilience. We show how they might inform the four resilience potentials and contribute to theoretical development in this field by guiding further research in healthcare systems. This will in turn contribute to refining the framework.

1.1 Resilient healthcare principles

A group of multi-disciplinary specialists have argued that resilience is necessary for complex organisations to deliver high quality safe care (Nemeth et al, 2008; Hollnagel et al, 2013; Wears et al, 2015; Braithwaite et al, 2017). Resilient healthcare draws on the concepts of complex systems and views healthcare organisations as those in which effects are nonlinear, time delayed and unpredictable (Robson, 2015). Some of the assumptions about the nature of healthcare systems are as follows:

1. Healthcare is a complex system in which pressures and demands are often unpredictable and this requires staff, teams and organisations to anticipate problems, flexibly adapt procedures and prioritise competing demands
2. Procedures or protocols that attempt to constrain how work is achieved are not always helpful because they cannot possibly anticipate all the interactions between competing demands that affect the work
3. Adapting safely to pressures is what keeps the healthcare system functioning and improvement efforts should focus on strengthening this capacity.

A key distinction is drawn between work as it is "imagined" in policies and procedures (described and/or prescribed) and how work goals are achieved in practice through flexible adaptation. Rather than viewing healthcare work through the lens of compliance or violation of standard operating procedures and guidelines, a resilience lens focuses

attention on the nature of the healthcare system and the adaptive work that is done to deliver safe care (for example, Back et al, 2017). It proposes an ontology of care that emphasises unpredictability, adaptation and change, based on a growing literature documenting how healthcare work proceeds (for example, Sujan et al, 2015; Perry et al, 2012; Wachs et al, 2016).

Resilient healthcare can be characterised as a philosophical shift in understanding how safe, high-quality care is achieved, but it has not always been clear how this depiction of healthcare can be used prospectively to improve quality across healthcare systems. Indeed, most resilient healthcare research has focused on describing and understanding how work is achieved at the clinical front line (Berg, 2019). If these ideas are to be useful for improving quality there is now a need to develop and apply theories of resilience to describe and more fully explain the adaptive capacity of healthcare systems, and to move beyond description to explaining relationships. Developing and testing more sophisticated theoretical and conceptual frameworks of resilience is now a priority for the field, both to provide frameworks for future research and to provide guidance for practical improvement. (Anderson et al, 2016; Wiig & Fahlbruch, 2019; Macrae & Wiig, 2019, LeCoze, 2019).

1.2 The resilience potentials

Hollnagel (2018) has developed the four resilience potentials (anticipating, monitoring, responding, learning) that are proposed to underpin successful “work as done”. Responding to developing changes and problems in the work system is necessary to ensure that good performance is maintained. Examples include a sudden influx of emergency patients, equipment breaking down or lack of staff. Responding to problems is a large part of the expertise of healthcare staff and so could be expected to be well practiced and recognised

in professional practice. Monitoring refers to the ability to detect things which could affect performance and is clearly linked to responding. One needs to detect a developing problem in order to respond to it. Anticipation refers to the ability to ascertain needs further into the future and could involve detecting emerging problems, risks, constraints or opportunities. Learning from experience, both positive and negative is crucial for knowing how to increase positive outcomes and avoid negative ones.

The potentials are assumed to be integrated and should not be considered in isolation (Hollnagel, 2018). For example, the ability to anticipate future needs interacts with the ability to monitor, respond and learn from current events. Emerging research has confirmed the usefulness of the abilities to understand how resilience is manifest in work systems (Bergerød et al 2018; Heggelund & Wiig 2018; Anderson et al, 2019), but is at an early stage. More testing in different contexts and settings is needed to understand what is meant by the four abilities, their mechanisms of action and how they can be improved (Heggelund & Wiig 2018; Bergerød et al 2018).

