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Learning Practices to Enhance the Performance of Experienced Healthcare Dyads in Acute Care Settings: A Scoping Review

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Title

Learning Practices to Enhance the Performance of Experienced Healthcare Dyads in Acute Care Settings: A Scoping Review

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Abstract

Objectives

To map the evidence on learning practices experienced dyads use to achieve and maintain excellent performance. The hypothesis is that through understanding these learning practices, better performance will result. Through the lens of collaboration, the authors' goal is to enhance team performance and guide future research, policy, and practice.

Setting

The review included studies from North America, Europe, Australasia, and Asia. All studies were conducted in acute care settings such as operating rooms, emergency rooms, intensive care units and simulation centers.

Participants

The participants were experienced healthcare professionals who work in acute settings of any age or any sex. The group was interprofessional including two or more disciplines and/or professions. Characteristics of participants who were excluded were students, novices, healthcare professionals who work in non-acute care settings and single profession studies.

Primary and secondary outcome measures

Aligned to the protocol quantitative and qualitative analyses were conducted. Thematic analysis was used to evaluate and categorize study findings, that is, the types of learning practices that optimize expert dyad performance and tools used to measure excellence. Secondary outcome measures were the different types of learning practices used in combination to produce excellence.

Results

Most empirical studies were qualitative studies (46%), 31% were mixed methods and 23% were quantitative studies. There were also 24 reviews and 10 commentaries. The most frequent learning practices were structured observation and case scenarios (21%) followed by audio/video analysis and surveys (17%). Next was interviews and didactic presentations (12%) followed by prebriefing/debriefing and checklists (11%). Other learning practices accounted for less than 10%. Overall, 84 of the 86 publications, examined learning practices of teams larger than two participants.

Conclusions

While the quality of studies was high, and there was a broad range of empirical studies, reviews, and commentaries, there was no consensus on best practice and measurement.

Strengths and limitations of this study.

1. This scoping review is the first to examine learning practices of experienced healthcare dyads
2. This review is comprehensive, including all study designs and grey literature from the past 5.5 years.
3. The use of a detailed data extraction tool and a transparent, iterative team approach added rigor to the review.
4. The paucity and quality of literature addressing the learning practices of experienced healthcare dyads limited findings.
5. This study will contribute to the literature on the learning practices that experienced healthcare teams and dyads use to develop, demonstrate, and sustain excellent performance.

Key words: dyads, learning practices, experienced teams, acute settings, expert performance

Introduction

Rationale

Medical error in healthcare, particularly in acute care environments, remains a major cause of morbidity and mortality. The World Health Organization in 2019[1], reported that unsafe surgical care interventions cause complications in up to 25% of patients, resulting in 1 million deaths during or immediately after surgery annually. Cooper in 2018,[2] specifically suggests the collaboration between each surgeon–anesthesiologist dyad in the operating room, is perhaps the most critical element of overall operating room team performance. He says a well-functioning dyad is conducive to safe, effective care. Dysfunctional collaboration can promote unsafe conditions and contribute to an adverse outcome. Anecdotally, this appears to be true of dominant dyads in other acute care settings such as the emergency room, labor and delivery, critical care, and pediatrics. The goal of this scoping review is to understand the learning practices, that experienced dyads use in acute care settings to reach and maintain excellent performance. The definition of learning practices for the purpose of this review, is simply the activities that dyads undertake to improve their team performance and develop and maintain their expertise. Finding the answer as to why there is not uniformity in exemplary

performance may assist in averting medical errors and assist experienced dyadic teams to function more routinely, with excellence. This will achieve the objective of the review and provide recommendations to inform best practice in experienced healthcare dyad learning practices. As there were so few studies related to purely dyadic learning practices, we extended the review to include learning practices of larger experienced healthcare teams in acute care settings. We reviewed all studies where learning practices informed best practice by experienced healthcare teams, in clinical acute care settings, or simulated environments.

This review is limited to experienced healthcare teams only. Avgerinos et al, in 2017[3], says that the team's expert function is dependent on the operation of the least experienced dyad in the team. They call the most this dyad "a bottleneck pair" and suggest that in complex situations collaboration f these dyads dictate performance.

The unit of analysis that we are interested in, is the dyad, not individuals, and so we are only investigating collaboration in experienced dyads and larger teams.

Figure 1 demonstrates cognitive frameworks to build high performance dyadic collaboration from poor to excellent performance. The framework represents the elements of distributed cognition and relational coordination that influence cognitive load in the dyad and in turn the level of performance in complex situations. Distributed cognition (DC) was first described by Hutchins in 1995 [4]. He realized that cognitive science until the mid 90's had taken the individual agent as its unit of analysis and that in most human pursuits, outcomes were the result of two or more experts interacting and usually with multiple technical devices as well. This concept grew and Hazlehurst in 2007 [5], performed a study in the operating room during the management of cardioplegia, where the surgeon and perfusionist's role is to coordinate activities during open heart surgery. This is a complex situation that requires each member of the dyad and the other team members to perform at their best. Using data from this distributed cognition study, the authors agreed on the six factors that promote robust team performance. These are (1) frequent direction, (2) status reporting, (3) alert reporting, (4) goal-

sharing, (5) problem solving, and (6) frequent explanation. It appears that when these elements of performance are addressed, performance improves.

Relational Coordination (RC)[6] is a process whereby there is mutual reinforcement of communication and relating for the purpose of task integration. The concepts of shared goals, shared knowledge and mutual respect are deployed to achieve the highest work performance. This concept was first identified from a study of flight departures within the commercial aviation industry by Gittell 2001 and 2002 [7] [8]. Comparisons are often drawn between the generic competencies required in aviation and healthcare, and subsequent studies have been conducted in healthcare. [6, 9] Analyzing learning practices through the lenses of distributed cognition and relational coordination enables identification of strengths and weaknesses of dyad performance. This may be where deliberate practice [10] could be incorporated to address dyadic weaknesses. Deliberate practice is result of adaptation to extended and intense practice activities of weaknesses in performance. Cognitive load is typically seen as the load imposed on working memory by the task (intrinsic), irrelevant factors (extraneous) and the voluntary effort of learning (germane).[11] Cognitive load theory purposes to explain how the load it takes to process new information can affect the learner's ability to process that information and to embed the new knowledge in long-term memory. If the dyad is an expert team, they may have enough free working memory resources to address the increased load. If the dyad is inexperienced, and is confronted with a complex issue, the cognitive load may become too high, hampering learning and transfer. In order to promote learning and transfer, cognitive load is best managed in such a way that cognitive processing irrelevant to learning is minimized and cognitive processing germane to learning is optimized, always within the limits of available cognitive capacity [12]. Figure 2 demonstrates mapping the elements of distributed cognition with relational coordination and cognitive load theory and how cognitive load may be affected in complex situations. Highly complex tasks can best be performed by a team, because the intrinsic load of a complex task might be too high to be performed by one individual, but it can be performed by a (well-trained) team.[13]

The authors are considering whether the amelioration of cognitive load through learning practices, using distributed cognition factors and relational coordination factors, prove the difference between good performance versus excellent performance. Eduardo Salas in 2007 [14], defines an expert team as team members who are interdependent, each having expert-level knowledge, skills, and experience related to the task they are performing. These teams can also adapt, coordinate, and cooperate as a team, and are able to produce sustainable and repeatable expert performance. The hypothesis is that these excellent teams are characterized by their ability to undertake activities to improve their team performance and develop their expertise.

Four authors of this review have worked in acute healthcare settings in large hospital systems for more than 20 years and have been involved in case review during that time. Case review casts a spotlight on cases where patient care has been suboptimal, and improvement is needed. It also illustrates cases where the patient care was excellent, and the healthcare team performed as an expert team. The authors agree that from reflecting on these case reviews, when there is a breakdown in collaboration, the failure is usually between two specific members of the healthcare team, the dominant dyad. We believe that by focusing on the collaboration in healthcare dyads, we may derive how expert dyads operate as opposed to weak ones and the learning practices experts use.

Out of the array of literature reviews available, (i.e., narrative, or traditional literature reviews, systematic or realist reviews), we chose a scoping review methodology to provide a clear understanding of the extent of research completed in this area including published and unpublished scripts. Scoping reviews also help us identify gaps in the literature. [15] We examined learning practices, that healthcare teams use to improve performance in healthcare teams [16]. In summary in this scoping review, we aimed to explore the breadth or extent of the literature, summarize the evidence, and inform future research [17], with the overarching objective of providing a 'map' of the available evidence on the range of learning practices. The authors considered it

important to provide this evidence map to guide best practice in learning practices that expert teams and more specifically healthcare dyads or pairs deploy.

Collaboration in healthcare dyads is a complex phenomenon, and as shown in Figure 2 three theoretical perspectives have been selected, that are relevant to this problem: cognitive load [11], distributed cognition including shared mental models[5], and relational coordination theory. [6]

A deeper understanding of the three theories listed above, and how they interact and complement each other, may assist us to reflect on expert dyadic function. We reviewed this problem specifically in acute healthcare settings, and only manuscripts including expert, interprofessional, dyads and teams were examined. Student training, single discipline training and ambulatory care teams were not examined. A preliminary search of MEDLINE, the Cochrane Database of Systematic Reviews and *JBI Evidence Synthesis* was conducted and no current or underway systematic reviews or scoping reviews on the topic were identified.

[18] Sebok-Seyer et al [19] in 2021 published a scoping review on the approaches for measuring 'interdependent' collaborative performances and found a strong level of interdependence between dyads of trainees and their supervisors. Interdependence refers to the extent team members rely on each other for the functioning of the team. Although this was an interesting review of dyad performance, this scoping review focusses on expert dyadic team, not trainees.

Due to the limited research on the learning practices of experienced healthcare dyads, the scoping review was extended to include all teams rather than only the smallest team, the dyad.

Objectives

The overarching objective of this scoping review was to assess the extent of the literature with respect to identifying and characterizing learning practices that experienced healthcare dyads and teams use in acute care settings to build excellent performance. The two main questions this scoping review aims to answer are: what are the learning practices that experienced healthcare dyads and teams use to optimize performance in acute settings, and how are the learning practices deployed?

Methods

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Protocol and Registration

Our protocol was drafted using the Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping review (PRISMA-ScR) tool.

Unlike a systematic review, scoping reviews do not tend to produce, and report results that have been synthesized from multiple evidence sources following a formal process of methodological appraisal to determine the quality of the evidence. Rather, scoping reviews aim to provide an overview or map of the evidence. As a result, an assessment of methodological limitations or risk of bias of the evidence was not performed. Systematic reviews normally inform the development of trustworthy guidelines and recommendations whereas scoping reviews provide an overview of the evidence or answer questions regarding the nature and diversity of the topic.

The final protocol was registered prospectively with the Open Science Framework on https://osf.io/.

The protocol, "*Optimizing expert dyad performance in acute care settings: a scoping review protocol"* was published in BMJ Open and can be found at http://dx.doi.org/10.1136/bmjopen-2020-047260

Eligibility criteria

Described below are the population, concept, context, and study designs eligibility criteria. The participants were experienced healthcare professionals who work in acute settings of any age or any sex. The group was interprofessional including two or more disciplines and/or professions. Characteristics of participants who were excluded were students, novices, healthcare professionals who work in non-acute care settings and single profession studies. The concept was learning practices that drive expert performance of experienced healthcare dyads with a focus on cognitive

load, distributed cognition and relational coordination. This also included learning practices that promote and inform future expertise. The exclusion criteria were learning practices for novices and students as well as individual psychomotor skill acquisition. The context includes all acute care settings in hospitals including the operating room, emergency room and critical care environments. Settings in all countries were included and there are no racial or gender-based exclusions. The exclusion criteria were all non-acute care settings including ambulatory care, behavioral health, and home care. Only manuscripts from January 2016 to June 30, 2021 were included and only those written in English were reviewed. Our rationale for reviewing manuscripts from the past 6 years was that the research in this area is continually evolving and the data would be more contemporary from this more recent timeline. (Manser, 2008).

Table 1 describes the inclusion and exclusion criteria.

Table 1. Inclusion & exclusion criteria.

Criterion	Inclusion	Exclusion
Date	2016-June 30, 2021	Before 2016 and after June 30, 2021
Exposure of interest	Healthcare teams/dyads analysis and learning practices	Individual learning practices/non-clinical teams
Language	English	All other languages
Participants	Experienced healthcare teams/dyads of registered health professionals	Exclude all single discipline student training and interprofessional student team training.
Peer review	Peer reviewed literature and non-peer reviewed	None
Objective measures	Measuring the number and type of learning practices experienced healthcare teams use.	None
Reported outcomes	Using objective measures, self-reported data	None
Setting	Acute care facilities	Ambulatory care, home care

Type of publication	Original studies, commentaries, reviews & editorials, position papers.	None

Information Sources

The databases we searched comprised Maastricht University Libsearch including PsycINFO, MEDLINE, Education Resources Information Center (ERIC) and Web of Science (WoS). Sources of unpublished studies/ gray literature were sourced using Google search. The references of all included manuscripts were searched, and the relevant articles included. The searches were conducted between 13 March 2020 and 4 July 2021.

Search

The text words contained in the titles and abstracts of relevant articles, and index terms were used. A full search strategy for the Educational Resources Information Center, ERIC database is presented in Table 2. The librarians at Maastricht University were advisors to the research team and played a key role in assisting the research team to refine the search terms.

The final search string was:

("healthcare dyad*" OR "healthcare team*" OR "medical team*" OR "operating room team*") AND ("Learn*" OR "practic*" OR "educat*" OR "communic*" OR "coordinat*" OR "perform*")

Table 2. Search strategy - Education Resources Information Center (ERIC)

#	SEARCHES	RESULTS
S1	("Operating room teams") AND ("performance")	0
S2	("Operating room teams") AND ("practice")	0
S3	("distributed cognition") AND ("team performance")	0
S4	("Operating room teams") AND ("learning")	0
S5	("Cognitive Load") AND ("dyad performance")	0

S6	"Health dyads" AND "Learning" or "Behavior"	0
S7	("dyad" OR "surg* dyads" OR "health dyads" OR "surgery") AND ("communicat*" OR "perform*" OR "coordinat*" OR "expect*" OR "practice*" OR "cognit*" OR "lead*")	109
S8	("surg* dyads") AND ("communicat*" OR "perform*" OR "coordinat*" OR "expect*" OR "practice*" OR "cognit*" OR "lead*")	4
S9	("surgeon dyads" OR "health dyads" OR "medical dyads") AND ("communicat*" OR "perform*" OR "coordinat*" OR "expect*" OR "practice*" OR "cognit*" OR "lead*")	6
S10	("expert healthcare dyad*" OR "expert healthcare team*" OR "expert medical team*" OR "expert operating room team*") AND (Learn* OR practic* OR educat* OR "deliberate practice" OR communic* OR coordinat*) AND (performance)	1
S11	("healthcare dyad*" OR "healthcare team*" OR "medical team*" OR "operating room team*") AND ("Learn*" OR "practic*" OR "educat*" OR "communic*" OR "coordinat*" OR "perform*")	11

Selection of sources of evidence.

In this study, we mapped the literature on learning practices to identify key concepts, gaps in practice, measurement, and optimization.

The authors acknowledge the importance of individual psychomotor skills practice and the role this plays in expertise, however, this research focused on rehearsals and practices experienced teams use to directly improve collaboration.

Following the search, all identified citations were collated and uploaded into *EndNote X9/June 2019 (Clarivate Analytics, PA, USA))* and duplicates removed. Any disagreements that arose between reviewers at each stage of the selection process were resolved through discussion with an additional reviewer. A random sample of 25 titles/abstracts were selected and reviewed by the team of five researchers. When 75% agreement was achieved on the citations/abstracts the team of five commenced screening. The final records/abstracts were determined. Two reviewers then reviewed all records/abstracts against the inclusion criteria and determined full text articles for inclusion and exclusion, with the reasons for exclusion clearly articulated. Any discrepancies

were reviewed by a third independent researcher. The same process that was used for records/abstracts was then used for the full text manuscripts. The justifications for exclusion of any full text articles were clearly stated. The final full text manuscripts were determined.

The results of the search and the study inclusion process was reported in full in a Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping review (PRISMA-ScR) flow diagram (see Figure 3, Selection of Sources of Evidence Flow Chart) [20].

Our multidisciplinary research team included selected individuals, as researchers from interprofessional backgrounds including medical education researchers, nurses and physicians. Each person contributed to the determination on the sources to be either included or excluded, the development of the data extraction instrument and authorship of the manuscript. In selecting these individuals, it was important to consider availability and willingness to participate, and the ability to communicate experiences and opinions in an articulate, expressive, and reflective manner.

Areas of controversy were around whether a certain practice could be classified as a learning practice which led to finding the right definition to describe learning practices in the context of this study. Resolution of these disputes was key to the results of the review.

KW is interested in healthcare reform and decreasing error and has spent the past 20 years deploying simulation to inform new policy development. KW is also an avid tennis player and throughout the research process, has reflected on how her interest in, and knowledge about, team and individual sports influenced our analysis. JvM and MA are Professors in Medical Education and have done research on expertise and expertise development. MM, KC and TY are specialist physicians and nurses who work in the simulation program at NYC Health + Hospitals, USA, developing and delivering simulation programs in response to, and to mitigate hospital system errors. JR is a professor in behavioral science and the Executive Director of the Center for Medical Simulation in Boston and a lifelong athlete. All authors have made substantive intellectual contributions to the development of this scoping review. We were very explicit about own individual

perspectives and what they brought to the review throughout the course of the research. During this process our perspectives were both challenged and confirmed by our findings. Articles were highly variable in methods, populations studied, educational interventions, evaluative practices and results.

Data charting process

Data was extracted from manuscripts by five independent reviewers using a data extraction tool developed by the reviewers. The extraction instrument followed the JBI data extraction tool template with customization to answer the review objectives. The data extracted included specific details about the participants, concept, context, study methods and key findings relevant to the review question/s.

