Resilient Health Care: a systematic review of conceptualisations, study methods and factors that develop resilience.

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Abstract

Background Traditional approaches to safety management in health care have focused primarily on counting errors and understanding how things go wrong. Resilient Health Care (RHC) provides an alternative complementary perspective of learning from incidents and understanding how, most of the time, work is safe. The aim of this review was to identify how RHC was conceptualised, described and interpreted, to describe the methods used to study, and to identify factors that develop RHC.

Methods Electronic searches of PubMed, Scopus and Cochrane databases were performed to identify relevant peer-reviewed studies, and a hand search for studies published in books that explained how RHC as a concept was interpreted, methods used to study, and factors to develop RHC. Studies were evaluated independently by two researchers. Data was synthesised using a deductive thematic approach.

Results Twenty-seven studies were included; they shared similar descriptions of RHC which was the ability to adjust its functioning prior to, during, or following events and thereby sustain required operations under both expected and unexpected conditions. Qualitative methods such as observations and interviews were used to study RHC. Models for studying RHC currently exist and were in the early stages of implementation. Effective team relationships, trade-offs and healthcare ‘resilience’ training of health care professionals were factors used to develop RHC.

Conclusions Although there was consistency in the conceptualisation of RHC, methods used to study and factors to develop RHC, further research should focus on operationalising RHC assessment methods and developing, testing and evaluating interventions for developing RHC.

Background
Globally, it is reported that about 10% of hospitalised patients experience adverse health care events. Health care organisations may struggle to provide safe and high quality care, and as a result, people might experience unintentional harm [1-3]. The traditional approach to increasing safety has focused on counting incidents, identifying system failures, and understanding the causes of incidents in order to develop strategies to eliminate or reduce incidents [4]. This is called a Safety-I1 approach [5] which assumes that complex systems have two ends - a sharp and a blunt end. In a healthcare context, health care professionals are at the sharp end and interact directly with a hazardous process, representing the actual workplace. At the blunt end, regulators, policy makers and managers control and balance the resources, constraints and multiple demands imposed on health care professionals. Safety problems are not always a direct result of a lack of knowledge or effort by health care professionals - they are usually a result of work that is complex, often involving the use of technology [7]. There is often a mismatch, however, between what happens in everyday clinical work and how work is presumed to have happened [5, 6]. These mismatches could sometimes lead to safety problems and therefore, there is value in learning from the full range of work outcomes including usual outcomes (when things go right), negative outcomes (for example, errors) and everything in between despite the inevitable risks and complexity. This is the core concept of the Safety-II approach [7]. Health care professionals often work under varying conditions using principles of both Safety-I and Safety-II, but policymakers, regulators and/or health care managers typically focus their efforts on standardising work practice based on Safety-I principles. For example, safety efforts often focus on counting and tracking events that fail rather than those that succeed [7, 8]. Resilient Health Care (RHC) provides a complementary perspective of learning from incidents and understanding how everyday clinical work is successful [9-11]. RHC
acknowledges that health care systems such as a clinic, ward, hospital, country, are complex adaptive systems that are constantly changing and can result in unexpected work situations. Health care professionals are viewed as resources and assets because they are able to anticipate, monitor, respond and adapt to threats rather than a problem to be solved or standardised. Therefore, the focus is on how every day clinical work is performed rather than solely on the unpredictable accidents or incidents [4, 7, 9]. RHC does not focus on an individual’s coping and resilience capacity but rather the factors and methods that enable the workers, team and unit or organisation to adapt and cope effectively in different situations.

The current literature on RHC has reported factors that promote resilience. Examples include training and educating health care professionals to cope with the various conditions [12, 13, 4], encouraging different departments and specialities to communicate about concerns pertaining to work practice [12, 14], repeated exposure to similar disturbances [13, 15, 4], enhancing the knowledge and experience of health care professionals to respond to actual work conditions and to enact important trade-offs [15, 4], reducing cognitive load on healthcare practitioners by simulation training to manage expected and unexpected situations [4] and integrating human factors and health economics in the design process [16]. Although RHC is conceptually and theoretically attractive, there is a need for more clarity around how RHC is currently conceptualised and operationalised in health care.

As there is currently no ‘gold standard’ for studying and developing RHC in health care, the objectives of the systematic review were to: 1. identify how RHC is conceptualised in health care studies 2. identify and describe methods used to study RHC 3. identify and describe factors that develop and enhance RHC.

Methods
A protocol for the systematic review was registered with PROSPERO (registration number: PROSPERO 2019 CRD42019129049). This systematic review is reported following the Preferred Item for reporting Systematic Reviews and Meta-Analysis (PRISMA) guidelines for reporting of systematic reviews [17].

**Ethical Approval**

Ethical approval was not required as the study was a systematic review of peer-reviewed journal studies and studies published in books.