1.3 Theory development

Commensurate to the relatively recent development of resilient healthcare research many theoretical models of resilience in complex organisations have been proposed (for example, see Patriarca et al, 2018; Lundbert & Johansson, 2015; van der Beek & Schraagen, 2015; Saurin & Werle, 2017; Woods & Wreathall, 2008). These models have often been based on engineering concepts such as slack (Saurin & Werle, 2017), stress-strain limits (Woods & Wreathall, 2008), or constraints and functional dependencies (Lundberg & Johansson, 2015), or employ language and concepts that are difficult for non-specialists such as healthcare professionals to understand (for example, Grecco et al, 2012). Engineering

concepts may be useful metaphors to inform thinking but are unlikely to accurately reflect human behaviour in complex systems dominated by social, not technical, processes. Finally, many theoretical models do not clearly define the concepts and so it is difficult to envisage how to apply them in practice (Wiig & Fahlbruch 2019). The need is to define the elements of a social, cultural and organisational model to guide resilient healthcare research.

Theories are fundamental to the progress of science and are proposed to comprise explicit, abstract concepts that can be used to rationalize, explain and predict phenomena in the world (Chalmers, 2013) The extent to which this idea of theory, derived from the natural sciences, is relevant to human activity is contested (Flyvberg, 2001) and the nature of theory is a matter of debate (Sutton & Staw, 1995; Weick, 1995). It may be helpful to distinguish types of theories based on their scope (Davidoff et al, 2015). While grand theories address problems across a range of domains and are at a level of abstraction that permits generalisation, middle range theories have a limited scope and domain of application (Davidoff et al, 2015). Examples of grand theories in safety science include normal accident theory and high reliability theory (Tamuz & Harrison, 2006). Likewise, resilience engineering, which describes how human activity achieves dependable results in a complex and variable environment could be described as a grand theory. The proposed role of the four resilience potentials in creating safe healthcare, having a smaller scope, could be described as a middle range theory.

Middle range theories are constructed from observations which are then described, labelled and used to generate general statements (Davidoff et al, 2015). Further empirical testing of these statements is then used to develop the theory (Hoeck & Delmar, 2018). Weick (1974) describes this as a process of observing the everyday events and everyday places to build

patterns and explanations that can be elaborated and tested further. One of the first steps in theorising is identifying and naming the constructs of interest (Davidoff et al, 2015). Without well-defined constructs it is difficult to design research that focuses on the important parts of the everyday phenomena that compete for a researcher's attention when observing practice. Well defined constructs are also required in order to propose and test relationships between phenomena, which is a core aspect of theorising (Shepherd & Suddaby, 2017). Further elements of theory building involve such activities as abstraction, developing typologies and comparing newly collected data with published literature (Shepherd & Suddaby, 2017).

Theorising is needed to clarify the core concepts underpinning resilient performance. Hollnagel (2018) has proposed that anticipating, monitoring, responding and learning are required for resilient systems, but it is not clear what activities these potential abilities encompass. Of the myriad activities undertaken to care for a patient, a clinician might expect care needs to develop as they have for previous patients, and on this basis might anticipate a patient will need certain therapies or facilities over the course of a day. Is this type of routine anticipation, which enables teams to prepare to meet a patient's needs, what is meant by resilient potential? And how is it related to monitoring vital signs or responding to a patient's request? Or is the intent of resilient healthcare to explain resilience as it unfolds across an organisation? Similar questions can be posed about the other potentials: what should be monitored, learned and responded to? And, who is involved in achieving these potentials? The abstract nature of the concepts means that researchers investigating resilience in the field will find it hard to select a focus, and different researchers may resolve this dilemma differently. This will slow the rate of

progress and accumulation of evidence unless guidance is provided. Clear definitions of the four resilience potentials are needed for progress in understanding adaptive capacity in healthcare (Berg et al 2018;2019, Bergerød et al 2018).

1.4 Multi-level perspective

Human factors science has long recognised that roles which are not directly patient facing can remain critical to the safety and quality of care (Reason, 1997; Rasmussen 1997; Cook & Rasmussen 2005). Frameworks such as the 'Swiss Cheese' model of accident causation explicitly acknowledge that organisational factors create the latent conditions that contribute to accidents (Reason, 2000). Latent factors include poor management processes, unsuitable guidelines, poorly designed equipment, inadequate supervision and lack of training (Reason, 2000; Parker & Lawton, 2006). The activities and responsibilities of managers, regulators and policy makers may not directly involve the care of patients, but their actions can significantly shape services which have an impact on staff and patients.