The reviewers independently charted the data, discussed the results and continuously updated the data charting form in an iterative process. Data from eligible studies were extracted using the data abstraction tool designed for this

study. The tool captured the relevant information on key study characteristics and detailed information on learning practices in acute care settings. Four reviewers independently charted the data from each eligible article using the survey monkey tool. Any disagreements were resolved through a virtual call discussion between two reviewers and further determination by a third reviewer.

Data items

We abstracted data on article characteristics (e.g., country of origin, year of publication), and contextual factors (e.g., acute care setting, number of participants, learning practices identified, research design), and how the learning practices were deployed. The draft data extraction tool was modified and revised as necessary during the process of extracting data from each included evidence source. (Appendix 1 Data Extraction Tool.) As the study synthesis progressed several elements were discarded, and new areas explored.

Synthesis of results

We grouped the studies by charting the learning practices deployed in each acute care setting. We summarized the empirical studies by type of settings, populations and study designs for each research study, including the number of healthcare professionals participating. We identified twenty-four reviews, including systematic, narrative, and scoping reviews, that met our inclusion criteria. We also included ten commentaries in the review.

Patient and Public Involvement

We did not involve patients or the public in this scoping review, but rather plan to use the results to inform patients and the public with the view to designing new projects in which they will be involved.

Results

Selection of sources of evidence

After duplicates were removed, a total of 687 citations were identified from searches of electronic databases and references from the review articles. Based on the title and the abstract, 501 were excluded, with 186 full text articles

to be retrieved and assessed for eligibility. Of these, 100 were excluded for the following reasons: they were focused on team temporality, patient/healthcare team interaction, inter-country collaboration and delivering bad news which were all concepts not considered part of this review. Several were not set in acute care settings, and one was based on the oil industry. Some studies were on gaining individual expertise, student training and only included single discipline which did not meet inclusion criteria.

The remaining 86 studies were considered eligible for this review. Figure 3 is the selection of sources of evidence flow chart.

Characteristics of sources of evidence

Of the 86 manuscripts included in the synthesis, 52 were empirical studies from data base searches or reference reviews, 24 were various types of reviews and 10 were commentaries. For the empirical studies, each citation was characterized by year of publication, location of study by continent, type of setting, acute

care or simulation, the number of participants or cases in the study, the profession of participants, research design and learning practices identified. (**Appendix 2(a): Characteristics of Sources of Evidence- Empirical Studies.**) Review articles were characterized by the type of review, the population studied and the main ideas and recommendations from the study. **(Appendix 2(b): Characteristics of Sources of Evidence-Reviews.)** The recommendations or main ideas were the characteristics captured for commentaries. **(Appendix 2(c): Characteristics of Sources of Evidence- Commentaries)**

Results of Individual Sources of Evidence

Table 3 illustrates 15 different learning practices deployed by acute care setting or simulation center. Structured observation, case scenarios and surveys were the most used, while coaching, cognitive aides (other than checklists), serious games and online learning were least popular.

Table 3. Results of Individual Sources of Evidence

	SETTING									
	SIMULATION CENTER	OPERATING ROOM	EMERGENCY ROOM	INTENSIVE CARE UNIT	LABOR & DELIVERY	GENERAL MEDICAL UNIT	PEDIATRIC EMERGENCY ROOM	NEONATAL INTENSIVE CARE UNIT	*TOTAL*	
STRUCTURED OBSERVATION	1	10	2	3	0	0	1	1	*18*	21.24
CASE SCENARIOS	3	10	4	1	0	0	0	0	*18*	21.24
AUDIO/VIDEO ANALYSIS	2	7	2	2	0	0	0	1	*14*	16.52
PREBRIEFING/ DEBRIEFING	2	3	3	1	0	0	0	0	*9*	10.62
1:1 REFLEXIVE CONVERSATIONS	0	0	0	0	0	0	0	0	*0*	
COACHING	0	0	0	1	0	0	0	0	*1*	1.18
INTERVIEWS	0	8	0	1	0	0	0	1	*10*	11.8
PEER REVIEW & DISCUSSION	0	4	0	0	0	0	0	0		4.72
FOCUS GROUPS	2	0	0	0	0	0	0	0	*2*	2.36
CHECKLISTS	1	6	0	1	1	0	0	0	*9*	10.62
COGNITIVE AIDS	0	1	0	0	0	0	0	0	*1*	1.18
RATING SCALES	0	4	1	0	0	0	1	0	*6*	7.08
LEARNING BY DOING	0	0	0	0	0	0	0	0	*0*	

	EXPERIMENTATION /TRIAL & ERROR	0	0	0	0	0	0	0	0	*0*	
	SURVEYS	2	10	1	0	0	1	0	0	*14*	16.52
	SERIOUS GAMES	0	1	0	0	0	0	0	0	*1*	1.18
	DIDACTIC PRESENTATIONS	1	4	3	1	0	0	1	0	*10*	11.8
	WEB-BASED INFORMATION & SOCIAL MEDIA	0	0	0	0	0	0	0	0	*0*	
	ONLINE LEARNING	0	0	1	0	0	0	0	0	*1*	1.18
	JOURNAL CLUBS	0	0	0	0	0	0	0	0	*0*	

Synthesis of results

Eighty-six studies discussed learning practices of experienced healthcare teams in acute care settings and simulation centers. The majority were from North America (29), with 17 from Europe, 5 from Australasia and 1 from Asia. See Figure 4, manuscripts by location of study.

Most empirical studies were qualitative studies (46%), 31% were mixed methods and 23% were quantitative studies. See Figure 5. Manuscripts by Research design. There were also 24 reviews which included systematic, narrative, realist, and scoping reviews and 10 commentaries. The most frequent team-based learning practices were structured observation and case scenarios (21%) followed by audio/video analysis and surveys of unit clinical teams (17%). Next was unit staff reflective interviews and didactic presentations (12%) followed by Prebriefing/Debriefing and Checklists (11%). Rating scales accounted for 7%, peer review and discussion 5%, focus groups of unit clinical team participants 2% and finally online learning, serious games, cognitive aides and coaching 1%. Overall, 84 of the 86 publications selected, examined the learning practices of teams that were larger than two participants. While most manuscripts reported improved team behaviors from implementing suggested learning practices, none incorporated direct measures of dyad performance. Of the quantitative studies, 50% were observational (non-experimental), 10% were surveys, 8% were prospective cohort studies and observational (experimental) studies, 4% were descriptive, cross-sectional,

questionnaires, pre/posttests, and randomized clinical trials. See Figure 6: Manuscripts by Research Design-Quantitative.

Of the qualitative studies, 30% were interviews, 25% were observational and grounded theory studies and 20% were ethnography. See figure 7: Manuscripts by Research Design – Qualitative.

Of the mixed methods studies, 75% were before and after studies, 13% were interviews and structured observation and 6% were observational and sequential studies. See Figure 8: Manuscripts by Research Design – Mixed Methods.

There were also 24 reviews which included systematic, narrative, realist, and scoping reviews and 10 commentaries.

A large majority of the research was conducted in the operating room (29), followed by 7 in the emergency room and 6 studies in simulation centers. Four studies were based in intensive care units, 3 in pediatric units, 2 in neonatal intensive care units and 1 each in labor and delivery and general medical units. See Figure 9, Manuscripts by Setting.

Discussion

Summary of evidence

We found that most manuscripts on teamwork in acute care settings were empirical studies that included structured observations, case studies and surveys. While the number of empirical articles was increasing year by year prior to the pandemic, the 52 studies do not yet rate the efficacy of one learning practice over another, demonstrate any consistency on when or how the practice is applied, or objectively measure the effect. This finding is concerning as apart from healthcare systems and hospitals spending thousands of dollars each year on teamwork training, we are unclear on the efficacy of that training. Many studies report on the use of simulation to deliver learning practices, but there is no determined best practice on how often or who should participate in the training. Some studies focused on training clinical leaders in units. More empirical research is needed, particularly research where collaboration is measured and its effect on team performance.

Fifteen learning practices were identified from the manuscripts we examined. More work is needed to map the identified learning practices to improvement in teamwork collaboration. Specifically, research to determine how to improve team and dyad collaborative expertise is needed, as the limited empirical work in this area indicates that reproducibility may be a weakness of current team training. While many of the publications we reviewed provided potential solutions (e.g., debriefing of structured observation and case scenarios) the lack of reproducibility might be solved with improved clarity of the measurement of team collaboration and in turn the measurement of team performance. One of the most important tasks in any field of study is to develop a shared nomenclature. It is only through a shared understanding of words that shared concepts can evolve into more focused ideas. When words are used imprecisely, generalizing results is more difficult. Many of the publications we reviewed, were not specific about the learning practices deployed and did not unearth a shared understanding of teamwork collaborative measurement and measurement of team performance. We can think of collaboration as the mediating variable and teamwork excellence as the dependent variable. More exploration is required to identify the constellation of learning practices that focus on collaboration.

Efforts were taken to ensure that the results of this scoping review would benefit the field. The methodology we used in this scoping review was rigorous, following evidence-based guidelines on how to effectively scope a field of literature. We solicited input from a wide range of stakeholders and sought input on early drafts.

We were interested in how identified learning practices can help develop excellent dyad performance, and if and how this can be explained by the three theoretical perspectives of distributed cognition, relational coordination, and cognitive load theory. We surmise that checklists and other types of cognitive aids can possibly help to decrease workload and so free up processing resources that can be used for improved relational coordination. Reviewed studies also show that prebriefings and debriefings might help dyads to develop a common understanding of the task through distributed cognition enabling a shared mental model and so improve coordination. There have also been learning practices identified that seem to be unrelated to the underpinning theories. These include practices such as the use of rating scales. We find this particularly

interesting as it suggests that additional theoretical perspectives are necessary in future research, e.g., rating scales might suggest that theories of (self-)assessment may also be important to understand how dyads develop into excellent teams.

In figure 2 we introduced the frameworks of distributed cognition, relational coordination, and cognitive load. We have interpreted our findings on learning practices in relation to the three theoretical frameworks in the following way. When considering the 15 learning practices identified, we found that elements of both distributed cognition and relational coordination could be addressed through clustering the learning practices into the 5 broader topic areas or constellations. These are (1) evaluate performance, (2) practice, (3) feedback, (4) utilize just-in-time aids and (5) study ideal examples. Evaluating performance would be achieved through structured observation, audio/video analysis and rating scales. Practice would employ case scenarios, with an emphasis on prebriefing and debriefing. Feedback would entail coaching, interviews, peer review, focus groups and surveys. Just-in-time aids refers to checklists and cognitive aids and finally, studying ideal examples could be demonstrated through serious games, online learning, and didactic presentations. Figure 10 demonstrates learning practice constellations in relation to collaborative frameworks.

Literature has supported that the application of cognitive load theory improves efficiency of learning [12]. Creative learning practices that consider cognitive load will optimize skill acquisition in dyadic collaboration. By shaping learning practices that break down the complexity of collaborative frameworks through the study of ideal examples and feedback (the intrinsic load, see learning practices 6-10 and 13-15 in figure 10), while managing to minimize the irrelevant information through just-in-time aids (the extraneous load, learning practices 11-12 in figure 10) and optimizing germane processing through practice and evaluating performance (learning practices 1-3 and 4-5), dyads may train more efficiently to achieve expert performance.

Limitations

There are limitations in our scoping review. To make our review more feasible, we extended the scope of the review to include larger teams as there were so few manuscripts on dyadic learning. Another limitation stemmed from using the dyad or duo as the unit of analysis, rather than the individual. There has been so little research conducted on what constitutes learning practices when the individual is not the unit of analysis. Further adding to this issue is how do we measure these learning practices and determine their suitability for developing and maintaining dyadic and team expertise rather than individual expertise.

Another potential limitation is how we created the search for our review. We didn't search on terms that may have provided a broader net such as "duos" or "pairs" and so we may have missed some relevant work in the initial searches. We did do a comprehensive snowball search on the references of all included manuscripts and this process unearthed more relevant studies. Regardless of these limitations, we think the review demonstrates a clear progression in the domain of team learning practices and casts a light on areas of weakness and areas needing further study. Furthermore, some may consider a scoping review as lacking in rigor as the results are simply mapped, not synthesized. In summary, this review clearly demonstrated the dearth of research on healthcare pairs or dyads and areas for further research.

Conclusions

The lack of evidence to support learning practices that promote expert performance of experienced healthcare dyads in acute care settings poses a challenge to excellence in healthcare delivery and reduction of error. How do we develop expert healthcare dyads when we don't understand the learning practices, that dyads should undertake to achieve excellence? The aim of this scoping review was to identify gaps in the literature which may guide further research on excellent performance in healthcare dyads. However, the lack of evidence found on dyadic learning practices means that we will need to turn to our expert dyadic teams and question them to understand how they became experts and the learning practices they participate in to guide future performance. Currently, evidence is insufficient to guide the nature of best learning practice interventions.

There is also limited evidence to describe how learning practices should be evaluated and rated to determine their efficacy. Examination of the underpinning frameworks of workload theories, distributed cognition and relational coordination may guide the dyadic unit to increased collaboration and therefore guide the best learning practices the dyad should undertake to achieve excellence. This advocates the need for high quality research to determine the learning practices the dyad should undertake, how these learning practices should be deployed and how dyadic performance can be measured. Further research questions may include the learning practices used by healthcare dyads, which are most beneficial? And how are these practices best deployed? Our review has identified five constellations of learning practices and maybe positive effects will mainly be realized by the integration of these constellations into medical education. For example, teams need to receive information on what is excellent performance (study ideal examples), practice in particular ways (also using simulation, role play), and receive feedback on their own performance (rating scales, video feedback etc.). If we want to reach positive effects, a combination of learning practices will probably be necessary.

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Data sharing statement No additional data available.

Ethical Approval Not applicable/No human participants included

Patient consent for publication Not required.

Provenance and peer review Not commissioned, externally peer reviewed.

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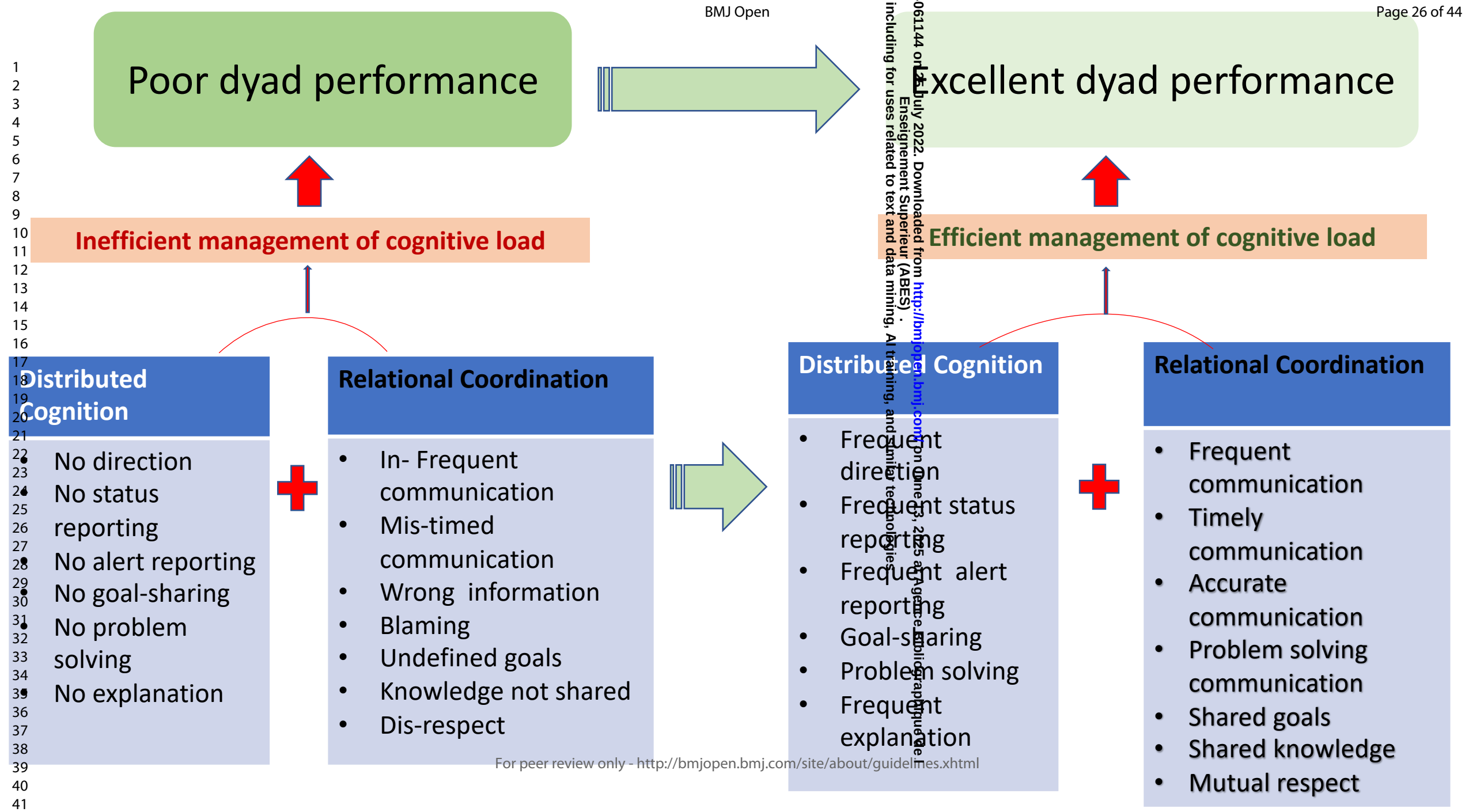
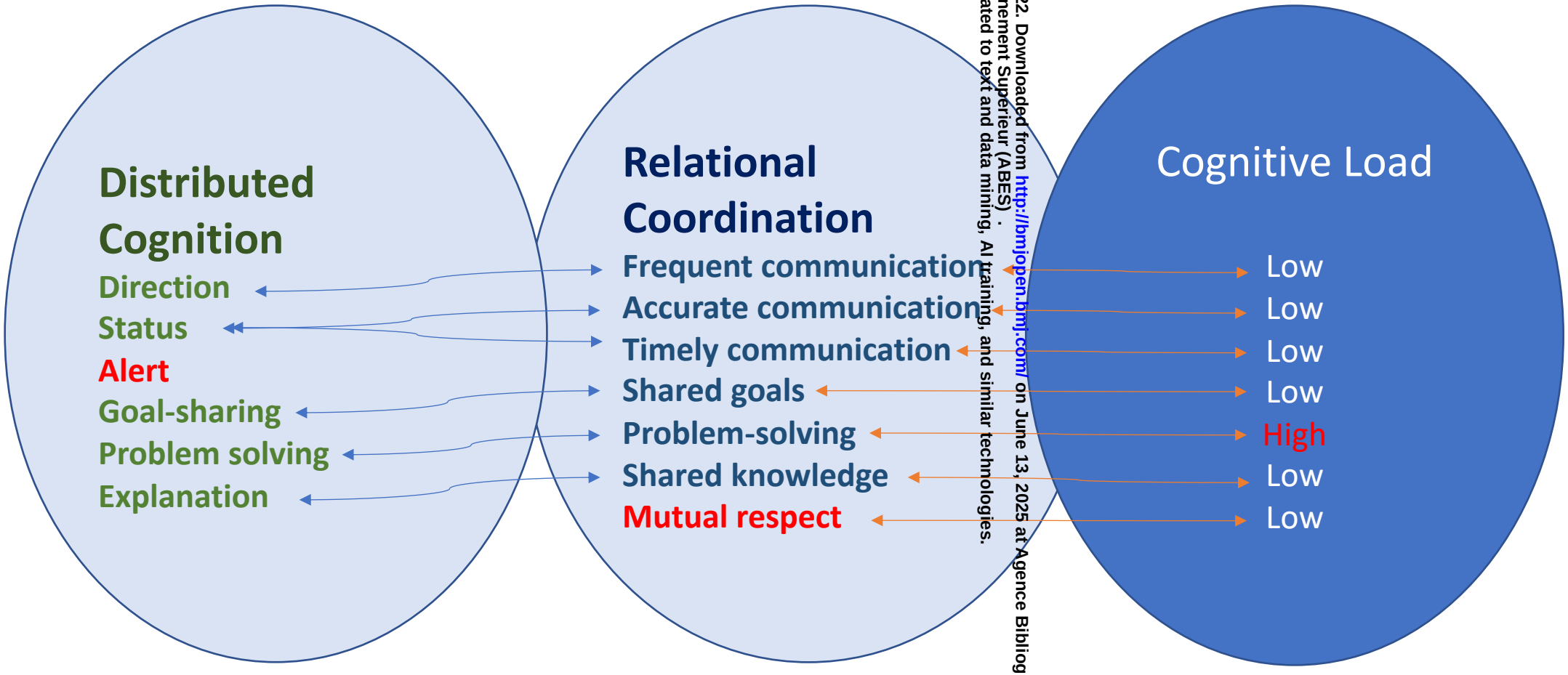
Figure Legend