**Inclusion and Exclusion Criteria**

The systematic review was limited to:

Scholarly peer-reviewed journal studies and studies published in books, written in English. Studies published in journals and books that described RHC, and/or methods used to study RHC and/or factors to develop and enhance RHC in any health care setting.

Studies were excluded if:

They were about resilience in non-health disciplines.

They were about individual or community resilience.

**Search Strategy and Study Selection**

Electronic searches of PubMed, Scopus, and Cochrane databases were conducted using the following search terms: (organisational/organizational resilien* and health care or hospitals) and (organisational/organizational resilien* in health care and/or tools, measures, strategies, solutions). Other search methods such as hand searching, serendipity/browsing, checking with experts, and searching the specialist website resilienthealthcare.net were also performed to identify further relevant peer-reviewed studies and studies published in books. The search covered a time period from January 1982 to April 2019. The titles and abstracts of identified studies were screened independently by two researchers (MI and RL) applying the a priori inclusion and exclusion criteria. Full-text studies of retained references were then obtained and screened independently by three researchers (MI, RL and KR) using the inclusion/exclusion criteria.
Disagreements were resolved by discussion to achieve consensus.

**Data Extraction**

MI independently extracted the following information: authors, year of publication, country where the study was conducted, aim of study, study design and methodology, study setting, sample size, descriptions of RHC, methods used to study RHC and factors that develop RHC where available.

**Risk of Bias Assessment**

The quality of the included studies was evaluated using the Mixed Methods Appraisal Tool (MMAT) Version 2018 [18], an established tool that enables critical appraisal of quantitative, qualitative, and mixed methods studies. See Table 1 for items assessed. The appraisal of all studies (by MI) and a random selection of a third of the studies (by RL) was conducted. Any disagreements were discussed between MI and RL to reach consensus. Table 1 Mixed Methods Appraisal Tool (MMAT) checklist items [18].
### Methodological quality criteria

| 1. Screening questions  | 1.1. Are there clear research questions? |
|------------------------|-------------------------------------------|
| (for all types)        | 1.2. Do the collected data allow to address the research questions? |
|                        |                                           |
| 2. Qualitative studies | 2.1. Is the qualitative approach appropriate to answer the research question? |
|                        | 2.2. Are the qualitative data collection methods adequate to address the research question? |
|                        | 2.3. Are the findings adequately derived from the data? |
|                        | 2.4. Is the interpretation of results sufficiently substantiated by data? |
|                        | 2.5. Is there coherence between qualitative data sources, collection, analysis and interpretation? |
| 3. Quantitative descriptive studies | 3.1. Is the sampling strategy relevant to address the research question? |
|                        | 3.2. Is the sample representative of the target population? |
|                        | 3.3. Are the measurements appropriate? |
|                        | 3.4. Is the risk of nonresponse bias low? |
|                        | 3.5. Is the statistical analysis appropriate to answer the research question? |
| 4. Mixed method studies | 4.1. Is there an adequate rationale for using a mixed methods design to address the research question? |
|                        | 4.2. Are the different components of the study effectively integrated to address the research question? |
|                        | 4.3. Are the results adequately brought together into overall interpretations? |
|                        | 4.4. Are divergences and inconsistencies between quantitative and qualitative data adequately addressed? |
|                        | 4.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved? |

**Data Synthesis:**

Due to the heterogeneity of study designs, it was not possible to use a meta-analysis approach to analyse quantitative findings. Data was synthesised using a deductive thematic approach [19]. This included the following steps [20]:

- **Familiarisation:** studies were read multiple times to ensure familiarity with the content.
- **Developing a coding framework:** data were coded line by line based on the key aims of the systematic
review, which were descriptions RHC, methods used to study RHC and factors used to enhance RHC in health care settings.

Indexing: shared categories were developed while reading and comparing between different studies.

Charting: the coded data and similar findings were grouped into key themes and subthemes within and across studies.

Mapping and interpretation: subthemes were aligned to the main theme to provide explanation for the findings.

Results

Studies included in the review

Eight hundred and fifty-two studies were identified in the initial database searches.

Following screening, 59 studies were left for full text review. From these, a total of 11 studies published in peer-reviewed journals and 16 studies published in books were included in the review. Figure 1 shows the study selection process.

Figure 1: PRISMA flow chart for study selection process

Study Characteristics

The methods used to study RHC varied in the studies: seven were qualitative [29, 30, 27, 28, 23, 24, 31], and four used mixed methods [22, 21, 25, 26]. The methods used in the studies published in books, however, were mainly qualitative [32–34, 36, 37, 39–43, 45–47, 35] except two studies that used mixed methods [38, 44].

Studies reported in peer-reviewed journals were mostly conducted in developed countries: the United Kingdom [27–29, 25, 24], the United States of America [21, 23], Finland [31] and Israel [26]. Two studies were conducted in developing countries: Brazil [30] and South Africa [22]. For studies published in books, all were conducted in developed countries: the United Kingdom [36, 39, 45, 46], New Zealand [41, 47], Norway [34, 40], France [32], Switzerland [33], Australia [37], Denmark [42], Canada [43], the United States of America [35], Japan [44] and one unstated, possibly USA [38].