The argument is that decisions made at one level of the system can support or hinder adaptive capacity at lower hierarchical levels of the system, and within its own level. This builds on the Complex Adaptive Systems literature that suggests that systems levels are integrated and scale across the system. Accordingly, each level of the system affects the adaptive capacity of other levels by setting the framework within which activity can take place. Each level also requires resilience to respond appropriately to disturbances within its own field of responsibility. For example, regulatory bodies have system-wide responsibilities and must respond to system wide disturbances such as the blood contamination scandal that occurred in the NHS in the 1970's and 1980's and resulted in 30,000 people being infected with HIV. RHC may provide a helpful lens for studying how regulators responded to

this crisis by analysing their four resilience potentials of anticipating, monitoring, responding and learning, and for understanding the effect of new regulations in relation to blood transfusions on the delivery of patient care. Recent literature has also started deepening our understanding about the relationship between resilience and regulation illustrating the knowledge gap, and perhaps misunderstanding about this in the current literature (Øyri & Wiig 2019; Wiig et al in press).

The need for a multi-level perspective in resilience research has been identified (Berg & Aase, 2019), but RHC research has so far not been able to adequately explain the links between resilience at different system levels or empirically investigate how actions taken at one level influence another (Wiig & Fahlbruch, 2019; Berg et al 2019).

1.5 CARE model

The Concepts for Applying Resilience (CARE) model (Figure 1) was developed to guide in depth fieldwork in a study to identify resilience and how it could be increased (Anderson et al, 2016). It proposes that healthcare work is characterised by misalignments between demand and capacity that occur because it is not possible to anticipate demand with the precision necessary to perfectly align capacity to meet such demand. This mirrors the difference between “work as imagined” in protocols and “work as done” in practice. Misalignments can occur because of shortfalls of staffing numbers or skill level, unforeseen increases in patient numbers, a patient emergency, equipment breakdowns, unavailability of protocols for a given situation, or a need to accommodate a patient’s preference for their treatment which is outside common practice.

Misalignments create the need for adaptations. Outcomes, both positive and negative, emerge from the interplay between misalignments and adaptations. The CARE model was

helpful in focusing researchers in the field on the relevant aspects of work (e.g. Back et al, 2017). However, it is also under specified; adaptations to clinical work does not only occur because of misalignments. Opportunities to innovate, increase efficiency and reduce workload also drive adaptations (Rasmussen, 1997). Hollnagel includes the ability to respond to opportunities as an element of the potential for resilient performance (Hollnagel, 2018). The CARE model requires further development to include these drivers of adaptation and to specify how it applies at multiple system levels and in different healthcare contexts.

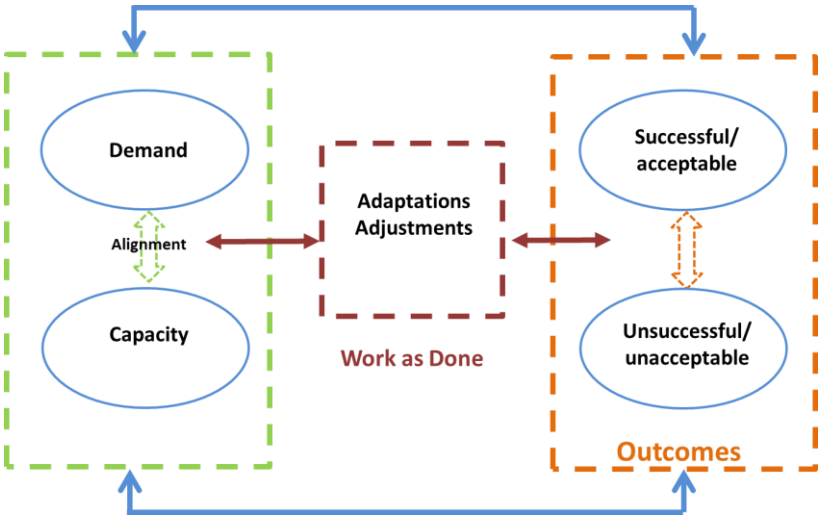

Figure 1. CARE model of resilience concepts (Anderson et al, 2016)

1.6 Moments of Resilience

Second, Macrae (2019), recognising the need to broaden the focus of resilience investigations, has developed a framework for differentiating between resilience at multiple scales of time and space (see Figure 2). The micro-meso-macro framework may not be the

most useful for understanding how activities of resilience unfold, enlarge and become linked across different scales of activity. Instead of a system level orientation, Macrae (2019) uses the idea of temporal and spatial scales to propose that resilience can be described as situated, structural and systemic in the healthcare system.