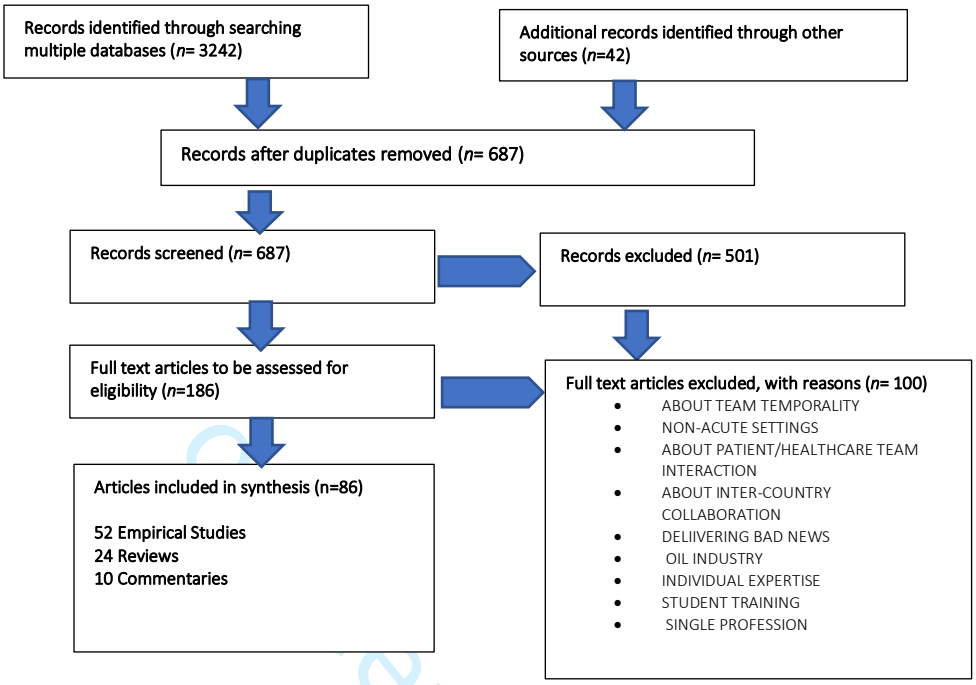
1. Figure 1. Cognitive frameworks to build high performance dyadic collaboration
2. Figure 2: Mapping the elements of distributed cognition with relational coordination and cognitive load theory
3. Figure 3. Selection of Sources of Evidence Flow Chart
4. Figure 4. Manuscripts by location of Study
5. Figure 5. Manuscripts by Research Design
6. Figure 6. Manuscripts by Research Design- Quantitative
7. Figure 7. Manuscripts by Research Design – Qualitative
8. Figure 8. Manuscripts by Research Design – Mixed Methods
9. Figure 9. Manuscripts by setting
10. Figure 10. Learning practice constellations in relation to collaborative frameworks

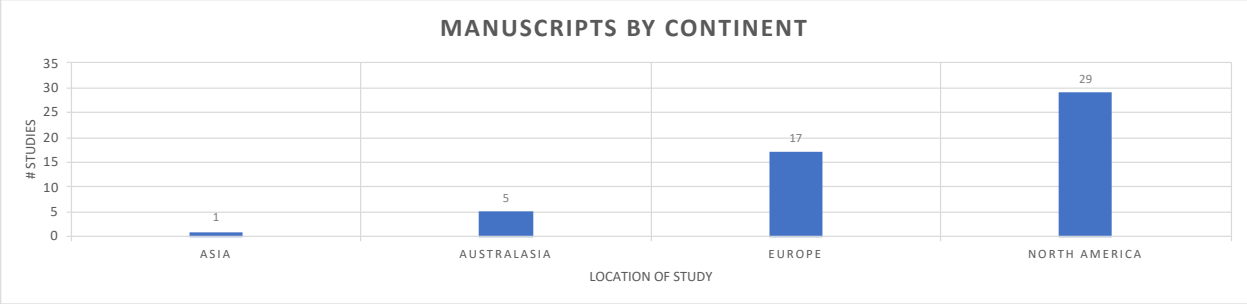
Appendix Legend

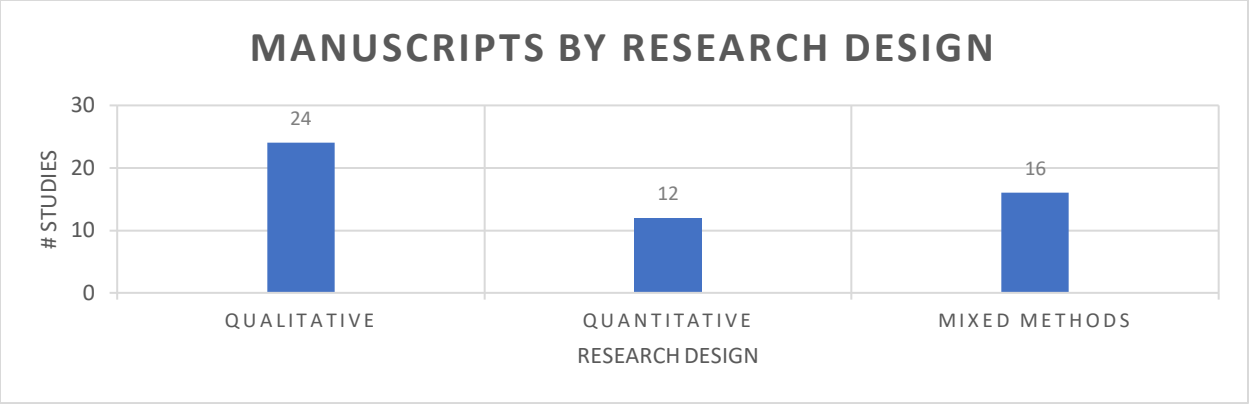
1. Appendix 1 Data Extraction tool
2. Appendix 2 (a) Characteristics of Sources of Evidence- Empirical Studies.
3. Appendix 2(b): Characteristics of Sources of Evidence-Reviews.
4. Appendix 2(c): Characteristics of Sources of Evidence- Commentaries.