Risk of Bias

Quality assessment of the studies is presented in Table 2. Qualitative studies were mostly
well designed. Studies using mixed methods had not explicitly explained any inconsistencies between qualitative and quantitative results and/or the risk of nonresponse bias in the quantitative component [21, 22, 25, 26, 38, 44]. Mixed method studies were however included in the review as RHC is a relatively ‘young’ research field and these studies added important insights to the review and addressed at least two of the three research questions.

Table 2: Quality assessment of included studies

| Study reference | Screenin g question s | Qualitative studies | Quantitative descriptive Studies | Mixed methods studies |
|-----------------|-----------------------|---------------------|---------------------------------|-----------------------|
| 1               | 1.2                   | 2.1                 | 2.3                             | 2.4                   |
| 1               | 2.1                   | 2.2                 | 3.3                             | 4.3                   |

Studies published in journals

1. Gittell J. (2008) [21]

2. Mash BJ, et al. (2008) [22]

3. Nemet h C, et al. (2011) [23]

4. Ross A, et al. (2012) [24]

5. Crowe S, et al. (2014) [25]
|   | Drach-Zahav Y, et al. (2015) [26] | Ö | Ö | Ö | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Can’t tell | Ö  |
|---|----------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7. | Anderson J, et al. (2016) [27]   | Ö | Ö | Ö | Ö  | Ö  | Ö  | N/ A | N | N | N | N | N | N | N | N | N | N | N | N | N/A | N/A | N | / | A | A |
| 8. | McCray J, et al. (2016) [28]     | Ö | Ö | Ö | Ö  | Ö  | Ö  | N | N | N | N | N | N | N | N | N | A | A | A | A | A | A | N/A | N/A | N | / | A | A |
| 9. | Back J, et al. (2017) [29]       | Ö | Ö | Ö | Ö  | Ö  | Ö  | N | N | N | N | N | N | N | N | N | N | N | N | N | N/A | N/A | N | / | A | A |
| 10. | Rosso C, et al. (2018) [30]      | Ö | Ö | Ö | Ö  | Ö  | Ö  | N | N | N | N | N | N | N | N | N | N | N | N | N/A | N/A | N | / | A | A |
| 11. | Wahlstrom M, et al. (2018) [31]  | Ö | Ö | Ö | Ö  | Ö  | Ö  | N | N | N | N | N | N | N | N | N | N | N | N | N/A | N/A | N | / | A | A |

Studies published in books

|   | Cuvelier L, et al. [32]          | Ö | Ö | Ö | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Can’t tell | Ö  |
|---|----------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12. | Pariès J, et al. [33]            | Ö | Ö | Ö | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Can’t tell | Ö  |
| 13. | Laugal and K, et al. [34]        | Ö | Ö | Ö | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Can’t tell | Ö  |
| 14. | Steph                            | Ö | Ö | Ö | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Ö  | Can’t tell | Ö  |
| Reference | Study ID | Country | Year | Outcome | Quality | Methodology | Data Source | Comments |
|-----------|----------|---------|------|---------|---------|-------------|-------------|----------|
| ens RJ, et al. [35] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Ander son JE, et al. [36] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Debon o D, et al. [37] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Deuts ch E, et al. [38] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Furnis D, et al. [39] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Hegge lund C, et al. [40] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Horsley C, et al. [41] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Houns gaard J, et al. [42] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Hunte G, et al. [43] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Nakajima K, et al. [44] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Ross A, et al. [45] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| Sujan M, et al. [46] | Ö Ö Ö Ö Ö Ö Ö | N N N N N N N | N/A | N/A |
| | | | | | | | | |
Table 3 shows the descriptions of RHC, methods used to study and factors that develop RHC.

Although the descriptions of RHC varied across studies, most of them shared key characteristics of RHC that including:

- Adapting and coping with unforeseen situations [21, 24, 23, 31].
- Using proactive and reactive approaches to avoid or manage expected and unforeseen situations.
- Reconciling the gap between Work-as-imagined (WAI) and Work-as-done (WAD) to enhance safety by learning from everyday clinical work instead of focusing only on adverse events [27, 29, 30, 32, 36, 39, 46, 47, 38, 41, 43].
- Viewing resilience as effective use of strategies to deal with and mitigate the impact of threats to patient safety before they escalate rather than an outcome of successful management of threats [25, 23, 33].
- Coping or bouncing back from errors by maintaining a positive adjustment to flourish amidst adverse situations [28, 26].
- Sustaining capacity of manoeuvre (adaptive behaviour) to respond to future events [35].
- Selecting and prioritising goals in the midst of competing demands (the quality of trade-offs) [33, 37].
- Defining clearly acceptable and successful outcomes in health care systems [34].
- Advancing health care setting toward long-term goals of safe, patient-centred care delivered by engaging health care practitioners [41].