Situated resilience refers to the management of unexpected events that occur in relatively small scales of time and space and unfold by drawing on pre-existing sociotechnical resources and practices (such as skills, knowledge, tools, data) to respond to and address some disruption or source of stress—such as a surgical team responding to an unexpected perioperative emergency. Structural resilience is the process of examining and redesigning resources and practices themselves, so these better support work, and typically unfolds over larger scales of time and space—such as redesigning a surgical checklist. Systemic resilience involves activities that are focused on entirely reformulating the way that sociotechnical resources and practices are produced and organised—such as reconfiguring systems of inspection and regulation of surgical services. This may occur over an entire industry and a large scale of time and space.

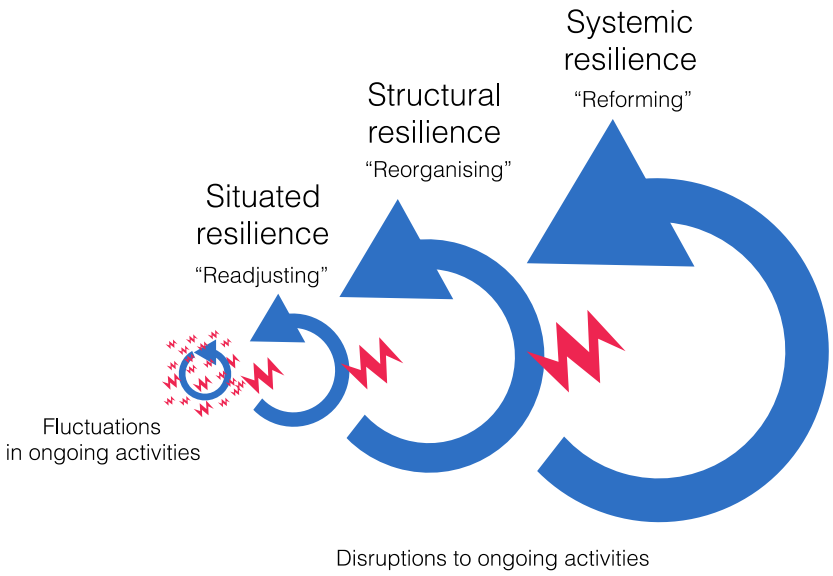

Figure 2. Resilience at different temporal and spatial scales (Macrae & Wiig, 2019, p. 126).

2 Aim

The aim of this paper is to develop and present a framework to guide future research into resilient processes, effects and interventions at all scales of healthcare activities. We use theory to consider how to define the four resilience potentials by integrating these concepts with the CARE model and the Moments of Resilience model. We aim to develop theory to inform data collection and analysis, which in turn informs further theoretical development. Theory can be used to identify research gaps, inform data collection, and interpret findings empirically and theoretically.

3 Methods

The Moments of Resilience model was developed based on studies from finance, healthcare and aviation (Macrae, 2019). The CARE model was developed in studies of hospital emergency care and older people's care to guide data collection (Anderson et al, 2016). The four resilience potentials are proposed to be fundamental to resilience (Hollnagel, 2018) but the empirical evidence for their importance is mostly derived from studies in emergency departments (Berg et al 2018). We have integrated these models and concepts in order to provide examples that are incorporated into a research framework. The framework was developed conceptually as a result of discussions about the difficulty of identifying and studying resilience activities that are not only performed by staff involved in providing direct patient care but are enacted throughout a healthcare system.

4 Results

In this section we present a new framework integrating the four resilience potentials with the Moments of Resilience idea of temporal and spatial scales, and the CARE model. The CARE model concepts are integrated into each of the four potentials. Table 1 shows the structure of the framework.