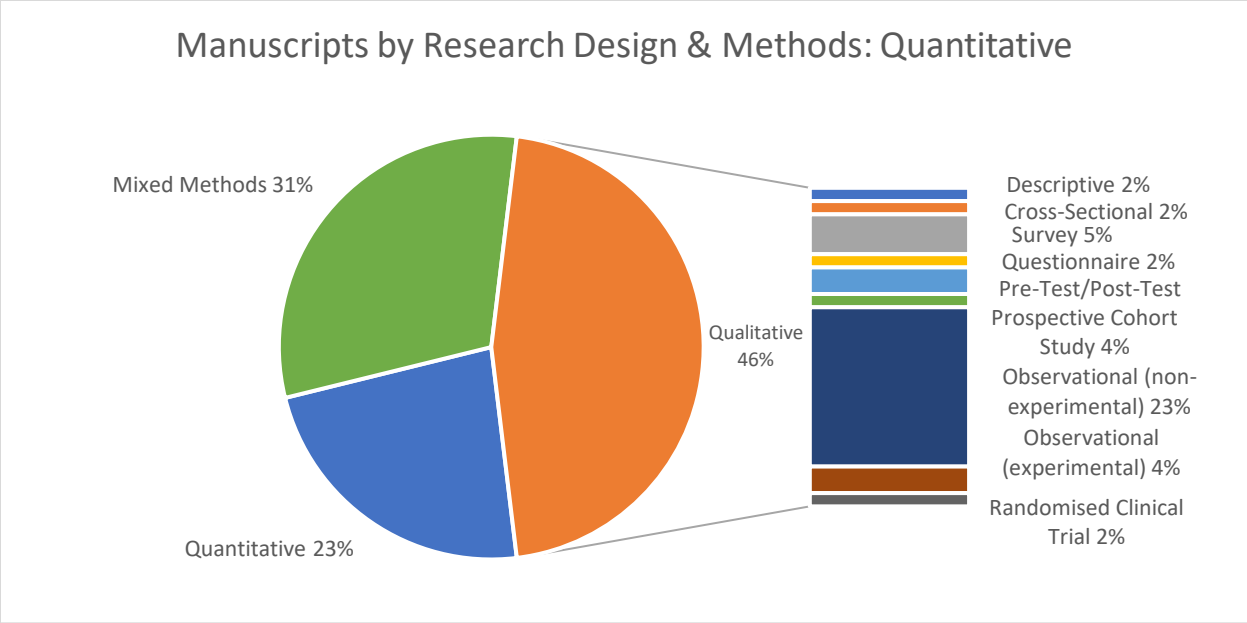


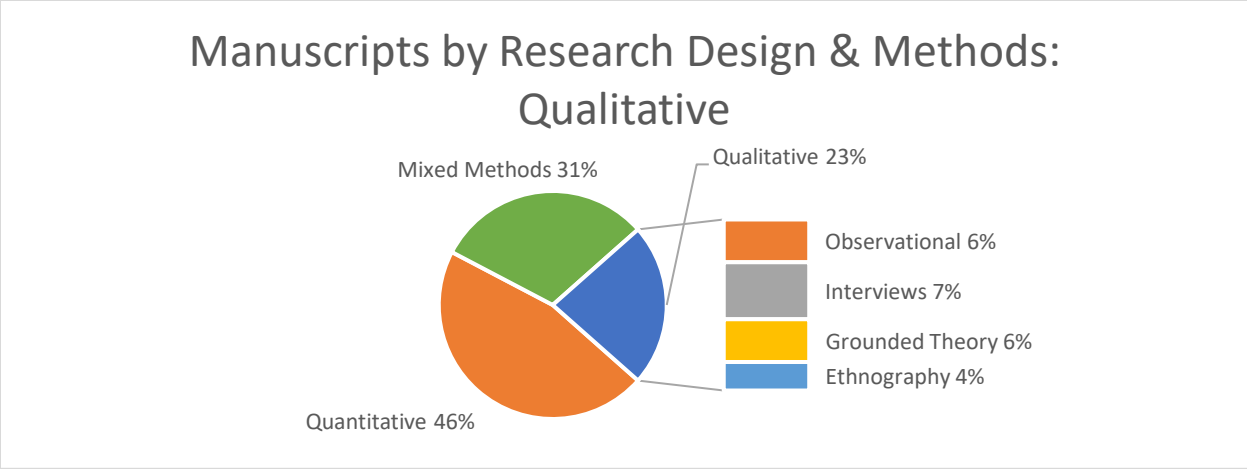


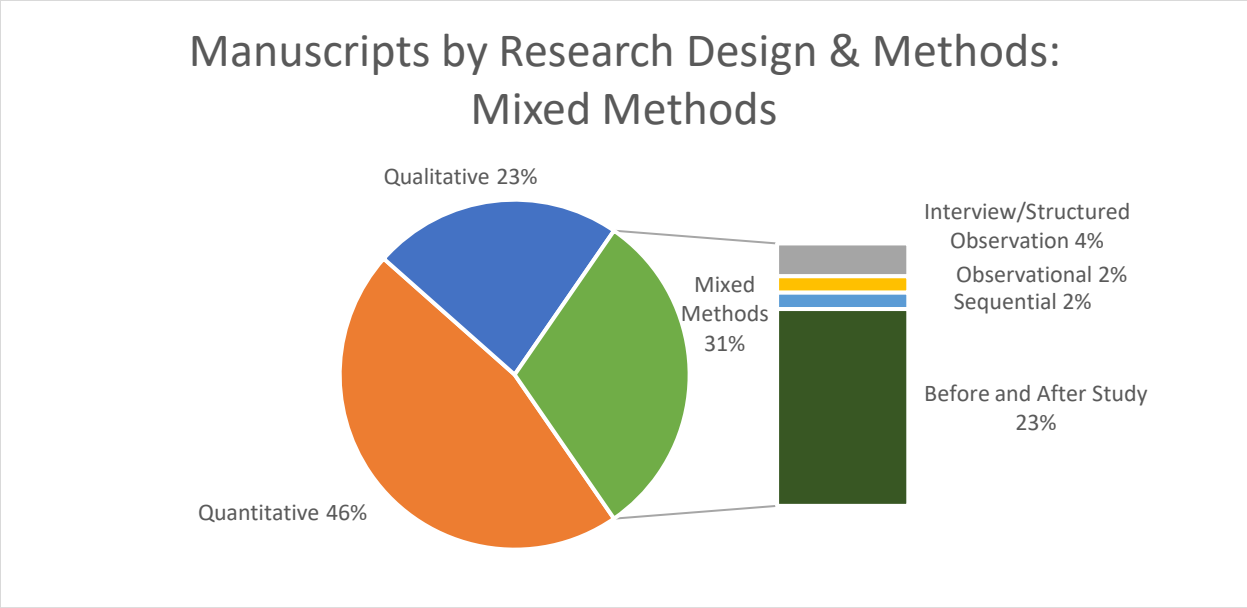


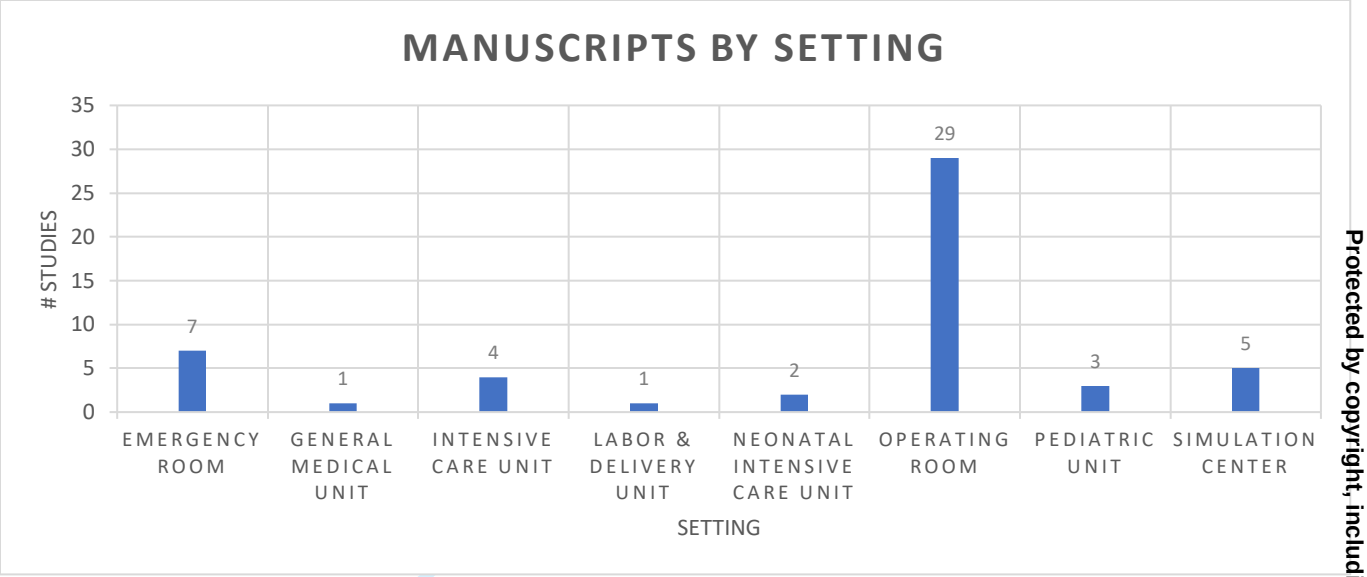


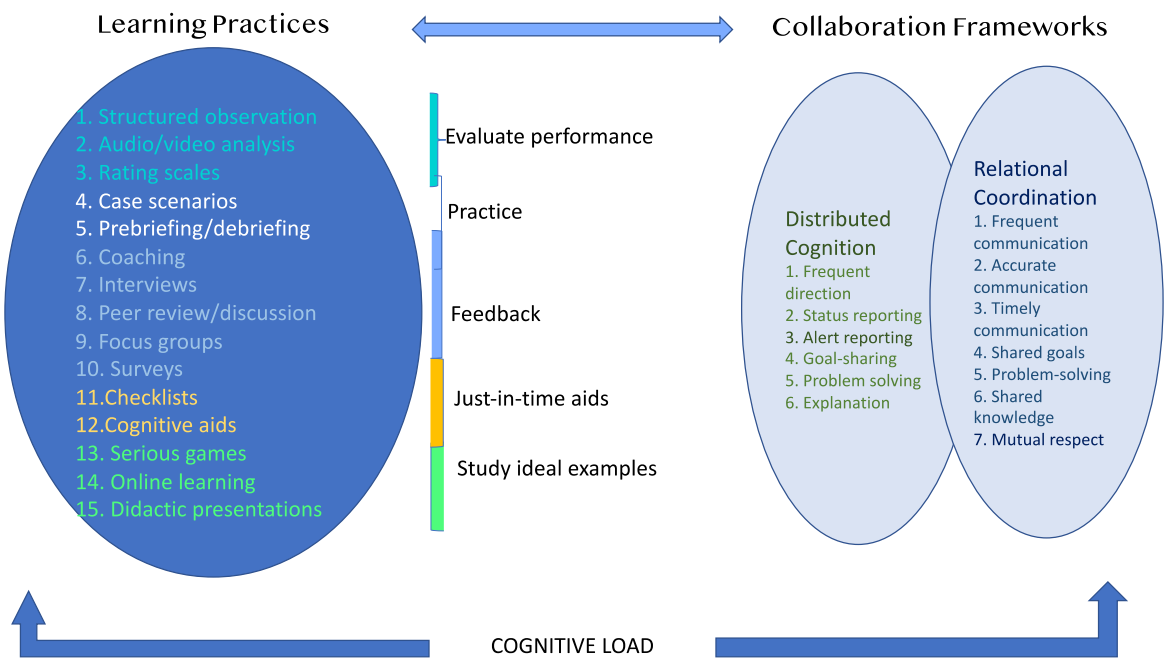












Appendix 1. Data Extraction Tool

Hidden Dynamics in Healthcare; Learning Practices that Optimize Expert Dyad Performance in Acute Care Settings: A Scoping Review 2016-2020

Scoping Review Details

- Name of Reviewer
- Date of Review

EVIDENCE SOURCE DETAILS & CHARACTERISTICS

1. Citation details: author/s, title, journal, volume, issue, pages
2. Year of publication
3. Location. (please fill in by looking at affiliation of first author)
4. What was the setting of the study?
5. Number of participants enrolled in study
6. What was the profession of the participants enrolled in the study?

DETAILS/RESULTS EXTRACTED FROM SOURCE OF EVIDENCE.

1. Which learning practices were identified?
2. How were learning practices conducted?
3. How was learning measured?
4. Was there a specific guide for future learning?
5. What was the research design?
6. Was there agreement or controversy from the authors about the efficacy of the learning practices?
7. Were specific learning practices suggested to optimize future learning?
8. Were there gaps identified to the uptake of effective learning practices?

	Article	Year of Publicatio	Location of Study	Setting : Acute Care	Number of Participants	Profession of Participants	Research Design	Learning Practices
1	Boyd, M., Cumin, D., Frampton, C., Merry, A., Webster, C., Weller, J., & Nakarada-Kordic, I. (2016). Assessing the similarity of mental models of operating room team members and implications for patient safety: a prospective, replicated study. *16*, 1-11.	2016	Australasia	Operating Room	120	Anesthesiologists, Surgeons, Nurses	Quant/Non-experimental/descriptive	Serious games
2	Cabral RA, Eggenberger T, Eller K, Gallison BS, Newman D. Use of a Surgical Safety Checklist to Improve Team Communication. AORN J 2016;104(3);206-216.	2016	North America	Operating Room	114	Surgeons, nurses, Surigcal technologists	Quant/non-experimental/ pre-test/post-test	Checklist
3	Conn LG, Haas B, Cuthbertson BH, Amaral AC, Coburn N, Nathens AB. Communication and culture in the surgical intensive care unit: boundary production and the improvement of patient care. Qual Health Res. 2016;26(7):895-906.	2016	North America	Intensive Care unit	43	Surgeons, Intensivists, Nurses	Qual/ethnography	Structured observation/interviews
4	Di Renna, T., Crooks, S., Pigford, A.-A., Clarkin, C., Fraser, A. B., Bunting, A. C., . . . Boet, S. (2016). Cognitive Aids for Role Definition (CARD) to improve interprofessional team crisis resource management: An exploratory study. *JOURNAL OF INTERPROFESSIONAL CARE, 30*(5), 582-590. 1179271	2016	North America	Operating Room	128	Anesthesiologists, Surgeons, Nurses	Mixed Methods - sequential	Use of cognitive aids
5	Duclos, A., Jl, P., Piriou, V., Occelli, P., Denis, A., Bourdy, S., . . . Group, I. S. (2016). Cluster randomized trial to evaluate the impact of team training on surgical outcomes. *The British journal of surgery TA - TT -, 103*(13), 1804-1814.	2016	Europe	Operating Room	Operating Room Teams from 31 hosptials	Anesthesiologists, Surgeons, Nurses & Quality Managers	Quant/Experimental /Randomized Clinical Trial	Case scenarios/ checklists
6	HärgestamM, HultinM, Brulin C, et al. Trauma team leaders' non-verbal communication: video registration during trauma team training. Scand JTrauma Resusc Emerg Med 2016;24:37.	2016	Europe	Emergency Room	18 Trauma Teams - 108 participants	Physicians, Nurses, Enrolled Nurses	Quant/non-experimental/ Observational	Structured Observation/Video analysis
7	Hilton, G., Daniels, K., Goldhaber-Fiebert, S., Lipman, S., Carvalho, B., & Butwick, A. (2016). Checklists and multidisciplinary team performance during simulated obstetric hemorrhage. International Journal of Obstetric Anesthesia, 25(1), 9–16 doi:10.1016/j.ijoa.2015.08.01	2016	North America	Labor and Delivery	140	Anesthesiologists, Obstetricians, Nurses, Surgical Technicians	Quant/non-experimental/ Observational	Checklists
8	Kemper PF, de Bruijne M, van Dyck C, So RL, Tangkau P, Wagner C. Crew resource management training in the intensive care unit. A multisite controlled before–after study. BMJ Qual Saf 2016; 25: 577–587.	2016	Europe	Intensive Care unit	474	ICU Physicians, Nurses, Managers	Mixed Methods - Before and after study	Didactic presentations/Structured observation/
9	Leenstra, N. F., Jung, O. C., Johnson, A., Wendt, K. W., & Tulleken, J. E. (2016). Taxonomy of Trauma Leadership Skills: A Framework for Leadership Training and Assessment. *ACADEMIC MEDICINE, 91*(2), 272-281.	2016	North America	Operating Room	207 procedures	Emergency physicians, Trauma surgeons, anesthesiologists Emergency nurses,	Qual/grounded theory	Interviews
10	Singer, S. J., Molina, G., Li, Z., Jiang, W., Nurudeen, S., Kite, J. G., . . . Berry, W. R. (2016. Relationship Between Operating Room Teamwork, Contextual Factors, and Safety Checklist Performance. *JOURNAL OF THE AMERICAN COLLEGE OF SURGEONS, 223*(4), 568-U557.	2016	Europe	Intensive Care Unit	2100	Nurses, physicians (medicine/peds/surgery).	Mixed Methods - Before and after study	Checklists/Structured Observation/Coaching
11	Tiferes J, Hussein AA, Bisantz A ed al. The Loud Surgeon Behind the Console: Understanding Team Activities During Robot-Assisted Surgery. J Surg Educ. 2016;73:504-512.	2016	North America	Operating Room	89	Surgeons, Physician Assistants, Nurses.	Quant/non-experimental/ Observational	Structured Observation
12	Weld LR, Stringer MT, Ebertowski JS, et al. TeamSTEPPS improves operating room efficiency and patient safety. Am J Med Qual. 2016;31:408–414.	2016	North America	Operating Room	1481 cases	Anesthesiologists, Nurse Anesthesiologists, Surgeons, Physician Assistants, Nurses.	Mixed Methods - Before and after study	Prebriefing and debriefing
13	Weller JM, Cumin D, Civil ID, et al. Improved scores for observed teamwork in the clinical environment following a multidisciplinaryoperating room simulation intervention. N Z Med J 2016;129:59–67	2016	Australasia	Simulation Center-University	120	Anesthesiologists, Surgeons, Nurses	Mixed Methods - Before and after study	Case scenarios
14	Weller J, Civil I, Torrie J, et al. Can team training make surgery safer? Lessons for national implementation of a simulation-based programme. N Z Med J 2016;129:9–17.	2016	Australasia	Operating Room	48	Anesthesiologists , Surgeons, Nurses, Anesthetic Techs	Qual/interviews	Interviews

15	Yu, D., Lowndes, B., Thiels, C. et al. Quantifying Intraoperative Workloads Across the Surgical Team Roles: Room for Better Balance?. World J Surg 40, 1565–1574 (2016). https://doi.org/10.1007/s00268-016-3449-6	2016	North America	Operating Room	192	physicians, nurses, Surgical Technicians	Quant/non-experimental/ Observational	Structured Observation
16	Avgerinos, E., & Gokpinar, B. (2017). Team Familiarity and Productivity in Cardiac Surgery Operations: The Effect of Dispersion, Bottlenecks, and Task Complexity. *19*, 19-35.	2017	North America	Emergency Room	112	Nurses, physicians, respiratory therapist, PCA, paramedic, social worker	Quant/non-experimental/ Observational	Structured Observation
17	Calder, L. A., Mastoras, G., Rahimpour, M., Sohmer, B., Weitzman, B., Cwinn, A. A., . . . Parush, A. (2017). Team communication patterns in emergency resuscitation: a mixed methods qualitative analysis. *International Journal of Emergency Medicine TA - TT -, 10*(1), 1-9.	2017	North America	Operating Room	not known	physicians, nurses, Surgical Technicians	Mixed Methods Observational	Interviews/Case scenarios/Structured Observation
18	Carpenter, J. E. (2017). Medical Team Training Improves Team Performance LK - https://maastrichtuniversity.on.worldcat.org/oclc/7160490186. *journal of bone and joint surgery.American volume TA - TT -, 99*(18), 1604-1610.	2017	North America	Operating Room	55	Anesthesiologists, Surgeons, Nurses	Mixed Methods - Before and after study	Debriefing/case scenario/Structured observation
19	Cavuoto, L. A., Hussein, A. A., Vasan, V., Ahmed, Y., Durrani, A., Khan, S., . . . Guru, K. A. (2017). Improving Teamwork: Evaluating Workload of Surgical Team During Robot-assisted Surgery. *UROLOGY, 107*, 120-125.	2017	Europe	Simulated Operating Room	120	Anesthesiologists, Surgeons, Nurses	Quant/non-experimental/ Questionnaire	Survey
20	Cumin, D., Skilton, C., & Weller, J. (2017). Information transfer in multidisciplinary operating room teams: a simulation-based observational study. *BMJ QUALITY & SAFETY, 26*(3), 209-216.	2017	North America	Simulated Operating Room	34/42	Anesthesiologists, Surgeons, Nurses	Quant/non-experimental/ Observational	case scenarios/video analysis
21	D'Agostino, T. A., Bialer, P. A., Walters, C. B., Killen, A. R., Sigurdsson, H. O., & Parker, P. A. (2017). A Communication Training Program to Encourage Speaking-Up Behavior in Surgical Oncology. *AORN Journal TA - TT -, 106*(4), 295-305.	2017	North America	Simulated Operating Room	26	Anesthesiologists, Surgeons	Mixed Methods - Before and after study	Case Scenarios/ didactic training/ focus groups/debriefing
22	Doumouras, A. G., Hamidi, M., Lung, K., Tarola, C. L., Tsao, M. W., Scott, J. W., . . . Yule, S. (2017). Non-technical skills of surgeons and anaesthetists in simulated operating theatre crises. *British Journal of Surgery TA - TT -, 104*(8), 1028-1036.	2017	Europe	Operating Room	150	Anesthesiologists, Surgeons, Nurses	Qual/observational	Case Scenarios/ Rating Scale
23	Erestam, S., Haglind, E., Bock, D., Andersson, A. E., & Angenete, E. (2017). Changes in safety climate and teamwork in the operating room after implementation of a revised WHO checklist: a prospective interventional study. *PATIENT SAFETY IN SURGERY, 11*.	2017	Australasia	Operating Room	99	Anesthesiologists, Surgeons, Nurses	Quant/non-experimental/ Observational	Checklists/Structured Observation/Didactic/ Survey
24	Frasier LL, Pavuluri Quamme SR, Becker A, et al. Investigating teamwork in the operating room: engaging stakeholders and setting the agenda. JAMA Surg. 2017;152:109e111.	2017	North America	Operating Room	23	Anesthesiologists, Surgeons, Nurses, Surgery Residents, Operating Room Technicians, Anesthetist Technicians	Qual/grounded theory	Focus groups/audio recording.
25	Gillespie, B. M., Steel, C., Kang, E., Harbeck, E., Nikolic, K., Fairweather, N., & Chaboyer, W. (2017). Evaluation of a Brief Team Training Intervention in Surgery: A Mixed-Methods Study. *AORN Journal TA - TT -, 106*(6), 513-522.	2017	Asia	Operating Room	217	Anesthesiologists, Surgeons, Nurses, Surgery Residents, Operating Room Technicians, Anesthetist Technicians	Mixed Methods - Before and after study	survey/Structured observation/interviews/ checklists
26	McComb SA, Lemaster M, Henneman EA, Hinchey KT (2017) An evaluation of shared mental models and mutual trust on general medical units: implications for collaboration, teamwork, and patientsafety. J Patient Saf 13(4):237–242	2017	North America	General Medical Units	79	Physicians, Nurses,	Quant/non-experimental/ survey	Survey
27	Mousavi, E., Aarabi, A., Mojdeh, S., & Mehraban, M. A. (2017). HEALTHCARE PROVIDERS ATTITUDE REGARDING EFFECTIVENES OF HEALTHCARE TEAM IN OPERATING ROOM. *PHARMACOPHORE, 8*(6, S).	2017	Europe	Emergency Room	29	Surgeons, Emergency physicians , Nurses,	Quant/non-experimental/ survey	Survey
28	Raley, J., Meenakshi, R., Dent, D., Willis, R., Lawson, K., & Duzinski, S. (2017). The Role of Communication During Trauma Activations: Investigating the Need for Team and Leader Communication Training. *JOURNAL OF SURGICAL EDUCATION, 74*(1), 173-179.	2017	North America	Operating Room	226	Surgeons, Nurses	Quant/non-experimental/ Observational	Survey/Structured observation/Rating scales
29	Siems A, Cartron A, Watson A, McCarter R, Levin A. Improving pediatric rapid response team performance through crew resource management training of team leaders. Hosp Pediatr 2017; 7: 88–95	2017	North America	Pediatric Unit	37 cases	Physicians, Nurses, Nurse Practicitioners Respiratory Therapist	Mixed Methods - Before and after study	Didactic presentations/Structured observation/Rating Scale