Many studies conceptualised RHC [33, 30, 23, 36, 38, 40, 41, 43–45, 47] as the ability to:

1) Monitor: monitor, predict and address critical issues by scrutinising and observing the operations in the health care system to recognise the usual culture of the system.

2) Respond or cope: address situations as they occur, that is, know when and how to respond or cope with a threat or an adverse outcome to prevent it from happening or from becoming worse.

3) Anticipate or foresee: address potential or predict untoward incidences and consider likely and unlikely future conditions that might affect the organisation’s ability to work.

4) Learn or recover: learn from experience, incorporate this experience into future performance and recover from adverse outcomes.
Methods for studying RHC

A key concept in RHC is understanding the mismatch or gap between WAI and WAD. Most of the studies included in this review used the distinction between WAI and WAD, or the focus on WAD as a rationale for conducting their research. Almost all the studies addressed key methods to study resilience by identifying the gaps between WAI and WAD, learning how gaps developed, how they impacted patient care, and understanding how practitioners coped and dealt with them. Methods that were used to understand how work actually takes place in practice included cognitive task analysis to assess human performance in decision making and problem solving [23, 24], interviews and/or observations [22–24, 26, 31, 32, 34, 35, 37, 44, 27, 29, 30, 36, 39–42, 45], focus groups [28, 37, 30, 40], work domain analysis, process tracing, and artefact analysis [23], simulation and debriefing [38, 41], The National Aeronautics and Space Administration-Task Load Index (NASA-TLX) a widely used multidimensional tool to assess perceived workload [38], and an autoethnographic approach in which the author relied on self-reflection to explore his experience while connecting this to a wider context [47].

Some studies developed and/or used models, frameworks and quasi-models to study RHC.

Models:

The Model of Relationships and Resilience: Based on coping and contingency theories, Gittell et al. (2008) developed and used the Model of Relationships and Resilience to study how health care practitioners working in orthopaedics perceive external pressures and respond with both coping responses and organisational formal work practices [21]. The results showed substantial support for the model as the relational work practices played a significant role in supporting coping responses. In this study, there was no clear description on what mediating variables were available between work stressors and resilient responses [21].

A computer software tool: This tool was developed by Crowe et al. (2014) to assist in decision-making concerning services reconfiguration in the National Health Service (NHS) in England [25]. This study explored the feasibility of assessing resilience in health care settings by developing an analytical framework for modelling the impact on care service activity of potential disruptions to a health system. A prototype tool and an explicatory example that involved a hypothetical health care setting under different configurations were constructed to assess the feasibility of the suggested model. The end users of the tool raised apprehensions regarding the scope and usefulness of introducing new software tools and other new initiatives exiengent of their attention. The authors did not mention the capability of
the organisation to return to usual work nor to allow for disruption to an existing waiting list because
the modelling approach used simple assumptions in which demands were met immediately preceding a
disruption [25].

Concepts for Applying Resilient Engineering (CARE) model:
Anderson et al. (2016) developed the CARE model that provides a framework of how resilience is
apparent in health care, how it affects the outcomes and how it can be strengthened [27]. This model,
mainly based on the theoretical principles of resilience, was the first to use resilience in quality
improvement initiatives.
Back et al. (2017) used the CARE model to guide data collection and analysis [29]. Their aim was to
examine escalation policies used in Emergency Department in theory and practice to recognise the gap
between formal escalation policies and actual practices [29]. Escalation policies are major codified
organisational responses that are designed to enable an emergency department to remain resilient
against unexpected variability in demand and capacity, and continue to meet external and internal
targets of care [48]. Their results showed that formal escalation policies cannot always be attained.
Instead, escalation processes were adapted to manage pressures informally [29]. Further studies are
needed to co-design interventions to develop more realistic and useful escalation policies.
Another study used the CARE model to form the basis of their approach and to develop practical tools
to study resilience and to identify potential quality improvement initiatives [36]. The authors were able
to identify one quality improvement initiative by developing an artefact to monitor progress towards a
shared and transparent discharge in an Older Persons’ Unit in London. Further studies are needed to
implement and evaluate effect and outcomes of the intervention [36].
Ross et al. also used the CARE model to guide their interpretation and understanding of how delivery of
care happened in inpatient diabetes care. Data was elicited from interviews with staff to understand the
routine adjustments necessary for inpatient diabetes care. The interpretation of data pointed to the
misalignment between demand and the ways in which clinical staff adjust their work to be able to
perform as needed [45].