Table 1. Overview of the Resilience Attributes Framework

Resilience potentials	**Situated resilience -** Re-adjusting processes by integrating and applying existing resources and practices	**Structural resilience** - Re-organising and restructuring sociotechnical resources and practices	**Systemic resilience –** Reforming and reconfiguring how resources and practices are produced
Anticipating -disruptions or opportunities in the future	Anticipate • demand-capacity misalignments in ongoing practical work • opportunities to apply and draw on resources and skills Capacity to anticipate	Anticipate • demand-capacity misalignments between resources and requirements • opportunities to restructure resources and practices Capacity to anticipate	Anticipate • demand-capacity misalignments in the processes that produce and circulate resources and practices • opportunities to reconfigure methods and systems Capacity to anticipate
Monitoring – the work system or environment	Monitor • task demand-capacity misalignments • team performance • task environment • task tools and equipment • performance outcomes • opportunities Capacity to monitor	Monitor • service demand and capacity misalignments • service environment • service tools and equipment • performance outcomes • opportunities Capacity to monitor	Monitor • system demand and capacity misalignments • environment • tools and equipment • performance outcomes • opportunities Capacity to monitor
Responding – to demands	Respond to • task demands • opportunities via flexible adaptation Capacity to respond	Respond to • service demands • opportunities at a service level Capacity to respond	Respond to • system demands • opportunities at a system level Capacity to respond
Learning – from experience	Case based learning Experience based learning Performance feedback Capacity to learn and implement changes	Organisational performance feedback Capacity to learn and implement changes	System learning and feedback Capacity to learn and implement changes

In Appendix 1 we show a detailed version of the framework populated with examples from our own research. We consider how demand-capacity misalignments, outcomes and opportunities are anticipated, responded to, monitored and learned about. We also incorporate capacity by giving examples of the types of activities that are required if an organisation is able to perform resiliently. The aim of the framework is to begin to answer questions, such as, what does resilience look like at each system level and at different scales of time and space? Where can we begin research activities if we want to diagnose weaknesses in the potential for resilient performance, or suggest strategies for increasing it? And, importantly, how can we shift research attention from the front line to the role of managers, hospital boards, policy makers, regulatory bodies and other actors who, although removed from direct patient care, play a key role in resilience in healthcare? The framework is not exhaustive; there may be further activities that are not yet documented or widely understood as contributing to resilient performance. However, the framework can be used as a starting point to develop and test these ideas in further research and can function as a guide for researchers when investigating adaptive capacities in healthcare.

5 Discussion

We have presented the first version of an Integrated Resilience Attributes Framework to conceptualise and define the different resilience potentials that may or may not actuate at

different temporal and spatial scales in healthcare and how the system will need to balance demands and capacity in its constant effort to deliver sound and safe patient care. At systemic level, which could include the functions of policy makers, regulators, commissioners and professional bodies, strategy is determined, and future operations are planned. At the structural level, aspects of operations such as infrastructure planning and provision, organisational performance monitoring, emergency response planning and workforce planning are co-ordinated. At this level actions are tactical and aim to ensure that the organisation can deal with pressures and perform adequately. Finally, situated resilience involves anticipating pressures such as patient flow or equipment malfunctioning, responding to patients, monitoring the environment and learning through structured activities such as handover and ward rounds.

The idea of different temporal and spatial scales of activity is important because it allows us to think about how resilience does or does not scale up across whole systems of activity and to conceptualise whole systems of actions. It is evident that there may be some overlap between the Moments of Resilience model and the micro-meso-macro framework. For example, the idea of spatial scales could map easily to the scope of actions taken at micro-meso-macro levels. Action at a macro level has wide scope and therefore occurs on a large spatial scale affecting work in distant locations. Micro level activity almost by definition has a narrow spatial scope. The temporal scale is not so easily mapped to the micro-meso-macro framework but even here there are some commonalities. For example, smaller systems are likely to change faster than larger systems (Liljenstrom & Svedin, 2005), and so activity at the micro level is likely to happen on smaller time scales than macro level activity,

such as regulatory regimes. The exact definition of the different spatial and temporal scales is one that can be addressed in future research.