30	Bui, A. H., Guerrier, S., Feldman, D. L., Kischak, P., Mudiraj, S., Somerville, D., . . . Leitman, I. M. (2018). Is video observation as effective as live observation in improving teamwork in the operating room? *Surgery, 163*(6), 1191-1196.	2018	North America	Operating Room	N/A	Anesthesiologists, Surgeons	Quant/experimental/ Observational	Structured Observation/Video analysis/Feedback
31	Esce, A., Rodeberg, D. A., Rothstein, D. H., Browne, M., & Wakeman, D. D. o. S. L. V. M. C. A. P. (2018). Prevalence and Perceptions of Team Training Programs for Pediatric Surgeons and Anesthesiologists. *JOURNAL OF SURGICAL RESEARCH, 232*, 559-563.	2018	Europe	Operating Room	N/A	Surgeons, Physician Assistants, Nurses, OR Techs	Quant/non-experimental/ survey	Survey
32	Haerkens MH, Kox M, Noe PM, Van DHJ, Pickkers P. Crew Resource Management in the trauma room: a prospective 3-year cohort study. Eur J Emerg Med 2018	2018	Europe	Emergency Room	80	Anesthesiologists, Nurses , ED Physician	Quant/non-experimental/ prospective cohort study	Rating Scale/case studies/video review/didactic
33	Heath, C., Luff, P., Sanchez-Svensson, M., & Nicholls, M. (2018). Exchanging implements: the micro-materialities of multidisciplinary work in the operating theatre. *Sociology of Health & Illness, 40*(2), 297-313.	2018	North America	Operating Room	9	Surgeons, Physician Assistants, Nurses.	Qual/grounded theory	Video-analysis/peer discussion
34	Raheem, S., Ahmed, Y. E., Hussein, A. A., Johnson, A., Cavuoto, L., May, P., . . . Guru, K. A. (2018). Variability and interpretation of communication taxonomy during robot-assisted surgery: do we all speak the same language? *BJU International, 122*(1), 99-105.	2018	Europe	Pediatrics	281	Nurses, Physician Assistants	Quant/non-experimental/ Observational	Video-analysis/peer discussion
35	Schmutz, J. B., Lei, Z., Eppich, W. J., & Manser, T. (2018). Reflection in the heat of the moment: The role of in-action team reflexivity in health care emergency teams. *Journal of Organizational Behavior, 39*(6), 749-765.	2018	North America	Operating Room	50	Surgeons, Nurses	Quant/non-experimental/ Observational	case scenarios/video analysis
36	Sharma, K., Morgan, A. L., Mackinnon, S. E., & Stroud, J. (2018). The Whiteboard Technique: Personalized Communication to Improve Operating Room Teamwork. *ANNALS OF SURGERY, 268*(2), 225-227.	2018	Europe	Simulation Center-University	3	Anesthesiologists, Nurses , ED Physician	Quant/experimental/ Observational	Checklists/Structured Observation/ Survey
37	Tisserand, L. (2018). High Fidelity Simulation: From Simulation to Debrief, Assessing Leadership and Followership Management. *Hacettepe Universitesi Egitim Fakultesi Dergisi-Hacettepe University Journal of Education, 33*, 134-155.	2018	Europe	Emergency Room	70	Nurses, ED attendings and medicine residents	Qual/observational	Didactic presentations/Case scenario /debriefing
38	Truta, T. S., Boeriu, C. M., Copotoiu, S. M., Petrisor, M., Turucz, E., Vatau, D., & Lazarovici, M. (2018). Improving nontechnical skills of an interprofessional emergency medical team through a one day crisis resource management training. *MEDICINE, 97*(32), e11828.	2018	Europe	Emergency Room	70	Nurses, ED attendings and medicine residents	Quant/non-experimental/ Observational	Didactic presentations/Case scenario /debriefing
39	Truta, T. S., Boeriu, C. M., Lazarovici, M., Ban, I., Petrisor, M., & Copotoiu, S. M. (2018). Improving Clinical Performance of an Interprofessional Emergency Medical Team through a One-day Crisis Resource Management Training. *Journal of Critical Care Medicine, 4*(4), 126-136.	2018	Europe	Operating Room	1396	Anesthesiologists , Surgeons, Nurses, Anesthetic Techs	Mixed Methods - Before and after study	Didactic presentations/Case scenario /debriefing/rating scale
40	Widmer, L. W., Keller, S., Tschan, F., Semmer, N. K., Holzer, E., Candinas, D., & Beldi, G. (2018). More Than Talking About the Weekend: Content of Case-Irrelevant Communication Within the OR Team. *World Journal of Surgery : Official Journal of the International Society of Surgery/Société Internationale de Chirurgie, 42*(7), 2011-2017	2018	Europe	Pediatric Unit	96	Pediatric Nurses, Pediatric Residents, Pediatric Physicians	Quant/non-experimental/ Observational	Structured Observation
41	Coolen, E., Draaisma, J., & Loeffen, J. (2019). Measuring situation awareness and team effectiveness in pediatric acute care by using the situation global assessment technique. *EUROPEAN JOURNAL OF PEDIATRICS, 178*(6), 837-850.	2019	North America	Operating Room	9	Anesthesiologists, Surgeons, perfusionist	Mixed Methods - Before and after study	Rating Scale/case scenario
42	Dias, R. D., Zenati, M. A., Conboy, H. M., Clarke, L. A., Osterweil, L. J., Avrunin, G. S., & Yule, S. J. (2019). Dissecting Cardiac Surgery: A Video-Based Recall Protocol to Elucidate Team Cognitive Processes in the Operating Room. *ANNALS OF SURGERY*.	2019	North America	Operating Room	60	Anesthesiologists , Surgeons, Nurse Practitioners	Mixed Methods-interviews/structured observation	structured observation /Interviews
43	Frasier, L. L., Pavuluri Quamme, S. R., Ma, Y., Wiegmann, D., Leverson, G., DuGoff, E. H., & Greenberg, C. C. D. o. P. H. U. o. W.-M. M. W. (2019). Familiarity and Communication in the Operating Room. *JOURNAL OF SURGICAL RESEARCH, 235*, 395-403.	2019	Europe	Operating Room	15	Surgeons, Nurses	Mixed Methods-interviews/structured observation	Audio-video analysis/interviews/surveys
44	Grade MM, Tamboli MK, Bereknyei Merrell S, Mueller C, Girod S. Attending surgeons differ from other team members in their perceptions of operating room communication. J Surg Res. 2019;235:105e112.	2019	North America	Operating Room	54	Anesthesiologists , Surgeons, Nurses, Surgical Technicians	Qual/interviews	Interviews/ peer discussion

45	Henaux, P.-L., Michinov, E., Rochat, J., Hémon, B., Jannin, P., & Riffaud, L. (2019). Relationships Between Expertise, Crew Familiarity and Surgical Workflow Disruptions: An Observational Study. *World Journal of Surgery : Official Journal of the International Society of Surgery/Société Internationale de Chirurgie, 43*(2), 431-438.	2019	North America	Intensive care, Neonatal intensive care unit	50	Nurse Practitioners, Nurses, Neonatologists	Qual/observational	Audio-video analysis
46	Salih, Z. N. I., & Draucker, C. B. (2019). Facilitators of and barriers to successful teamwork during resuscitations in a neonatal intensive care unit. *Journal of Perinatology, 39*(7), 974-982.	2019	North America	Intensive Care Unit	35	Nurses, Nurse Practitioners, Therapists, Physician Assistants, ICU Physician, Nephrologist	Qual/interviews	Case Scenarios/debriefing/audio-video recording
47	Clapp, J. T., Diraviam, S. P., Lane-Fall, M. B., Szymczak, J. E., Muralidharan, M., Chung, J. J., . . . Fleisher, L. A. (2020). Nephrology in the Academic Intensive Care Unit: A Qualitative Study of Interdisciplinary Collaboration. *AMERICAN JOURNAL OF KIDNEY DISEASES, 75*(1), 61-71.	2020	North America	Neonatal Intensive Care	65	Nurses, Therapists, Neonatologists	Qual/ethnography	structured observation /Interviews
48	Eckels, M., Zeilinger, T., Lee, H. C., Bergin, J., Halamek, L. P., Yamada, N., . . . Quinn, J. (2020). A Neonatal Intensive Care Unit's Experience with Implementing an In-Situ Simulation and Debriefing Patient Safety Program in the Setting of a Quality Improvement Collaborative. *Children-Basel, 7*(11).	2020	North America	Emergency Room	60	Surgeons, Emergency physicians	Mixed Methods - Before and after study	Case Scenarios/debriefing/online learning
49	Hall, C., Robertson, D., Rolfe, M., Pascoe, S., Passey, M. E., & Pit, S. W. (2020). Do cognitive aids reduce error rates in resuscitation team performance? Trial of emergency medicine protocols in simulation training (TEMPIST) in Australia. Human resources for health, 18(1). doi:10.1186/s12960-019-0441-x	2020	North America	Operating Room	22	Anesthesiologists, Surgeons, Nurses	Mixed Methods - Before and after study	Case scenarios/ checklists/video-analysis/survey
50	Shi, R., Marin-Nevarez, P., Hasty, B., Roman-Micek, T., Hirx, S., Anderson, T., . . . Lau, J. N. (2020). Operating Room In Situ Interprofessional Simulation for Improving Communication and Teamwork. *The Journal of surgical research, 260*, 237-244. doi:10	2020	Australasia	Operating Room	3800	Anesthesiologists , Surgeons, Nurses, Anesthetic Techs	Qual/interviews	Interviews/survey
51	Jonsson, K., Hultin, M., Hargestam, M., Lindkvist, M., & Brulin, C. (2021). Factors Influencing Team and Task Performance in Intensive Care Teams in a Simulated Scenario. *Simul Healthc, 16*(1), 29-36.	2021	Europe	Operating Room	45	Anesthesiologists, Surgeons, perfusionist	Quant/non-experimental/cross-sectional	Survey/Case scenarios/video-analysis
52	Ridley, C. H., Al-Hammadi, N., Maniar, H. S., Ben Abdallah, A., Steinberg, A., Bollini, M. L., . . . Avidan, M. S. (2021). Building a Collaborative Culture: Focus on Psychological Safety and Error Reporting. *Ann Thorac Surg, 111*(2), 683-689.	2021	North America	Operating Room	73	Anesthesiologists , Surgeons, Nurses, Anesthetic Techs	Quant/non-experimental/ prospective cohort study	Survey/didactic learning

	Reviews			
	Author	Article type	Population	Main Ideas/Recommendations
1	1.Eddy K, Jordan Z, Stephenson M. Health professionals' experience of teamwork education in acute hospital settings: a systematic review of qualitative literature. JBI Database System Rev Implement Rep 2016;14(4):96–137.	Systematic Review	Interprofessional Healthcare Teams	1. All members of a team should be encouraged by their managers to partiipate in teamwork education in order to foster a positive culture of teamwork 2. Facilitators of teamwork education should understand how successful teams function and consider these factors 3. Facilitators of teamwork education should explore participant learning needs and experience level 4. Facilitators of teamwork education should provide learning opportunites that are practical, authentic and foster constructive debriefing and reflection 5. High fidelity simulation should be considered for the training of teamwork skills 6. Managers should harness the new confidence and motivation of staff and ensure opportunities to apply new skills into daily practice.
2	Ford, M. Menchine, E. Burner, S. Arora, K. Inaba, D. Demetriades, B. Yersin, Leadership and teamwork in trauma and resuscitation, West. J. Emerg. Med. 17 (5) (2016) 549e556.Ford	Narrative Review	Interprofessional Healthcare teams- Trauma	Future efforts should focus on better defining, teaching, and assessing leadership and trauma team organization and definitively equating improvements in processes of care with improved patient outcomes
3	Gjeraa, K., Spanager, L., Konge, L., Petersen, R. H., & Østergaard, D. (2016). Non-technical skills in minimally invasive surgery teams: a systematic review. Surgical Endoscopy : And Other Interventional Techniques 30(12), 5185-5199.	Systematic Review	Minimally Invasive Surgery (MIS) Teams	1. Non-Technical Skills (NTS) of MIS Teams imrpove workflow and prevent errors. 2. Working in fixed team improves workplace climate. 3. Communication in MIS Teams related much more to equipment and patient related topics than open surgery. 4. Future studies should focus on identifying which NTS skills are most important from the perspective of the whole team. 5. Training for NTS should include simulation, debriefing and followup in the clinical setting
4	Hughes AM, Gregory ME, Joseph DL, et al. Saving lives: a meta-analysis of team training in healthcare. J Appl Psychol 2016;101:1266–304.	Meta-analysis Review	Interprofessional Healthcare Teams	Participation in healthcare team training promotes learning which in turn induces training on the job, which improves results. Team training is effective across various team compositions. Recommendation for health practitioners to implement team training
5	Husebø, S. E., & Akerjordet, K. (2016). Quantitative systematic review of multi-professional teamwork and leadership training to optimize patient outcomes in acute hospital settings. Journal of Advanced Nursing TA - TT -, 72(12), 2980-3000. doi:10.1111/jan.13035 LK	Quantatative Systematic Review	Interprofessional Healthcare Teams	Training program interventions provide healthcare personnel with the opportunity to practice teamwork and leadership skills that can have an impact on patient safety, safety culture and patient outcomes.Managers should recognize that building a safety culture adjacent to implementing teamwork and leadership training interventions is essential. Further research to strengthen design, methodology and descriptions of interventions is required
6	Shams, A., Ahmed, M., Scalzitti, N. J., Stringer, M., Howard, N. S., & Maturo, S. (2016). How Does TeamSTEPPS Affect Operating Room Efficiency? OTOLARYNGOLOGY-HEAD AND NECK SURGERY, 154(2), 355-358.	Retrospective database review.	Interprofessional Healthcare Teams - Surgery	Although Team Steps is a highly acclaimed evidence-based method improving patient safety and teamwork, more study is needed to determine if it can decrease sentinel events and other preventable medical errors.
7	Lucas A, Edwards M. Development of crisis resource management skills: a literature review. Clin Simul Nurs 2017;13(8):347–358	Narrative Review	Interprofessional Healthcare Teams	Future studies comparing and correlating the achievement of targeted outcomes to the use of validated or unvalidated evaluation methods may illustrate gaps in study design and further guide tool selection for future educators. Other implications for future research may include a focus on evaluating performance of CRM behaviours inactual clinical areas. For this to be possible, a focus on teaching CRM concepts to a broader audience, making it part of health care culture in a way that is similar to aviation culture, is needed. Simulation education would need to be a standard in crisis education for all disciplines, along with an emphasis on team
8	Paradis, E., Pipher, M., Cartmill, C., Rangel, J. C., & Whitehead, C. R. (2017). Articulating the ideal: 50 years of interprofessional collaboration in Medical Education. Medical Education TA - TT -, 51(8), 861-872.	Narrative Review	Interprofessional Healthcare Teams	In order to meet goals of meaningful collaboration leading to higher-quality care, it behoves us as a community of educators and researchers to heed the ways in which we teach, think and write about interprofessional collaboration, interrogating our own language and assumptions that may be betraying and reproducing harmful care hierarchies.
9	Rutherford, J. S. (2017). Monitoring teamwork: a narrative review. Anaesthesia TA - TT -, 72(S1), 84-94.	Narrative Review	Interprofessional Healthcare Teams - anesthesia	team monitoring takes place both implicitly and explicitly in the anaesthetic environment. No single optimal model of teamwork monitoring for all situations was identified, but targeted teamwork training appears to have a positive impact on both teamwork and
10	Jones CPL, Fawker-Corbett J,Groom P, et al. Human factors in preventing complications in anaesthesia: a systematic review. Anaesthesia 2018;73(Suppl 1):12–24.	Systematic Review	Interprofessional Healthcare Teams	Recognition of human factors is now firmly embedded into clinical anaesthetic practice, and has been highlighted in several recent national reports and guidelines. We have reviewed the current literature and described the human factor components of teamwork, communication and situation awareness; we have also commented on human error. The importance of human factors in clinical practice has been highlightedusing the example of complex trauma
11	Larsen, T., Beier-Holgersen, R., Meelby, J., Dieckmann, P., & Ostergaard, D. (2018). A search for training of practising leadership in emergency medicine: A systematic review. Heliyon, 4(11).	Systematic Review	Interprofessional Healthcare Teams - emergency	For many years multiple taxonomies and leadership assessment tools have been developed but failed to come to terms with workable leadership training. Despite there being no clear definition, the literature describes lack of leadership as highly detrimental to performance during a critical, clinical situation and performance as very variable.
12	Low XM, Horrigan D, Brewster DJ. The effects of team-training in intensive care medicine: a narrative review. J Crit Care 2018;48:283–9.	Narrative Review	Interprofessional Healthcare Teams - intensive care	Team-training has been studied in multiple ICU team types, with crew resource management (CRM) and TeamSTEPPS curricula commonly used to support teaching via simulation. Clinical skills taught have included ALS provision, ECMO initiation, advanced airway management, sepsis management and trauma response skills. Teamtraining in ICU is well received by staff, facilitates clinical learning, and can positively alter staff behaviors. Few clinical
13	Rosenman, E. D., Fernandez, R., Wong, A. H., Cassara, M., Cooper, D. D., Kou, M., . . . Grand, J. A. (2018). Changing Systems Through Effective Teams: A Role for Simulation. Academic Emergency Medicine, 25(2), 128-143.	Narrative Review	Interprofessional Healthcare Teams	Continued collaboration between educators and researchers from EM and the team sciences is critical to advancing this work. Finally, we emphasize the importance of using a translational science approach to evaluate simulationbased team training, and to further elucidate the relationship between training and systems-level outcomes.
14	Salas, E., Zajac, S., & Marlow, S. L. (2018). Transforming Health Care One Team at a Time: Ten Observations and the Trail Ahead. GROUP & ORGANIZATION MANAGEMENT, 43(3), 357-381.	Narrative Review	Interprofessional Healthcare Teams	Measurement remains a challenge and there will be numerous opportunities in the future to gather additional types of data to bolster our understanding of the effect of health care team training. The multilevel, multidisciplinary, longitudinal, and rigorous studies currently needed (O'Dea 374 Group & Organization Management 43(3) et al., 2014) will undoubtedly require substantial resources (e.g., time, monetary investment, multidisciplinary knowledge); however, they will continue to advance and improve our understanding one team at a time.
15	Alshyyab, M. A., FitzGerald, G., Dingle, K., Ting, J., Bowman, P., Kinnear, F. B., & Borkoles, E. (2019). Developing a conceptual framework for patient safety culture in emergency department: A review of the literature. The International Journal of Health Planning and Management, 34(1), 42-55.	Systematic Review	Interprofessional Healthcare Teams - emergency	By using Plan-Do-Study-Act cycle, evaluation of the current status of safety culture components identified in the framework can be performed. Hence, appropriate strategies for improvementof safety culture in ED may be generated. Secondly, further research should be conducted to assess the relationship between patient safety culture in ED and staffing levels using objective data for staffing ratios and health care professionals' workload may assist with safety culture improvement. Thirdly, there are already existing instruments that measure the elements and concepts in the inner and outer context of proposed framework. Researchers and practitioners should identify the most commonly used and evaluate them for their validity and reliability. This will help them to prioritise and evaluate proposed actions and anticipate their impact on patient safety and the safety culture in general in EDs.
16	Aufegger, L., Shariq, O., Bicknell, C., Ashrafian, H., & Darzi, A. (2019). Can shared leadership enhance clinical team management? A systematic review. LEADERSHIP IN HEALTH SERVICES, 32(2), 309-335.	Systematic Review	Interprofessional Healthcare Teams	To design, develop and validate a shared leadership assessment tool that allows for rigorous evaluation of the degree of "sharedness" in leadership using for instance a social network analysis approach to understand the degree of density and centralization of shared leadership behavior in the team, medical organizations will be able to create specific and objective training opportunities across health professionals in a variety of settings. This would facilitate a culture that encourages and recognizes individual and team controbutions as well as accomplishments across expertise and seniority
17	Gross, B., Rusin, L., Kiesewetter, J., Zottmann, J. M., Fischer, M. R., Pruckner, S., & Zech, (2019) A.Crew resource management training in healthcare: a systematic review of intervention design, training conditions and evaluation. BMJ OPEN, 9(2).	Systematic Review	Interprofessional Healthcare Teams	Practitioners and researchers need to agree on common terms and definitions regarding the meaning of healthcare crew resource management (CRM)Researchers should consider good practice for reporting intervention design and data evaluation. More research is needed to establish criteria for success in implementing CRM in healthcare organisations. Attention should be paid to both the intervention itself as well as the conditions of the surrounding organisational structure.