Observation Grid Model: Paries et al developed the Observational Grid Model based on Hollnagel’s
(2010) [49] and Wood’s (2010) [50] resilience capabilities list. This model was used to observe how an
Intensive Care Unit (ICU) was functioning after the merger of two hitherto separate units, and to
understand how and why the merger units succeeded or failed in controlling variations. They found that
most of the resilience characteristics were observed in the ICU. These characteristics were facilitated by
a self-organisational process employed through crises after the merger, rather than intentionally being
engineered in the ICU or emerging from experience [33].

Frameworks:

Functional Resonance Analysis Method (FRAM):
Rosso et al. (2015) used FRAM as a tool to assess and analyse how things are done and to identify and
prioritise problems that hinder the safe and efficient delivery of care. This study developed a framework
for supporting a work system design by combining insights from lean production and resilience
concepts. This was tested in a health care system involving patient flow from an Emergency
Department to an ICU. The framework characterised the work system from a resilience perspective
using tools from FRAM [30].
Hounsgaard et al. used FRAM to elucidate the impact of variability on everyday work. Interviews with
experienced staff elicited information about the variability in daily routines that is part of everyday
work. At the Spine Centre of Southern Denmark, FRAM was used to elucidate the complexity of
persistent patient safety problems, explain how these problems occurred and suggest new perspectives
to solve the problems [42].
Sujan et al. employed different approaches to improve the safety of clinical handover in emergency care by developing a Safety-II case. This Safety-II case aimed to ensure that stakeholders understood the current safety position by understanding the gap between WAI and WAD. For WAI, systematic risk analysis resulted from process mapping and FMEA to identify errors, causes, consequences and preventive strategies. For WAD, FRAM was used to analyse participants’ reflections through observations and semi-structured interviews to understand how they dealt with variability and how this variability affected patient safety. The authors concluded that there is an urgent need for empirical evidence of the effectiveness of resilient approaches in practice [46].

Resilience Markers Framework (RMF): Furniss et al. developed the RMF to provide guidance for interview scripts to uncover resilience strategies used by anaesthetists [39]. The framework had a five-step structure to allow participants to reflect on their work demands and to contrast routine and non-routine aspects. The framework could be adapted to study healthcare resilience strategies in other contexts [39].

Quasi models:

Resilience performance requires four abilities: to respond, to monitor, to learn and to anticipate. While the notion of the four abilities is not presented as a theory, Hollnagel et al. (2019) suggested using it as a generic model or quasi model for resilience performance [9]. Three studies used this notion as the rationale for their research.

Team Resilience Framework: Horsley et al. designed a Team Resilience Framework scale to assess aspects of team functioning in a Critical Care Complex, describe elements of a functional team and how this forms a foundation to adapt to different situations. Interviews, simulation and in-practice observation of practitioners were conducted to understand people’s experiences after implementing the framework. The data was interpreted using the model of resilience, based on the four abilities, developed by Hollnagel [9]. The retrospective study examined the changes perceived by the staff, but it was hard to ascertain the impact of these changes on patients. As this approach was local to the Critical Care Complex, the individual elements in the framework may or may not be fully relevant to other settings [41].

Heggelund et al. identified what mechanisms shape resilience in maternity services in two different hospitals using a theoretical framework based on the four abilities of resilience: anticipation, monitoring, response and learning. The authors argued for the value of better understanding of WAD by identifying mechanisms for each ability and evaluating its quality. By identifying different mechanisms in people’s performance, possible interventions can be developed and implemented to enhance resilience [40].

Resilience Analysis Grid (RAG): RAG is a proxy measure for resilience which explores a set of precise questions to address important aspects of the four resilient abilities [49]. Hunte et al. adapted and evaluated the RAG to develop a context-specific framework for an urban Emergency Department in Canada. Data were collected using a technique called the World Café [51] where people from different departments met in a near-by meeting room and participated in dialogue workshops. The results from workshops were then compared and contrasted to find discrepancies, coherence and complementarity with reference to RAG. The edited RAG was acceptable and feasible for use in the department and the authors planned to use it for analysis on an annual basis to map and assess the resilience profile of the department over time [43].
Factors to develop and enhance RHC

Seven key factors that develop RHC were identified:

Teamwork was considered a factor to develop and sustain resilience in the healthcare sector [28, 26, 29, 24, 50, 40, 41, 43, 46, 47]. Aspects of teamwork included effective and frequent team meetings with respect to active listening, disagreement resolution and decision-making [22, 26, 28].

Effective communication characterised by respect, building trust between healthcare professionals, enhancing staff satisfaction to exchange information and ideas before and after the implementation of new practices [22, 26, 24, 40, 41, 43, 46].

Effective leadership keeping the organisation focused on key objectives while also remaining open to feedback from clinical staff to create a shared vision, and revise decisions if required [22, 28, 50, 47]. Effective involvement of clinicians as top-down leaders to look for positive work practices [28].

Effective team working structure between doctors, nurses and patient flow-coordinator roles to enhance the ability to expedite patient transfer to manage crowding in an emergency department [29].