One advantage of the Moments of Resilience model is that it allows us to think about the different scales of action at all levels – micro-meso-macro. For example, situated resilience may be required by regulators when managing their own performance (Macrae & Wiig, 2019). A research project can be envisioned which investigates how a regulatory body did or did not anticipate a system failure like Mid Staffordshire, monitored its own activities, responded to reputational problems as details of the care failings emerged, and learned. Similarly, a study of the introduction of robotic surgery, a technological innovation, could focus on the situated resilience of an organisation (meso level) to understand how the four potentials contributed to the introduction of the innovation, or on the structured resilience that was required to prepare for the introduction of this innovation. The Moments of Resilience model thus helps us to think about scales of resilience at each system level.

We intend the framework to be used as guide for researchers, but we do not recommend a purely deductive approach of looking for the activities suggested in the framework. Resilience is an emergent phenomenon and therefore we encourage looking beyond aspects in the framework too, in order to further develop our theoretical perspective of resilience and thereby improve our understanding of how resilience occurs at different scales and time in healthcare systems. Once mechanisms are identified, the framework could be used to generate hypotheses and help to focus research designs on the important questions that are relevant to resilient healthcare. For example, a fruitful avenue for future work is to examine how resilience is linked across system levels and whether action taken at one level

undermines or supports resilience at another. The framework could be used to map out the initial scope for the investigation and to guide data collection and analysis.

It is unlikely that most studies will investigate all the scales of activity encompassed by the framework. Individual studies will likely focus on one aspect of the temporal and spatial scales or investigate the links between a small number of resilience phenomena. We do not regard this as problematic but rather as an opportunity to build the evidence base using the framework to specify which scales and phenomena are being investigated. This should make it easier to compare findings across multiple studies and identify gaps in knowledge.

We acknowledge that the four resilience potentials of anticipating, monitoring, responding and learning are integrated (Hollnagel, 2018) and in some senses it is not possible or helpful to separate them. Equal to other studies (Bergerød et al 2018, Heggelund & Wiig 2018), we found it difficult to differentiate between them in some cases. For example, anticipating task outcomes is inextricably linked to monitoring task performance. Similarly, learning from previous experience of what works for a patient problem is linked to responding to future patients. Care emerges from the interactions between all the activities carried out by different staff and agencies at different times and places. Imposing a framework on the complexity of actions and interactions that combine to provide patient care is somewhat artificial, illustrating the tension between a systems theoretic perspective, which involves decomposing systems, and work as it is done in practice. However, a framework to guide data collection and analysis is needed, especially given the challenges of conducting resilience research, not least the difficulty of knowing what to look for when working in the field. Perhaps guidance is the key word here – all models are simplifications of reality to

some extent (e.g. LeCoze 2008; Anderson et al, 2016) but nevertheless provide useful guidance and structure discussion.

The Integrated Resilience Attributes Framework includes staff, patients and families/carers as sources of resilience, acknowledging the need to include information and feedback from staff and patients when monitoring and learning at all levels of the system. Patients and families/carers are valuable sources of system resilience. This is an area of developing interest in resilient healthcare studies (e.g. O'Hara et al,2018; Bergerød et al, 2018, Fylan et al, 2018, Schubert et al 2015; Wiig et al 2019a;b), although most studies do not integrate this into the research design (Berg et al 2018). By including the roles of the patient and family into research designs as suggested in our framework, we argue that our understanding of adaptive capacity at different scales in the healthcare systems will be more comprehensive. Similarly, the importance of staff as a source of feedback means that the extent to which their views are actively sought and acted upon should be seen as one indicator of resilience.

This framework inevitably has limitations. Integrating frameworks developed separately involves compromises and simplification of each, but we intend it to be tested and developed further empirically. Its strength is that it is grounded in empirical experience, involves multiple scales of activity and takes account of the social, cultural and organisational factors that are absent from many resilience models. The use of descriptions of activity is intended to guide researchers in the identification, description and enhancement of resilience mechanisms in all areas of healthcare and to articulate the links between different actions, including organisational, regulatory, policy and commissioning activities. Resilience at all scales of activity is required to produce high quality care but the

time lag and spatial distance of managers, regulators and others from patient care poses challenges for them in deciding what actions are needed, monitoring their effects and learning from the experience. The framework should help researchers to investigate this gap and devise solutions. The framework is intended to be general enough to use in different healthcare settings but has not been tested in practice. We expect that it will be refined and developed further during use in field studies and in different healthcare sectors, including in a planned multi-national resilient healthcare study commencing in 2021 (Aase et al 2018).