18	Kumar, H., Morad, R., & Sonsati, M. (2019). Surgical team: improving teamwork, a review. Postgraduate Medical Journal, 95(1124), 334-339	Narrative Review	Interprofessional Healthcare Teams - Surgery	This review has highlighted several attributes of an ideal team and fundamental areas in which teamwork can be improved in practice. This includes, but is not limited to, team communication and behaviour training, reducing staff turnover times by staggering shifts, and organising more permanent or 'fixed teams. A formal cost–benefit analysis of enrolling such schemes for developing surgical teams would also be helpful to inform this field of enquiry. The studies mentioned in the review provide good evidence to warrant enrolment of such trials; however, they require further investigation to ascertain transferability to other healthcare organizations
19	Lyman, B., Jacobs, J. D., Hammond, E. L., & Gunn, M. M. (2019). Organizational learning in hospitals: A realist review. JOURNAL OF ADVANCED NURSING, 75(11), 2352-2377.	Realist Review	Interprofessional Healthcare Teams	Researchers must develop valid, reliable instruments that more accurately and comprehensively reflect the range of factors associated with organizational learning. Developing and consistently using such instruments would help build a more coherent body of knowledge related to organizational learning in hospitals
20	Neuhaus, C., Lutnæs, D. E., & Bergström, J. (2019). Medical teamwork and the evolution of safety science: a critical review. Cognition, Technology & Work, 22(1), 13-27.	Narrative Review	Interprofessional Healthcare Teams	Despite the need for measurements and evaluation, the continuous integration of social and cultural aspects in teamwork research will most likely enrich the current discourse for a more humanistic and complete understanding of what happens in healthcare teams. Recognizing power dynamics at the workplace in an effort to understand team processes and guide the serious allocation of resources will certainly address current challenges faced by frontline medical staff more thoroughly than the application of normative frameworks. Before rating their 'sharpness', we should harness their narratives and listen to their current needs.
21	Schmutz, J. B., Meier, L. L., & Manser, T. (2019). How effective is teamwork really? The relationship between teamwork and performance in healthcare teams: a systematic review and meta-analysis. BMJ OPEN, 9(9).	Systematic Review	Interprofessional Healthcare Teams	Good teamwork can be achieved by joint reflection about teamwork during clinical event debriefings, as well as team trainings and system improvement.The clinical context might play a role in how team members collaborate. The extent to which team members actually worked together during prior clinical practice might predict of how effectively they perform together. We encourage future studies to include outcome performance measures despite the effort required.
22	Etherington, N., Larrigan, S., Liu, H., Wu, M., Sullivan, K. J., Jung, J., & Boet, S. (2021) Measuring the teamwork performance of operating room teams: a systematic review of assessment tools and their measurement properties. JOURNAL OF INTERPROFESSIONAL CARE	Systematic Review	Interprofessional Healthcare Teams - Surgery	OTAS and NOTECHS have acceptable measurement properties for assessing the teamwork of teams in intraoperative clinical settings and may be considered for future standardized use. However, both tools rely on the questionable assumption that the teamwork of a team is equivalent to the sum of individual performances. Future studies may investigate other assessment tools which consider the whole team as the unit of analysis along with the potential of these tools to provide healthcare providers with meaningful feedback in clinical practice.
23	Gregory, M. E., Hughes, A. M., Benishek, L. E., Sonesh, S. C., Lazzara, E. H., Woodard, L. D., & Salas, E. (2021). Toward the development of the perfect medical team: critical components for adaptation. Journal of Patient Safety, 17(2), 70.	Narrative Review	Interprofessional Healthcare Teams	Teamwork training is a learning strategy for systematically acquiring teamwork competencies requisite to effective team performance that has been found to be positively associated with improved team performance, task performance, and reduced medical errors.30 It is essential not to consider team training as a one-stop effort; rather, periodic retraining and refresher training should be provided. Furthermore, organizational and frontline leaders should
24	Sebok-Syer, S. S., Shaw, J. M., Asghar, F., Panza, M., Syer, M. D., & Lingard, L. (2021). A scoping review of approaches for measuring 'interdependent' collaborative performances. Med Educ.	Scoping Review	Interprofessional Healthcare Teams	Medicine is practiced in teams and interdependent collaborations exist within those teams; therefore, we need valid and reliable measures of interdependence to accurately assess trainees' competence in associated domains and provide them with feedback about the collaborative, team-based care they provide to patients.

	Commentaries	
	Author	Main Ideas/Recommendations
1	Leenders, R. T. A. J., Contractor, N. S., & DeChurch, L. A. (2016). Once upon a time: Understanding team processes as relational event net-works. Organizational Psychology Review,6, 92–115	Analyzing team process as relational events allows researchers to hypothesize and test fine-grained theoretical mechanisms and, perhaps even more importantly, derive specific findings that can inform the further development of more explicit time-sensitive theories.
2	Clapp JT, Diraviam SP, Fleisher LA. The "stranger effect" — a look at interactions between consultants and care teams through the lens of social science. N Engl J Med Catalyst. 2017.	Due to the dearth of scholarship examining the quality of interactions between medical teams and physician consultants, we don't know what an ideal collaboration looks like and what situations call for what type of interaction. In some cases, would it be advantageous to limit the contribution of a consulting physician to the performance of well-practiced procedures like intubation or dialysis?
3	Fernandez R, Shah S, Rosenman ED, et al. Developing team cognition: a role for simulation. Simul Healthc 2017;12(2):96–103.	As with any scientific endeavor, we recommend that clinicians, educators, and simulation experts partner with experts in teamscience to develop robust approaches to simulation-based training that targets team cognition constructs.
4	Harris, K. R., Eccles, D. W., & Shatzer, J. H. (2017). Team deliberate practice in medicine and related domains: a consideration of the issues. Advances in Health Sciences Education : Theory and Practice TA - TT -, 22(1), 209-220.	Following this, the authors propose that effective team performance depends at least in part on team members having similar models of the situation, known as a shared situation model. The authors then propose guiding principles for implementing team deliberate practice in medicine and describe how team deliberate practice can be used in an attempt to reduce barriers inherent in medical teams to the development of shared situation models.
5	Cooper JB. Critical role of the surgeon-anesthesiologist relationship for patient safety. Anesthesiology. 2018;129:402e405	Surveys, focus groups, observational studies, the critical incident method, or deep ethnography all could be used to shed light on what are the issues that make the surgeon–anesthesiologist dyad highly functional or highly dysfunctional.
6	Uhlig PN, Doll J, Brandon K, et al. Interprofessional practice and education in clinical learning environments. Acad Med. 2018;93(10):1441-1444.	There are many frameworks7 and models, but for us, the essential element is a spirit of collaboration and shared learning among health professionals, patients, and family members.
7	Halamek, L.P.; Cady, R.; Sterling, M.R. Using briefing, simulation and debriefing to improve human and system performance. Semin. Perinatol. 2019, 43, 151178.	Briefing, simulation and debriefing have been used successfully in these fields to address human and system weaknesses and are proving beneficial in healthcare in general and neonatal-perinatal medicine in particular. Continued implementation and refinement will only enhance the safe care of these most vulnerable of patients
8	9.Hill, N. M., & Fisher, D. M. (2019). Reinforcing collaboration and teamwork: the role of team communication and training. ANZ JOURNAL OF SURGERY, 89(7-8), 957-961.	Both briefing and debriefing are formal tools we can use to improve teamwork and collaboration in the perioperative setting. Simulation and other team training workshops are an opportunity to practice these communication tool in a safe environment.
9	Hartley, B. R., & Elowitz, E. (2020). Barriers to the Enhancement of Effective Communication in Neurosurgery. WORLD NEUROSURGERY, 133, 466-473	Communication education may be better incorporated, and more impactful, with refresher workshops throughout training and also following residency, when the neurosurgeon is actually out in practice.
10	Hartley, B. R., & Elowitz, E. (2020). Future Directions in Communication in Neurosurgery. WORLD NEUROSURGERY, 133, 474-482	Important themes include standardizing all elements of communication, including protocols, procedures, and policies; formalized, comprehensive education and training in all aspects for all participants at all levels; designing hospital systems and tools with communication principles in mind; implementing multimodal approaches to streamlining communication; and addressing issues at various strata in the medical system.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	
Limitations	20	Discuss the limitations of the scoping review process.	
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

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Learning Practices deployed in training Experienced Healthcare Teams & Dyads in Acute Care Settings: A Scoping Review

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Title

Learning Practices deployed in training Experienced Healthcare Teams & Dyads in Acute Care Settings: A Scoping Review

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Abstract

Objectives

To map the evidence on learning practices currently utilized by experienced healthcare teams and dyads. The hypothesis is that through reviewing the literature we will identify the number and array of current learning practices. Through the lens of collaboration, the authors' goal is to map current practice to guide future research, policy, and practice.

Setting

The review included studies from North America, Europe, Australasia, and Asia. All studies were conducted in acute care settings such as operating rooms, emergency rooms, intensive care units and simulation centers.

Participants

The participants were experienced healthcare professionals who work in acute settings of any age or any sex. The group was interprofessional including two or more disciplines and/or professions. Characteristics of participants who were excluded were students, novices, healthcare professionals who work in non-acute care settings and single profession studies.

Primary and secondary outcome measures

Aligned to the protocol quantitative and qualitative analyses were conducted. Thematic analysis was used to evaluate and categorize study findings. Secondary outcome measures were the different types of learning practices used together to produce excellence.

Results

Most empirical studies were qualitative studies (46%), 31% were mixed methods and 23% were quantitative studies. There were also 24 reviews and 10 commentaries. The most frequent learning practices were structured observation and case scenarios (21%) followed by audio/video analysis and surveys (17%). Next was interviews and didactic presentations (12%) followed by prebriefing/debriefing and checklists (11%). Other learning practices accounted for less than 10%. Overall, 84 of the 86 publications, examined learning practices of teams larger than two participants.

Conclusions

While the quality of studies was high, and there was a broad range of empirical studies, reviews, and commentaries, there was no consensus on best practice in determining which learning practices to use and measurement of the effect of these practices.

Strengths and limitations of this study.

1. This review is comprehensive, including all study designs and grey literature from 2016 until June 30, 2021.
2. A detailed data extraction tool and a transparent, iterative team approach was employed.
3. The review is anchored in the established theories of distributed cognition, relational coordination, and cognitive load theory
4. The paucity and quality of literature addressing the learning practices of experienced healthcare dyads limited findings.

Key words: dyads, learning practices, experienced teams, acute settings, expert performance

Introduction

Rationale

Medical error in healthcare, particularly in acute care environments, remains a major cause of morbidity and mortality. The World Health Organization in 2019[1], reported that unsafe surgical care interventions cause complications in up to 25% of patients, resulting in 1 million deaths during or immediately after surgery annually. Cooper in 2018,[2] specifically suggests the collaboration between each surgeon–anesthesiologist dyad in the operating room, is perhaps the most critical element of overall operating room team performance. He says a well-functioning dyad is conducive to safe, effective care. Dysfunctional collaboration can promote unsafe conditions and contribute to an adverse outcome. Anecdotally, this appears to be true of teams and dominant dyads in other acute care settings such as the emergency room, labor and delivery, critical care, and pediatrics. The goal of this scoping review is to understand the learning practices, that experienced teams and currently dyads use in acute care settings. The definition of learning practices for the purpose of this review, is simply the activities that teams and dyads undertake to improve their team performance and develop and maintain their expertise. Finding the answer as to why there is not uniformity in exemplary performance may assist in averting medical errors and assist experienced larger teams and dyadic teams to function more

routinely, with excellence. This will achieve the objective of the review and provide recommendations to inform best practice in experienced healthcare team and dyad learning practices. As there were so few studies related to purely dyadic learning practices, we extended the review to include learning practices of larger experienced healthcare teams in acute care settings. We reviewed all studies where learning practices informed best practice by experienced healthcare teams, in clinical acute care settings, or simulated environments.

This review is limited to experienced healthcare teams only. Avgerinos et al, in 2017[3], says that the team's expert function is dependent on the operation of the least experienced dyad in the team. They call this dyad "a bottleneck pair" and suggest that in complex situations collaboration of these dyads dictate performance. The unit of analysis that we are interested in, is the dyad, not individuals, and so we are only investigating collaboration in experienced dyads and larger teams.

Figure 1 demonstrates cognitive frameworks to build high performance dyadic collaboration from poor to excellent performance. The framework represents the elements of distributed cognition and relational coordination that influence cognitive load in the dyad and in turn the level of performance in complex situations. Distributed cognition (DC) was first described by Hutchins in 1995 [4]. He realized that cognitive science until the mid 90's had taken the individual agent as its unit of analysis and that in most human pursuits, outcomes were the result of two or more experts interacting and usually with multiple technical devices as well. This concept grew and Hazlehurst in 2007 [5], performed a study in the operating room during the management of cardioplegia, where the surgeon and perfusionist's role is to coordinate activities during open heart surgery. This is a complex situation that requires each member of the dyad and the other team members to perform at their best. Using data from this distributed cognition study, Hazlehurst et al. agreed on six factors that promote robust team performance. These are (1) frequent direction, (2) status reporting, (3) alert reporting, (4) goal-sharing, (5) problem solving, and (6) frequent explanation. From the authors analysis of this empirical study, they were able to prove that when health care professionals practice these elements of performance in the clinical environment, their performance was better.

Relational Coordination (RC)[6] is a process whereby there is mutual reinforcement of communication and relating for the purpose of task integration. The concepts of shared goals, shared knowledge and mutual respect are deployed to achieve the highest work performance. This concept was first identified from a study of flight departures within the commercial aviation industry by Gittell 2001 and 2002 [7] [8]. Comparisons are often drawn between the generic competencies required in aviation and healthcare, and subsequent studies have been conducted in healthcare. [6, 9] Analyzing learning practices through the lenses of distributed cognition and relational coordination enables identification of strengths and weaknesses of dyad performance. This may be where deliberate practice [10] could be incorporated to address dyadic weaknesses. Deliberate practice is result of adaptation to extended and intense practice activities of weaknesses in performance. Cognitive load is typically seen as the load imposed on working memory by the task (intrinsic), irrelevant factors (extraneous) and the voluntary effort of learning (germane).[11] Cognitive load theory purposes to explain how the load it takes to process new information can affect the learner's ability to process that information and to embed the new knowledge in long-term memory. If the dyad is an expert team, they may have enough free working memory resources to address the increased load. If the dyad is inexperienced, and is confronted with a complex issue, the cognitive load may become too high, hampering learning and transfer. In order to promote learning and transfer, cognitive load is best managed in such a way that cognitive processing irrelevant to learning is minimized and cognitive processing germane to learning is optimized, always within the limits of available cognitive capacity [12]. Figure 2 demonstrates mapping the elements of distributed cognition with relational coordination and cognitive load theory and how cognitive load may be affected in complex situations. Highly complex tasks can best be performed by a team, because the intrinsic load of a complex task might be too high to be performed by one individual, but it can be performed by a (well-trained) team.[13]

Eduardo Salas in 2007 [14], defines an expert team as team members who are interdependent, each having expert-level knowledge, skills, and experience related to the task they are performing. These teams can also

adapt, coordinate, and cooperate as a team, and are able to produce sustainable and repeatable expert performance. The hypothesis is that these excellent teams are characterized by their ability to undertake activities to improve their team performance and develop their expertise.

Four authors of this review have worked in acute healthcare settings in large hospital systems for more than 20 years and have been involved in case review during that time. This group of four developed the data extraction tool and extracted the data. Case review casts a spotlight on cases where patient care has been suboptimal, and improvement is needed. It also illustrates cases where the patient care was excellent, and the healthcare team performed as an expert team. The authors agree that from reflecting on these case reviews, when there is a breakdown in collaboration, the failure is usually between two specific members of the healthcare team, the dominant dyad. We believe that by focusing on the collaboration in healthcare dyads, we may derive how expert dyads operate as opposed to weak ones and the learning practices experts use.

Out of the array of literature reviews available, (i.e., narrative, or traditional literature reviews, systematic or realist reviews), we chose a scoping review methodology to provide a clear understanding of the extent of research completed in this area including published and unpublished scripts. Scoping reviews also help us identify gaps in the literature. [15] We examined learning practices, that healthcare teams and dyads use to improve performance in healthcare teams [16]. In summary in this scoping review, we aimed to explore the breadth or extent of the literature, summarize the evidence, and inform future research [17], with the overarching objective of providing a 'map' of the available evidence on the range of learning practices. The authors considered it important to provide this evidence map to guide best practice in learning practices that expert teams and more specifically healthcare dyads or pairs deploy.

Collaboration in healthcare dyads is a complex phenomenon, and as shown in Figure 2 three theoretical perspectives have been selected, that are relevant to this problem: cognitive load [11], distributed cognition including shared mental models[5], and relational coordination theory. [6]

A deeper understanding of the three theories listed above, and how they interact and complement each other, may assist us to reflect on expert dyadic function. We reviewed this problem specifically in acute healthcare settings, and only manuscripts including expert, interprofessional, dyads and teams were examined. Student training, single discipline training and ambulatory care teams were not examined. A preliminary search of MEDLINE, the Cochrane Database of Systematic Reviews and *JBI Evidence Synthesis* was conducted and no current or underway systematic reviews or scoping reviews on the topic were identified.

[18] Sebok-Seyer et al [19] in 2021 published a scoping review on the approaches for measuring 'interdependent' collaborative performances and found a strong level of interdependence between dyads of trainees and their supervisors. Interdependence refers to the extent team members rely on each other for the functioning of the team. Although this was an interesting review of dyad performance, this scoping review focusses on expert dyadic team, not trainees.

Due to the limited research on the learning practices of experienced healthcare dyads, the scoping review was extended to include all teams rather than only the smallest team, the dyad.