In-situ practical experience was a core factor in building resilience by providing a deep knowledge of how the system works and how the organisation adapts to and copes with expected and unexpected situations. Experienced healthcare professionals may teach novices how the healthcare system works and how to perform work. Managing different situations and cases will provide healthcare professionals with knowledge and experience that allows development of the resilient behaviours of anticipating, learning, monitoring and responding when facing similar situations [29, 31, 33, 40, 45]. Another example to build resilience is in-situ simulation training and debriefings, which provide opportunities for experts and novices to understand practice and adapt to routine and unexpected situations [24, 40, 41, 47].

Exposure to diverse views and perspectives on the patient’s situation provided the fundamental advantage of understanding the patient’s situation thoroughly while decreasing the likelihood of cognitive bias and maintaining the previous level of performance. One example was face-to-face verbal communication in handovers with interactive questioning and a summary written by the outgoing nurse helped to decrease the probability of bias that might occur through inappropriate assumptions of an incoming nurse [26, 33, 34, 40, 41].

Trade-offs: The clinical staff dynamically used their subjective assessment of the current situation to resolve stressors and tension. Being mindful and act proactively to shift from one mode to another in the presence of disturbances is one of the key reported factors to develop RHC [47, 46, 45, 36, 33, 32, 43].

The value of using protocols and checklists: The ability to define potential variabilities and situations that are well known in the clinical practice, well described in the literature of speciality, protocols and checklists needs to be used [32, 41].

System design: One empirical study developed and tested a framework in a healthcare environment by adopting insights from resilience engineering to create conditions that supported resilient performance. Eight design propositions were developed which can contribute to the re-design of sociotechnical systems to be safe and efficient at the same time [30].

Workarounds: These facilitated practice to continue by enabling staff to cope with challenges and maintain effective delivery of patient care [47, 45, 37].

Discussion
To the best of our knowledge, this study is the first comprehensive compilation of evidence, from the health care literature, of the descriptions, methods used to study and factors that develop RHC. Over the years, the focus has changed from theorising to examining how best to study and operationalise RHC.

An early notion of RHC used the continuation of successful work within an organisation that had bounced back from incidents [21, 28, 26]. In contrast, more contemporary descriptions of RHC use a general consensus that resilience is not success in the face of impedance but the ability to continue usual operations using strategies that mitigate the impact of threat(s) before they escalate, to cope and learn from incidents and to act in advance to prevent them [23, 25, 29, 27, 36, 30].

Recent studies have focused on understanding the gap between WAI and WAD, which shifts the focus to everyday clinical work instead of adverse events only, and the importance of reconciling this gap to enhance RHC [27, 30, 37, 44, 45, 47].

Most of the studies included in this systematic review used qualitative data from interviews, focus groups and observations to study everyday clinical work that explained frontline practitioners’ contribution to RHC and kept patients safe despite pressure [29–32, 47, 33, 35, 45, 36, 37, 39–42, 44, 46]. Although interviews and focus groups are widely used in qualitative research, the assumption that participant’s words are indicators of their inner experiences may be questionable [52]. Observational research reports what people actually do or say, rather than what they say they do. Observation, however, can include a high degree of researcher bias as the method relies on interpretation of what has been observed. The researcher cannot “see” attitudes and memories, and so it can be difficult to create an accurate analysis from observation alone. One study used self-confrontation video sessions in which the surgeons were encouraged to explain what took place while they were conducting surgery [31]. To understand in situ practices, describe
the complexity of health care, model and test specific kinds of recommendations to improve safety and resilience, more innovative approaches should be used to explore WAD in situ from the perspective of frontline practitioners. Video reflexive ethnography, developed by Iedema and colleagues [53], could be used to explore WAD. Video footage of real-time practices is shown back to participants in small groups where they collectively reflect to make sense of their work and negotiate meaningful, context-appropriate ways to improve their practices [54, 55, 53, 56].

Some models to study RHC had not incorporated sufficient details to enable problems to be understood and/or resolved in meaningful and comprehensive ways [25]. Current methods for studying RHC represent efforts to improve the understanding of RHC. Health care settings are constantly experiencing turnover of staff, policies, and equipment so future studies will need to investigate the practicality and feasibility of the methods, enhance their applicability and evaluate interventions for generalisation across organisations.

Few studies have taken a whole system approach to create resilience in health care. Recognising that the health care environment is complex and unpredictable, whilst also understanding how the system actually works in everyday and unexpected situations, is a starting point for improving patient safety. This review has highlighted potential methods to study RHC and factors to develop RHC in health care. The move from research to practice is still nascent. More work is needed to design interventions based on the identified factors and then to measure their effectiveness in different health care contexts, investigate the implementation of designs and artefacts, and explore how to operationalise the changes.