5.1 Conclusion

In this paper we have combined three theoretical contributions within resilient healthcare and developed the Integrated Resilience Attributes Framework with the purpose of defining and providing examples of the concepts and guiding research in resilient healthcare. Theoretical developments such as this require further testing with empirical data and further iterations. In its present form the framework could provide a focus for research focused on one temporal or spatial scale, or on linkages across levels and scales.

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8 Appendix A

Table 2. Extended Resilience Attributes Framework

Resilience potentials	**Situated resilience -** Re-adjusting processes by integrating and applying existing resources and practices	**Structural resilience** - Re-organising and restructuring sociotechnical resources and practices	**Systemic resilience –** Reforming and reconfiguring how resources and practices are produced
Anticipating disruptions or opportunities in the future	**Anticipate demand-capacity misalignments** • Increase in unscheduled patient numbers in winter • Reduced staffing levels due to recruitment problems • Equipment malfunctioning or missing **Anticipate opportunities** • New ways of working • New uses of patient care technology • Changes in staff training leading to new team configurations **Capacity to anticipate** • Team leadership • Team working • Inclusive culture • Team meetings • Prior experience • Time to anticipate	**Anticipate demand-capacity misalignments** • Lack of beds leading to increased length of stay and target breaches in Accident and Emergency department • Emergency response preparedness **Anticipate opportunities** • Formal or informal links with primary or social care staff to contribute expertise • Reconfiguration of space • New technological developments and IT systems **Capacity to anticipate** • Team leadership • Team working • Inclusive culture • Psychological safety • Links with other organisations	**Demand-capacity misalignments** • Need for new services due to changing patterns of health and illness such as aging population, rise in prevalence of diabetes or disease outbreak • Chronic staff shortages evolving over time due to training limitations **Anticipate opportunities** • New therapies and treatment modalities such as personalised medicine, robotic surgery, telecare **Capacity to anticipate** • Research involvement • Collaborative projects • International links • Organisational support for horizon scanning

		• Organisational mechanisms for discussing and sharing knowledge • Prior experience • Time to anticipate	• Formal or informal links between macro level organisations • Organisational mechanisms for discussing and sharing knowledge
Monitoring	**Monitor task demand-capacity misalignments** – • Staffing levels for shift • Number of patients presenting for treatment • Equipment malfunctioning or missing **Monitor team performance** • Competing demands, priorities, roles, standards, communication and co-ordination, briefings and debriefings **Monitor task environment** • Workload during a shift • Changing patient priorities • Time • Space **Monitor task tools and equipment** • Supplies, equipment functionality **Monitor task outcomes** • Patient outcomes – care completed, clinical goals met, preferences and needs met,	**Monitor service demand and capacity misalignments** • Patient numbers and acuity • Staffing levels – bank and agency staff use • Use and availability of space **Monitor teams** • Need for training and development • Staff turnover and burnout • Culture **Monitor service environment** • Workload modelling and management • Budgets • Time • Space **Monitor service tools and equipment** • Need for new tools and technology • Performance of current tools and technology **Monitor outcomes–**	**Monitor system demand and capacity** • Service uptake; physical infrastructure; patient needs; clinical performance; financial performance. • Monitor workforce - burnout; turnover; skills, need for training • Monitor functionality of regulation and standards **Monitor service environment** • Space, infrastructure **Monitor tools and equipment** • Need for new tools and technology across whole system. • Cost of new equipment **Monitor outcomes** • Targets; league tables, regulatory reports, mortality rates, professional body reports, patient compensation and complaint reports