Objectives

The overarching objective of this scoping review was to assess the extent of literature with respect to identifying and characterizing learning practices that experienced healthcare dyads and teams use in acute care settings to build excellent performance. The two main questions this scoping review aims to answer are: what are the learning practices that experienced healthcare dyads and teams use to optimize performance in acute settings, and how are the learning practices deployed?

Methods

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Protocol and Registration

Our protocol was drafted using the Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping review (PRISMA-ScR) tool.

Unlike a systematic review, scoping reviews do not tend to produce, and report results that have been synthesized from multiple evidence sources following a formal process of methodological appraisal to determine the quality of the evidence. Rather, scoping reviews aim to provide an overview or map of the evidence. As a result, an assessment of methodological limitations or risk of bias of the evidence was not performed. Systematic reviews normally inform the development of trustworthy guidelines and recommendations whereas scoping reviews provide an overview of the evidence or answer questions regarding the nature and diversity of the topic.

The final protocol was registered prospectively with the Open Science Framework on https://osf.io/.

The protocol, "*Optimizing expert dyad performance in acute care settings: a scoping review protocol"* was published in BMJ Open and can be found at http://dx.doi.org/10.1136/bmjopen-2020-047260

Eligibility criteria

Described below are the population, concept, context, and study designs eligibility criteria. The participants were experienced healthcare professionals who work in acute settings of any age or any sex. The group was interprofessional including two or more disciplines and/or professions. Characteristics of participants who were excluded were students, novice healthcare professionals who work in non-acute care settings and single profession studies. Novice is defined by Benner, 1982,[20] as a beginner with no experience. They are taught general rules to help perform tasks, and their rule-governed behavior is limited and inflexible. This would include healthcare professionals in their orientation phase post registration for at least the first six months.

The concept was learning practices that drive expert performance of experienced healthcare team and dyads with a focus on cognitive load, distributed cognition and relational coordination. This also

included learning practices that promote and inform future expertise. The exclusion criteria were learning practices for novices and students as well as individual psychomotor skill acquisition. The context includes all acute care settings in hospitals including the operating room, emergency room and critical care environments. Settings in all countries were included and there are no racial or gender-based exclusions. The exclusion criteria were all non-acute care settings including ambulatory care, behavioral health, and home care. Only manuscripts from January 2016 to June 30, 2021 were included and only those written in English were reviewed. Our rationale for reviewing manuscripts from the past 6 years was that the research in this area is continually evolving and the data would be more contemporary from this more recent timeline. (Manser, 2008).

Table 1 describes the inclusion and exclusion criteria.

Table 1. Inclusion & exclusion criteria.

Criterion	Inclusion	Exclusion
Date	2016-June 30, 2021	Before 2016 and after June 30, 2021
Exposure of interest	Healthcare teams/dyads analysis and learning practices	Individual learning practices/non-clinical teams
Language	English	All other languages
Participants	Experienced healthcare teams/dyads of registered health professionals	Exclude all single discipline student training and interprofessional student team training.
Peer review	Peer reviewed literature and non-peer reviewed	None
Objective measures	Measuring the number and type of learning practices experienced healthcare teams use.	None
Reported outcomes	Using objective measures, self-reported data	None
Setting	Acute care facilities	Ambulatory care, home care
Type of publication	Original studies, commentaries, reviews & editorials, position papers.	None

Information Sources

The databases we searched comprised Maastricht University Libsearch including PsycINFO, MEDLINE, Education Resources Information Center (ERIC) and Web of Science (WoS). Sources of unpublished studies/ gray literature were sourced using Google search. The references of all included manuscripts were searched, and the relevant articles included. The searches were conducted between 13 March 2020 and 4 July 2021.

Search

The text words contained in the titles and abstracts of relevant articles, and index terms were used. A full search strategy for the Educational Resources Information Center, ERIC database is presented in Table 2. The librarians at Maastricht University were advisors to the research team and played a key role in assisting the research team to refine the search terms.

The final search string was:

("healthcare dyad*" OR "healthcare team*" OR "medical team*" OR "operating room team*") AND ("Learn*" OR "practic*" OR "educat*" OR "communic*" OR "coordinat*" OR "perform*")

Table 2. Search strategy - Education Resources Information Center (ERIC)

#	SEARCHES	RESULTS
S1	("Operating room teams") AND ("performance")	0
S2	("Operating room teams") AND ("practice")	0
S3	("distributed cognition") AND ("team performance")	0
S4	("Operating room teams") AND ("learning")	0
S5	("Cognitive Load") AND ("dyad performance")	0
S6	"Health dyads" AND "Learning" or "Behavior"	0

S7	(“dyad” OR “surg* dyads” OR “health dyads” OR “surgery”) AND (“communicat*” OR “perform*” OR “coordinat*” OR “expect*” OR “practice*” OR “cognit*” OR “lead*”)	109
S8	(“surg* dyads”) AND (“communicat*” OR “perform*” OR “coordinat*” OR “expect*” OR “practice*” OR “cognit*” OR “lead*”)	4
S9	(“surgeon dyads” OR “health dyads” OR “medical dyads”) AND (“communicat*” OR “perform*” OR “coordinat*” OR “expect*” OR “practice*” OR “cognit*” OR “lead*”)	6
S10	(“expert healthcare dyad*” OR “expert healthcare team*” OR “expert medical team*” OR “expert operating room team*”) AND (Learn* OR practic* OR educat* OR “deliberate practice” OR communic* OR coordinat*) AND (performance)	1
S11	(“healthcare dyad*” OR “healthcare team*” OR “medical team*” OR “operating room team*”) AND (“Learn*” OR “practic*” OR “educat*” OR “communic*” OR “coordinat*” OR “perform*”)	11

Selection of sources of evidence.

In this study, we mapped the literature on learning practices to identify key concepts, gaps in practice, measurement, and optimization.

The authors acknowledge the importance of individual psychomotor skills practice and the role this plays in expertise, however, this research focused on rehearsals and practices experienced teams use to directly improve collaboration.

Following the search, all identified citations were collated and uploaded into *EndNote X9/June 2019 (Clarivate Analytics, PA, USA))* and duplicates removed. Any disagreements that arose between reviewers at each stage of the selection process were resolved through discussion with an additional reviewer. A random sample of 25 titles/abstracts were selected and reviewed by a team of four researchers. When 75% agreement was achieved on the citations/abstracts the team of four commenced screening. The final records/abstracts were determined. Two reviewers then reviewed all records/abstracts against the inclusion criteria and determined full text articles for inclusion and exclusion, with the reasons for exclusion clearly articulated. Any discrepancies were reviewed by a third independent researcher. The same process that was used for records/abstracts was

then used for the full text manuscripts. The justifications for exclusion of any full text articles were clearly stated. The final full text manuscripts were determined.

The results of the search and the study inclusion process was reported in full in a Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for scoping review (PRISMA-ScR) flow diagram (see Figure 3, Selection of Sources of Evidence Flow Chart) [21].

Our multidisciplinary research team included selected individuals, as researchers from interprofessional backgrounds including medical education researchers, nurses and physicians. Each person contributed to the determination on the sources to be either included or excluded, the development of the data extraction instrument and authorship of the manuscript. In selecting these individuals, it was important to consider availability and willingness to participate, and the ability to communicate experiences and opinions in an articulate, expressive, and reflective manner.

Areas of controversy were around whether a certain practice could be classified as a learning practice which led to finding the right definition to describe learning practices in the context of this study. Resolution of these disputes was key to the results of the review.

KW is interested in healthcare reform and decreasing error and has spent the past 20 years deploying simulation to inform new policy development. JvM and MA are Professors in Medical Education and have done research on expertise and expertise development. MM, KC and TY are specialist physicians and nurses who work in the simulation program at NYC Health + Hospitals, USA, developing and delivering simulation programs in response to, and to mitigate hospital system errors. JR is a professor in behavioral science and the Executive Director of the Center for Medical Simulation in Boston and a lifelong athlete. All authors have made substantive intellectual contributions to the development of this scoping review. We were very explicit about own individual perspectives and what they brought to the review throughout the course of the research. During this process our perspectives were both challenged and confirmed by our findings. Articles were highly variable in methods, populations studied, educational interventions, evaluative practices and results.

Data charting process

Data was extracted from manuscripts by four independent reviewers using a data extraction tool developed by the reviewers. The extraction instrument followed the JBI data extraction tool template with customization to answer the review objectives. The data extracted included specific details about the participants, concept, context, study methods and key findings relevant to the review question/s.

The reviewers independently charted the data, discussed the results and continuously updated the data charting form in an iterative process. Data from eligible studies were extracted using the data abstraction tool designed for this

study. The tool captured the relevant information on key study characteristics and detailed information on learning practices in acute care settings. Four reviewers independently charted the data from each eligible article using the survey monkey tool. Any disagreements were resolved through a virtual call discussion between two reviewers and further determination by a third reviewer.

Data items

We abstracted data on article characteristics (e.g., country of origin, year of publication), and contextual factors (e.g., acute care setting, number of participants, learning practices identified, research design), and how the learning practices were deployed. The draft data extraction tool was modified and revised as necessary during the process of extracting data from each included evidence source. (Appendix 1 Data Extraction Tool.) As the study synthesis progressed several elements were discarded, and new areas explored.

Synthesis of results

We grouped the studies by charting the learning practices deployed in each acute care setting. We summarized the empirical studies by type of settings, populations and study designs for each research study, including the number of healthcare professionals participating. We identified twenty-four reviews, including

systematic, narrative, and scoping reviews, that met our inclusion criteria. We also included ten commentaries in the review.

Patient and Public Involvement

We did not involve patients or the public in this scoping review, but rather plan to use the results to inform patients and the public with the view to designing new projects in which they will be involved.

Results

Selection of sources of evidence

After duplicates were removed, a total of 687 citations were identified from searches of electronic databases and references from the review articles. Based on the title and the abstract, 501 were excluded, with 186 full text articles

to be retrieved and assessed for eligibility. Of these, 100 were excluded for the following reasons: they were focused on team temporality, patient/healthcare team interaction, inter-country collaboration and delivering bad news which were all concepts not considered part of this review. Several were not set in acute care settings, and one was based on the oil industry. Some studies were on gaining individual expertise, student training and only included single discipline which did not meet inclusion criteria.

The remaining 86 studies were considered eligible for this review, acknowledging that 84 studies included teams that were larger than dyads. This was a major challenge for the hypothesis of this manuscript and shows that further research is needed on dyads. As most of the data comes from teams that were larger than two people, we are hoping that this review will set the stage for additional studies in this area.

Figure 3 is the selection of sources of evidence flow chart.

Characteristics of sources of evidence

Of the 86 manuscripts included in the synthesis, 52 were empirical studies from data base searches or reference reviews, 24 were various types of reviews and 10 were commentaries. For the empirical studies, each citation was characterized by year of publication, location of study by continent, type of setting, acute

care or simulation, the number of participants or cases in the study, the profession of participants, research design and learning practices identified. (**Appendix 2(a): Characteristics of Sources of Evidence- Empirical Studies.**) Review articles were characterized by the type of review, the population studied and the main ideas and recommendations from the study. **(Appendix 2(b): Characteristics of Sources of Evidence-Reviews.)** The recommendations or main ideas were the characteristics captured for commentaries. **(Appendix 2(c): Characteristics of Sources of Evidence- Commentaries)**

Results of Individual Sources of Evidence

Table 3 illustrates 15 different learning practices deployed by acute care setting or simulation center. Structured observation, case scenarios and surveys were the most used, while coaching, cognitive aides (other than checklists), serious games and online learning were least popular.

Table 3. Results of Individual Sources of Evidence

	SETTING									
	SIMULATION CENTER	OPERATING ROOM	EMERGENCY ROOM	INTENSIVE CARE UNIT	LABOR & DELIVERY	GENERAL MEDICAL UNIT	PEDIATRIC EMERGENCY ROOM	NEONATAL INTENSIVE CARE UNIT	*TOTAL*	
STRUCTURED OBSERVATION	1	10	2	3	0	0	1	1	*18*	21.24
CASE SCENARIOS	3	10	4	1	0	0	0	0	*18*	21.24
AUDIO/VIDEO ANALYSIS	2	7	2	2	0	0	0	1	*14*	16.52
PREBRIEFING/ DEBRIEFING	2	3	3	1	0	0	0	0	*9*	10.62
1:1 REFLEXIVE CONVERSATIONS	0	0	0	0	0	0	0	0	*0*	
COACHING	0	0	0	1	0	0	0	0	*1*	1.18
INTERVIEWS	0	8	0	1	0	0	0	1	*10*	11.8
PEER REVIEW & DISCUSSION	0	4	0	0	0	0	0	0		4.72
FOCUS GROUPS	2	0	0	0	0	0	0	0	*2*	2.36
CHECKLISTS	1	6	0	1	1	0	0	0	*9*	10.62
COGNITIVE AIDS	0	1	0	0	0	0	0	0	*1*	1.18
RATING SCALES	0	4	1	0	0	0	1	0	*6*	7.08
LEARNING BY DOING	0	0	0	0	0	0	0	0	*0*	

	EXPERIMENTATION /TRIAL & ERROR	0	0	0	0	0	0	0	0	*0*	
	SURVEYS	2	10	1	0	0	1	0	0	*14*	16.52
	SERIOUS GAMES	0	1	0	0	0	0	0	0	*1*	1.18
	DIDACTIC PRESENTATIONS	1	4	3	1	0	0	1	0	*10*	11.8
	WEB-BASED INFORMATION & SOCIAL MEDIA	0	0	0	0	0	0	0	0	*0*	
	ONLINE LEARNING	0	0	1	0	0	0	0	0	*1*	1.18
	JOURNAL CLUBS	0	0	0	0	0	0	0	0	*0*	

Synthesis of results

Eighty-six studies discussed learning practices of experienced healthcare teams in acute care settings and simulation centers. The majority were from North America (29), with 17 from Europe, 5 from Australasia and 1 from Asia. See Figure 4, manuscripts by location of study.

Most empirical studies were qualitative studies (46%), 31% were mixed methods and 23% were quantitative studies. See Figure 5. Manuscripts by Research design. There were also 24 reviews which included systematic, narrative, realist, and scoping reviews and 10 commentaries. The most frequent team-based learning practices were structured observation and case scenarios (21%) followed by audio/video analysis and surveys of unit clinical teams (17%). Next was unit staff reflective interviews and didactic presentations (12%) followed by Prebriefing/Debriefing and Checklists (11%). Rating scales accounted for 7%, peer review and discussion 5%, focus groups of unit clinical team participants 2% and finally online learning, serious games, cognitive aides and coaching 1%. Overall, 84 of the 86 publications selected, examined the learning practices of teams that were larger than two participants. While most manuscripts reported improved team behaviors from implementing suggested learning practices, none incorporated direct measures of dyad performance.

Of the quantitative studies, 50% were observational (non-experimental), 10% were surveys, 8% were prospective cohort studies and observational (experimental) studies, 4% were descriptive, cross-sectional,

questionnaires, pre/posttests, and randomized clinical trials. See Figure 6: Manuscripts by Research Design-Quantitative.

Of the qualitative studies, 30% were interviews, 25% were observational and grounded theory studies and 20% were ethnography. See figure 7: Manuscripts by Research Design – Qualitative.

Of the mixed methods studies, 75% were before and after studies, 13% were interviews and structured observation and 6% were observational and sequential studies. See Figure 8: Manuscripts by Research Design – Mixed Methods.

There were also 24 reviews which included systematic, narrative, realist, and scoping reviews and 10 commentaries.

A large majority of the research was conducted in the operating room (29), followed by 7 in the emergency room and 6 studies in simulation centers. Four studies were based in intensive care units, 3 in pediatric units, 2 in neonatal intensive care units and 1 each in labor and delivery and general medical units. See Figure 9, Manuscripts by Setting.

Discussion

Summary of evidence

We found that most manuscripts on teamwork in acute care settings were empirical studies that included structured observations, case studies and surveys. While the number of empirical articles was increasing year by year prior to the pandemic, the 52 studies do not yet rate the efficacy of one learning practice over another, demonstrate any consistency on when or how the practice is applied, or objectively measure the effect. This finding is concerning as apart from healthcare systems and hospitals spending thousands of dollars each year on teamwork training, we are unclear on the efficacy of that training. Many studies report on the use of simulation to deliver learning practices, but there is no determined best practice on how often or who should participate in the training. Some studies focused on training clinical leaders in units. More empirical research is needed, particularly research where collaboration is measured and its effect on team performance.

Fifteen learning practices were identified from the manuscripts we examined. More work is needed to map the identified learning practices to improvement in teamwork collaboration. Specifically, research to determine how to improve team and dyad collaborative expertise is needed, as the limited empirical work in this area indicates that reproducibility may be a weakness of current team training. While many of the publications we reviewed provided potential solutions (e.g., debriefing of structured observation and case scenarios) the lack of reproducibility might be solved with improved clarity of the measurement of team collaboration and in turn the measurement of team performance. One of the most important tasks in any field of study is to develop a shared nomenclature. It is only through a shared understanding of words that shared concepts can evolve into more focused ideas. When words are used imprecisely, generalizing results is more difficult. Many of the publications we reviewed, were not specific about the learning practices deployed and did not unearth a shared understanding of teamwork collaborative measurement and measurement of team performance. We can think of collaboration as the mediating variable and teamwork excellence as the dependent variable. More exploration is required to identify the constellation of learning practices that focus on collaboration.

Efforts were taken to ensure that the results of this scoping review would benefit the field. The methodology we used in this scoping review was rigorous, following evidence-based guidelines on how to effectively scope a field of literature. We solicited input from a wide range of stakeholders and sought input on early drafts.

We were interested in how identified learning practices can help develop excellent team and dyad performance, and if and how this can be explained by the three theoretical perspectives of distributed cognition, relational coordination, and cognitive load theory. We surmise that checklists and other types of cognitive aids can possibly help to decrease workload and so free up processing resources that can be used for improved relational coordination. Reviewed studies also show that prebriefings and debriefings might help dyads to develop a common understanding of the task through distributed cognition enabling a shared mental model and so improve coordination. There have also been learning practices identified that seem to be unrelated to the underpinning theories. These include practices such as the use of rating scales. We find this

particularly interesting as it suggests that additional theoretical perspectives are necessary in future research, e.g., rating scales might suggest that theories of (self-)assessment may also be important to understand how dyads develop into excellent teams.