Review limitations

First, relevant data might be missed from unpublished studies. To counteract this
limitation, a broad search was conducted to include both peer reviewed studies published in journals and relevant studies published in books. Second, most of the studies included were conducted in developed countries and more studies are needed to investigate whether the findings are applicable to other countries. Third, resilient factors reported were derived from specific case scenarios and this might affect their influence in different settings. Fourth, mixed method studies were included in the review despite quality of the studies as they added insights to the review. Lastly, the results of this systematic review represented the researchers’ interpretation and other researchers might have different perspectives and conclusions.

Conclusion

Most studies shared similar characteristics in their descriptions and conceptualisation of RHC. Although methods to study and factors that develop RHC currently exist, it is vital to understand how RHC works within existing health care systems, how to enhance RHC and how RHC can be sustained. In addition, it important to understand and explore how to develop RHC effectively to develop innovative interventions and to evaluate and design resilient socio-technical systems. Future research is needed to address the wider safety implications of RHC amidst organisational and institutional change.

List Of Abbreviations

CARE Concepts for Applying Resilient Engineering model
FRAM Functional Resonance Analysis Method
MMAT Mixed Methods Appraisal Tool
NASA-T LX The National Aeronautics and Space Administration- Task Load Index
NHS The National Health Services
PRISMA Preferred Item for reporting Systematic Reviews and Meta-Analysis
Declarations

Ethics approval and consent to participate

Ethical approvals were not required as the study was a systematic review of peer-reviewed journal studies and studies published in books.

Consent for publication

Not applicable.

Availability of data and materials

The data used in the study are available from the corresponding author on request.

Competing interests

Dr Rosemary Lim is an Associate Editor of the journal BMC Health Services Research. All other authors declare that they have no competing interests.

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Authors’ contributions

RL conceived the study; MI extracted study data and drafted the article. MI, RL and KR screened studies for eligibility for the study. MI and RL assessed the quality of the included studies. MI, RL, KR and CC contributed to the study design and data synthesis.
MI, RL, KR and CC revised the manuscript critically for intellectual content, agreed and
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Tables

| Authors/ Year/ (Country) | Description of RHC |
|--------------------------|--------------------|
| 1. Gittell 2008 (USA)[21] | Organisational resilience ... incorporates insights fr both coping and contingency theories. It refers to tl maintenance of positive adjustment and the ability flourish or thrive amid adverse conditions when rigi might otherwise be expected. |
| 2. | Mash B, J, et al. 2008 (South Africa)[22] | - The organisation’s ability to remain true to its core values, competencies and vision rather than invest specific structure. |
| 3. | Nemeth C, et al. 2011 (USA)[23] | - The ability of systems to mount a robust response unforeseen, unpredicted, and unexpected demands to resume or even continue normal operations.  
- Resilience is an emergent property of systems that not tied to tallies of adverse events or estimates of their probability.  
- Studies how people at all levels of an organization to anticipate paths that may lead to failure, to create and sustain strategies that are resistant to failure, to adjust tasks and activities to maintain margins in face of pressure to do more and to do it faster.  
- A resilient system can adjust its functioning prior to, during, or following changes and disturbances so that can sustain required operations, even after a major mishap or in the presence of continuous stress.  
- The notion of resilience frees safety research from hindsight bias by making it possible to understand how workers anticipate possible adverse outcomes and in advance to avert them. |
| 4. | Ross A, et al. 2012 (UK)[24] | The capacity of a system to adapt safely to changing conditions. Resilience can be defined as the ability of a system to self-correct and adapt to disturbances so that normal operations can be maintained even when unexpeced conditions are encountered. |
| No. | Authors and Year | Description |
|-----|-----------------|-------------|
| 5.  | Crowe S, et al. 2014 (UK)[25] | The capability of a health system to mitigate the impact of major external disruptions on its ability to meet the needs of the population during the disruption. |
| 6.  | Drach-Zahavy A, et al. 2015 (Israel)[26] | Identify, correct and ‘bounce back’ from errors, with obvious positive consequences for patient’s safety. |
| 7.  | Anderson JE, et al. 2016 (UK) [27] | The ability of the health care system to adjust its functioning prior to, during, or following events (changes, disturbances, and opportunities), and thereby sustain required operations under both expected and unexpected conditions. |
| 8.  | McCray J, et al. 2016 (UK)[28] | Team Resilience is a team’s ability to “bounce back” and “maintain” performance under adverse circumstances. Performance is the team outputs or delivery, and in the case of integrated teams in the health and social care sector, is likely to be linked to service user outcomes. |
| 9.  | Back J, et al. 2017 (UK)[29] | The intrinsic ability of a health care system to adjust its functioning prior to, during, or following events (changes, disturbances and opportunities), and thereby sustain required operations under both expected and unexpected conditions. |
| 10. | Rosso C, et al. 2018 (Brazil)[30] | The ability of the healthcare system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required performance under both expected and unexpected conditions. 
Resilience in healthcare ... shed light on the gap between WAI and WAD, as well as on new approaches to patient safety, which rely on learning from everyday work, instead of only from adverse events. |
| 11. | Wahlström M, et al. 2018 (Finland)[31] | The intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions. |
| 12. | Cuvelier L, et al. (France)[32] | The intrinsic ability of a system to adjust its functioning so that it can sustain required operations under both expected and unexpected conditions. It is not only the system’s ability to cope with unforeseen variability that fall outside the expected areas of adaptations, but also looks at its ability to operate in foreseen conditions. A resilient system is the one capable to detect that the conditions have changed, to assure transition to another state and to operate in the new state of resilience achieved. |
| 13. | Pariès J, et al. (Switzerland)[33] | The ability to make sacrificing decisions, such as accept failures to reach an objective in the short term to ensure another long-term objective, or ‘cutting one’s losses’ by giving up initial ambitions to save what is essential. The ability to acknowledge the need to shift from one mode to the other. It measures the quality and robustness of trade-offs; their stability in the presence of disturbances. |
| 14. | Laugaland K, et al. (Norway)[34] | The ability of healthcare system to succeed under varying conditions to increase the proportion of intended and acceptable outcomes. Adjustments could be deemed successful from one perspective but not from the viewpoint of others. Different outcomes thus represent different judgement of values that need to be explored and acknowledged in order to be able to share a common ground on what constitute acceptable, successful outcomes. |
| 15. | Stephens RJ, et al. (USA)[35] | Capacity for maneuver. |
| 16. | Anderson JE, et al. (UK)[36] | The ability of the health care system to adjust its functioning prior to, during, or following events (changes, disturbances and opportunities), and thereby sustain required operations under both expected and unexpected conditions. ... ability or capacity for adaptation, rather than a state of the system. Understands the complexities of the whole system rather than focuses on a discrete part. |
| 17. | Debono D, et al. (Australia)[37] | Adapt, flex and navigate competing demands |
The shifting and jostling demands of delivering care that prioritise one goal over another in a continually changing way, the role of context in influencing that process, and ongoing judgements about when to use (or not use) primary and secondary workarounds.