	family informed, safety and risks, length of stay, targets met • Staff fatigue, stress, burnout, satisfaction, skills acquired, learning experiences **Monitor opportunities** • Increase staff skill level through training • Quality improvement • More efficient ways of working • Reducing costs **Capacity to monitor** • Availability of data that supports team tasks • Shared communication artefacts • Completeness of documentation • Team leadership • Mechanisms to support team communication and co-ordination • Inclusive team culture	• Financial, adverse events, service targets, complaints, length of stay, mortality, patient experience, staff experience, regulatory reports **Monitor opportunities** • Improvement, ways of working, service redesign, new technology **Capacity to monitor** • Availability of data • Ability to visualise and interpret data • Organisational support for discussing competing interpretations • Organisational mechanisms for gathering diverse views from patients and staff • Benchmarking with other organisations	**Monitor opportunities** • Potential efficiencies, treatment improvements, diagnostic improvements, technology innovations **Capacity to monitor** • Reporting requirements • Data capture and reporting systems • Aggregation of data across organisations • Regulatory regimes • Research • System mechanisms for feedback, information gathering, discussion and sharing of knowledge • Links between macro level organisations
Responding	**Respond to task demands** as accepted in everyday practice via • Best clinical practice as set out in protocols and procedures - escalating to specialist as per guideline • Responding to emergencies • Changes in treatment plans	**Respond to service demands** • Co-ordinate organisational responses to an emergency, plan to reduce chronic staff shortages, investigate under performance, professional malpractice or patient harm **Responding to opportunities at a service level**	**Respond to system demands** • Organisational shortcomings or failures such as Mid Staffordshire, skills shortages via funding training places, professional malpractice, licensing and accreditation to ensure standards, introduce service targets, guidelines,

	Respond to opportunities via flexible adaptation • Opportunistic actions to reduce workload such as performing documentation in batches • Re-allocating team tasks as priorities change • Change patient medication based on previous case experience • Delay escalating to specialist on basis of knowledge of patient physiology • Patient preferences for treatment and care **Capacity to respond at a task level** • Available and usable protocols and procedures • Available technology, medication, staff • Adequate training • Team leadership • Team meetings • Team mechanisms to support co-ordination • Inclusive team culture	• Reconfiguring space to provide more beds in response to winter pressures • Incorporating GP services into the A & E department to treat increased numbers of patients presenting for routine problems • Disclosure of adverse events • Compensation for harmed patients **Capacity to respond at a service level via adaptive experience** • Team leadership • Team working • Psychological safety • Inclusive culture • Links with other organisations • Organisational mechanisms for discussing and sharing knowledge, planning and implementation • Prior experience	communication across organisations • Respond with regulatory actions such as special measures, increased monitoring and surveillance **Responding to opportunities at a system level** • System wide improvement initiatives • Introduce new therapies and treatments • Efficiencies and cost savings • System wide technological innovation • Culture change interventions such as duty of candour • Funding changes • Respond with change of regulation to support resilience mechanisms by more responsive regulation **Capacity to respond at a system level via adaptive experience –** • Research • System mechanisms for feedback, information gathering, discussion and sharing of knowledge

			• Links between macro level organisations • Political support for regulatory change
Learning	**Learn from experience** **Case based learning** • Case presentations; handover; ward rounds; team meetings; senior supervision, morbidity & mortality meetings. **Experience based learning** • Patient experiences and responses, family's needs **Systems problems and how to avoid them** • Local incident reports and investigations **Capacity to learn** • Competence and structures for collecting and storing data from diverse sources including staff, patients, families • System performance • How difficulties are overcome; adaptations that worked; simulation programs focusing on what went well • Mechanisms for discussing and sharing learning such as team meetings	**Learn from experience** **Organisational performance** • Adverse incidents, complaints, regulatory reports, staff survey, patient survey, success stories **Opportunities** • Research and development **Capacity to learn** • Data from diverse sources, and aggregated data at organisational level • Organisational mechanisms for discussing and sharing and disseminating learning across the organisation • Technology, skills and knowledge in interpreting data and identifying learning • Mechanisms for capturing research and new developments	**Learn from experience** **System learning** • Aggregated data such as national reporting systems, national investigations, national disease registries, infection rates, disease recurrence rates, mortality rates • System learning from patient and staff experiences **Identify and disseminate learning** • Release patient safety alerts and other performance notices **Learning from regulatory reports** • Financial reports; • Updates from executive board. **Opportunities** • Learn about new research and identify new opportunities, improved diagnosis, treatment and organisation of services • Participation in international fora for sharing knowledge and learning

	• Technology, skills and knowledge in interpreting data and identifying learning • Mechanisms for capturing research and new developments		• Incorporate lessons learnt into updated regulations **Capacity to learn** • Mechanisms for capturing, aggregating and analysing data • Knowledge and skills in interpreting data and identifying learning potentials • System mechanisms for discussing and sharing learning