| 18. | Deutsch E, et al. (Unstated)[38] | Reinforcing appropriate actions and resources making the margins and constraints of the system visible, and developing team behaviours that have the potential to improve the adaptive capacity of the team. |
| 19. | Furniss D, et al. (UK)[39] | It can adjust its functioning prior to, during, or following events (changes, disturbances, and opportunities), and thereby sustain required operations under both expected and unexpected conditions. |
| 20. | Hegelund C, et al. (Norway)[40] | N/A |
| 21. | Horsley C, et al. (New Zealand)[41] | The ability of the health care system to adjust its functioning prior to, during or following events (changes, disturbances, and opportunities) and thereby sustain required operations under both expected and unexpected conditions. The ability to adapt over multiple timescales that marks the concept of resilience as different from concepts of robustness or rebound, in which temporary stressors on the system (i.e., patient admissions, acute events, disasters) must be absorbed without overt failure. RHC should expand its aspiration beyond safety or even ‘sustaining operations’ to seeing the potential for this approach to advance health care towards the long-held goal of safe, patient-centred care delivered by engaged staff. |
|   | Authors and Country | Description |
|---|---------------------|-------------|
| 22. | Hounsgaard et al. (Denmark)[42] | N/A |
| 23. | Hunte G, et al. (Canada)[43] | The ability of a system to adjust its functioning prior to, during, or following events (changes, disturbances and opportunities), and thereby sustain required operations under both expected and unexpected conditions. Central to this proactive approach is the understanding that safety dynamic, emerges from everyday practice, and is something a system does. In a resilient system, large increases in work processed contribute to only small increases in recovery, and the system is able to keep pace. |
| 24. | Nakajima K, et al. (Japan)[44] | N/A |
| 25. | Ross A, et al. (UK)[45] | N/A |
| 26. | Sujan M, et al. (UK)[46] | RHC is able to reconcile the gap between the way everyday clinical work unfolds WAD with the way managers and administrators think about clinical practice WAI. |
| 27. | Zhuravsky L, (New Zealand)[47] | The ability of the health care system to adjust its functioning prior to, during, or following events (changes, disturbances and opportunities), and thereby sustain required operations under both expected and unexpected conditions. |

Note: N/A is used when studies did not report methods used to study and/or factors to develop resilience.

CARE = Concepts for Applying Resilience Engineering, FRAM = Functional Resonance Analysis Method, FMEA = Failure Mode Effects Analysis, NASA-TLX = The National Aeronautics and Space Administration- Task Load Index, RAG = Resilience Analysis Grid, RMF = Resilience Markers Framework, UK = The United Kingdom, USA = The United States of America, WAD = Work As Done, WAI = Work As Imagined

Figures
Figure 1

PRISMA flow chart for study selection process

Supplementary Files

This is a list of supplementary files associated with the primary manuscript. Click to download.

PRISMA 2009 checklist.doc