In figure 2 we introduced the frameworks of distributed cognition, relational coordination, and cognitive load. We have interpreted our findings on learning practices in relation to the three theoretical frameworks in the following way. When considering the 15 learning practices identified, we found that elements of both distributed cognition and relational coordination could be addressed through clustering the learning practices into the 5 broader topic areas or constellations. These are (1) evaluate performance, (2) practice, (3) feedback, (4) utilize just-in-time aids and (5) study ideal examples. Evaluating performance would be achieved through structured observation, audio/video analysis and rating scales. Practice would employ case scenarios, with an emphasis on prebriefing and debriefing. Feedback would entail coaching, interviews, peer review, focus groups and surveys. Just-in-time aids refers to checklists and cognitive aids and finally, studying ideal examples could be demonstrated through serious games, online learning, and didactic presentations. Figure 10 demonstrates learning practice constellations in relation to collaborative frameworks.

Literature has supported that the application of cognitive load theory improves efficiency of learning [12]. Creative learning practices that consider cognitive load will optimize skill acquisition in dyadic collaboration. By shaping learning practices that break down the complexity of collaborative frameworks through the study of ideal examples and feedback (the intrinsic load, see learning practices 6-10 and 13-15 in figure 10), while managing to minimize the irrelevant information through just-in-time aids (the extraneous load, learning practices 11-12 in figure 10) and optimizing germane processing through practice and evaluating performance (learning practices 1-3 and 4-5), dyads may train more efficiently to achieve expert performance.

Limitations

There are limitations in our scoping review. To make our review more feasible, we extended the scope of the review to include larger teams as there were so few manuscripts on dyadic learning. Another limitation stemmed from using the dyad or duo as the unit of analysis, rather than the individual. There has been so little research conducted on what constitutes learning practices when the individual is not the unit of analysis. Further adding to this issue is how do we measure these learning practices and determine their suitability for developing and maintaining dyadic and team expertise rather than individual expertise.

Another potential limitation is how we created the search for our review. We didn't search on terms that may have provided a broader net such as "duos" or "pairs" and so we may have missed some relevant work in the initial searches. We did do a comprehensive snowball search on the references of all included manuscripts and this process unearthed more relevant studies. Regardless of these limitations, we think the review demonstrates a clear progression in the domain of team learning practices and casts a light on areas of weakness and areas needing further study. Furthermore, some may consider a scoping review as lacking in rigor as the results are simply mapped, not synthesized. In summary, this review clearly demonstrated the dearth of research on healthcare pairs or dyads and areas for further research.

Conclusions

The lack of evidence to support learning practices that promote expert performance of experienced teams and healthcare dyads in acute care settings poses a challenge to excellence in healthcare delivery and reduction of error. How do we develop expert teams and healthcare dyads when we don't understand the learning practices, that should be undertaken to achieve excellence? The aim of this scoping review was to identify gaps in the literature which may guide further research on excellent performance in teams and healthcare dyads. However, the lack of evidence found on dyadic learning practices means that we will need to turn to our expert dyadic teams and question them to understand how they became experts and the learning practices they participate in to guide future performance. Currently, evidence is insufficient to guide the nature of best

learning practice interventions. There is also limited evidence to describe how learning practices should be evaluated and rated to determine their efficacy. Examination of the underpinning frameworks of workload theories, distributed cognition and relational coordination may guide teams and dyadic units to increased collaboration and therefore guide best learning practices teams and dyads should undertake to achieve excellence. This advocates the need for high quality research to determine the learning practices teams and dyads should undertake, how these learning practices should be deployed and how performance can be measured. Further research questions may include what are the learning practices used by healthcare teams and dyads, which are most beneficial? How are these practices best deployed? Our review has identified five constellations of learning practices and maybe positive effects will mainly be realized by the integration of these constellations into medical education. For example, teams need to receive information on what is excellent performance (study ideal examples), practice in particular ways (also using simulation, role play), and receive feedback on their own performance (rating scales, video feedback etc.). If we want to reach positive effects, a combination of learning practices will probably be necessary.

Contributorship statement

KW developed the concept under supervision and advice from JM, MA and JR. KW developed the data extraction tool in consultation with MM, TY and KCT. JM, MA, and JR gave final approval of the tool. KW, MM, KCT and TY met regularly to discuss how the data may be extracted and then extracted the data from manuscripts that met inclusion criteria. JM, MA, JR, and KW met regularly to discuss analysis of results and manuscript review.

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Data sharing statement No additional data available.

Ethical Approval Not applicable/No human participants included

Patient consent for publication Not required.

Provenance and peer review Not commissioned, externally peer reviewed.

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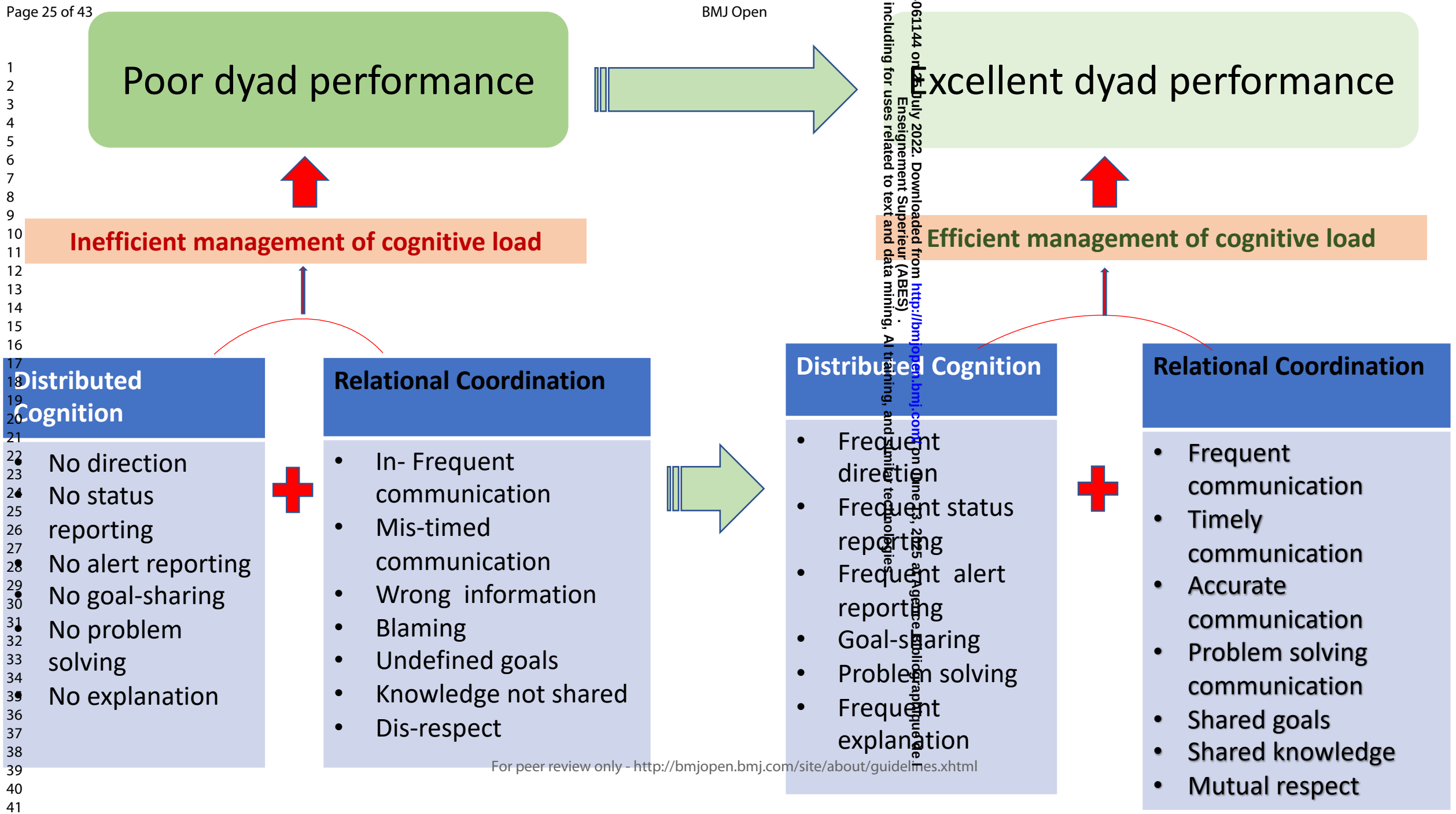
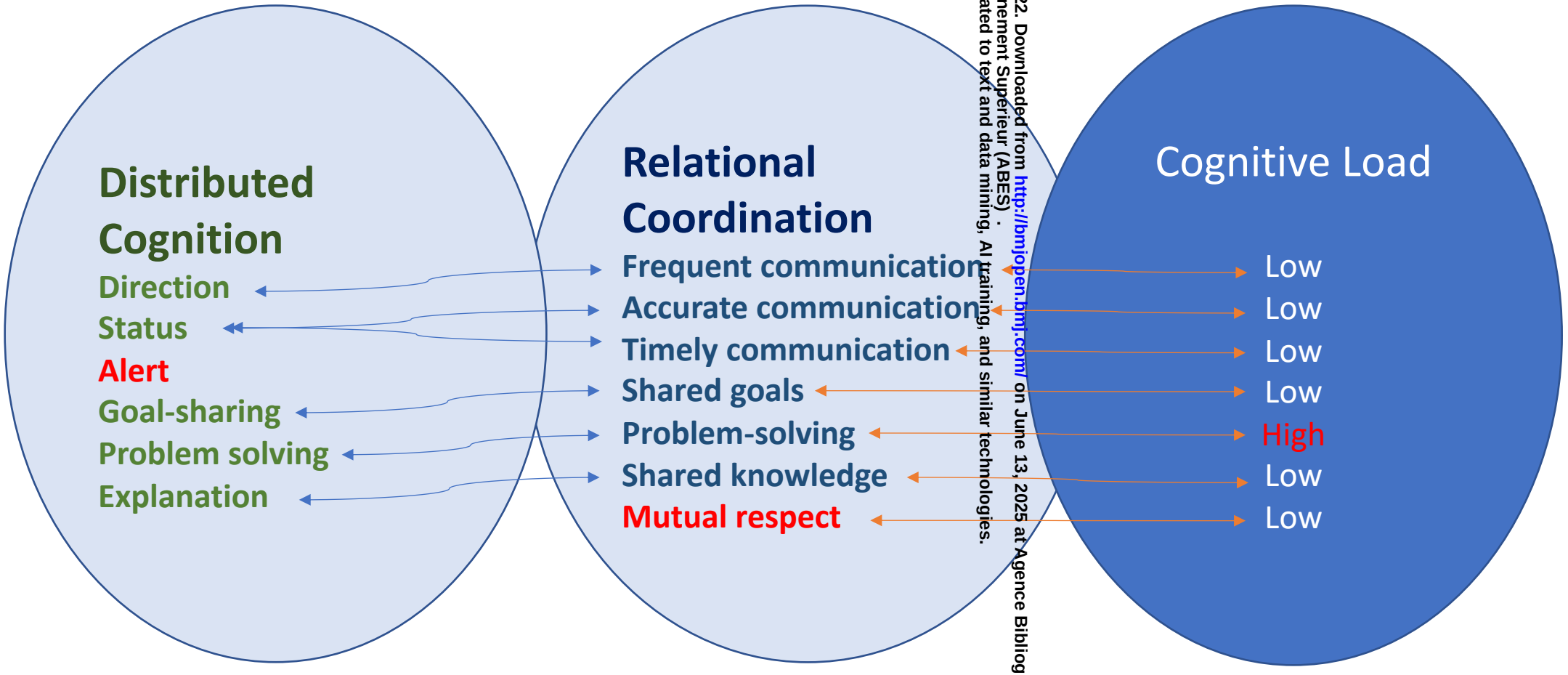
Figure Legend

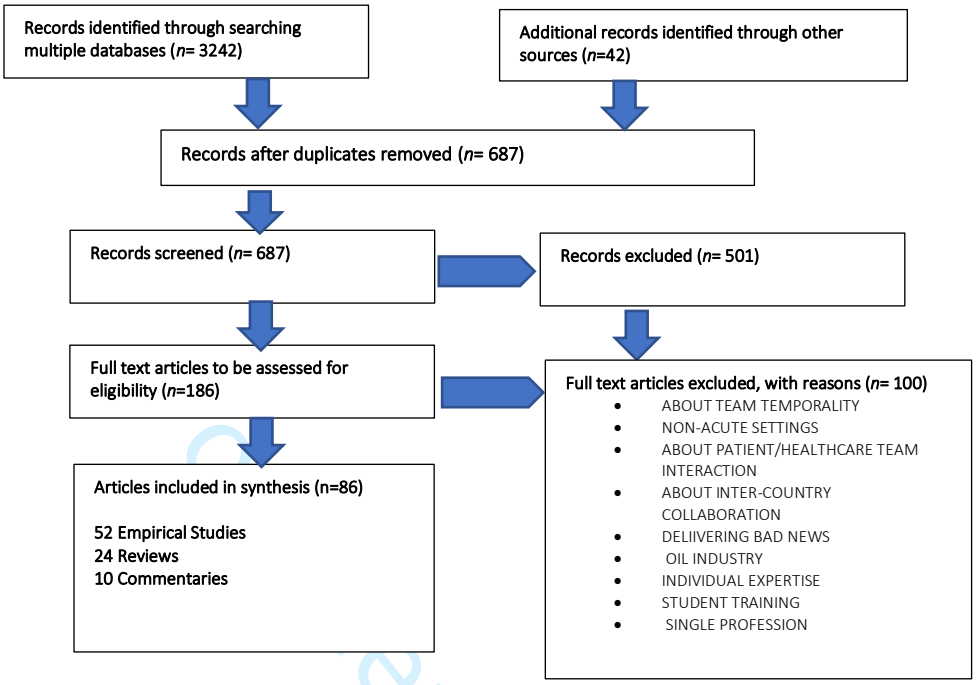
1. Figure 1. Cognitive frameworks to build high performance dyadic collaboration
2. Figure 2: Mapping the elements of distributed cognition with relational coordination and cognitive load theory
3. Figure 3. Selection of Sources of Evidence Flow Chart
4. Figure 4. Manuscripts by location of Study
5. Figure 5. Manuscripts by Research Design
6. Figure 6. Manuscripts by Research Design- Quantitative
7. Figure 7. Manuscripts by Research Design – Qualitative
8. Figure 8. Manuscripts by Research Design – Mixed Methods
9. Figure 9. Manuscripts by setting
10. Figure 10. Learning practice constellations in relation to collaborative frameworks

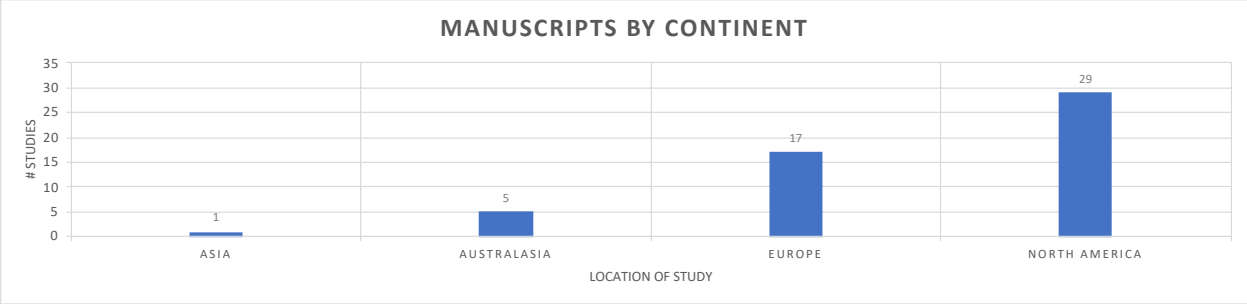
Appendix Legend

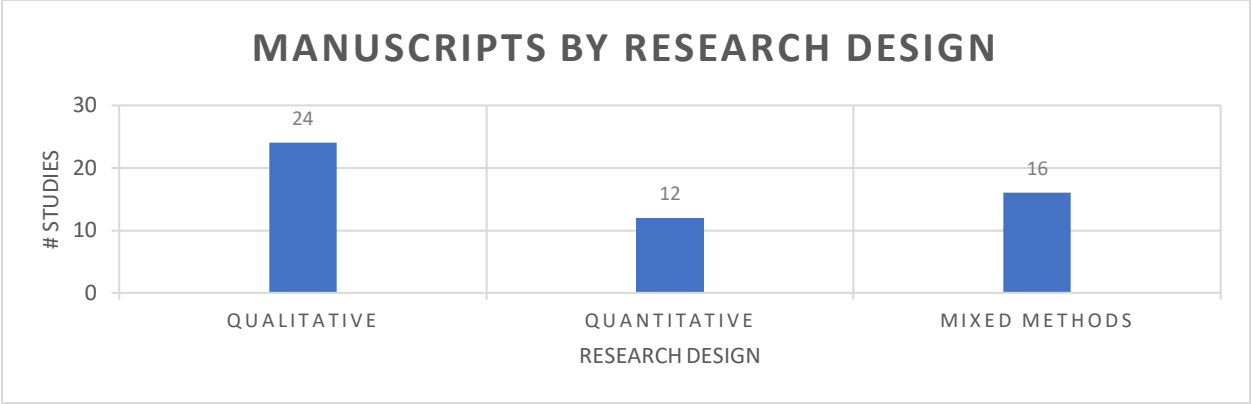
1. Appendix 1 Data Extraction tool
2. Appendix 2 (a) Characteristics of Sources of Evidence- Empirical Studies.
3. Appendix 2(b): Characteristics of Sources of Evidence-Reviews.
4. Appendix 2(c): Characteristics of Sources of Evidence- Commentaries.

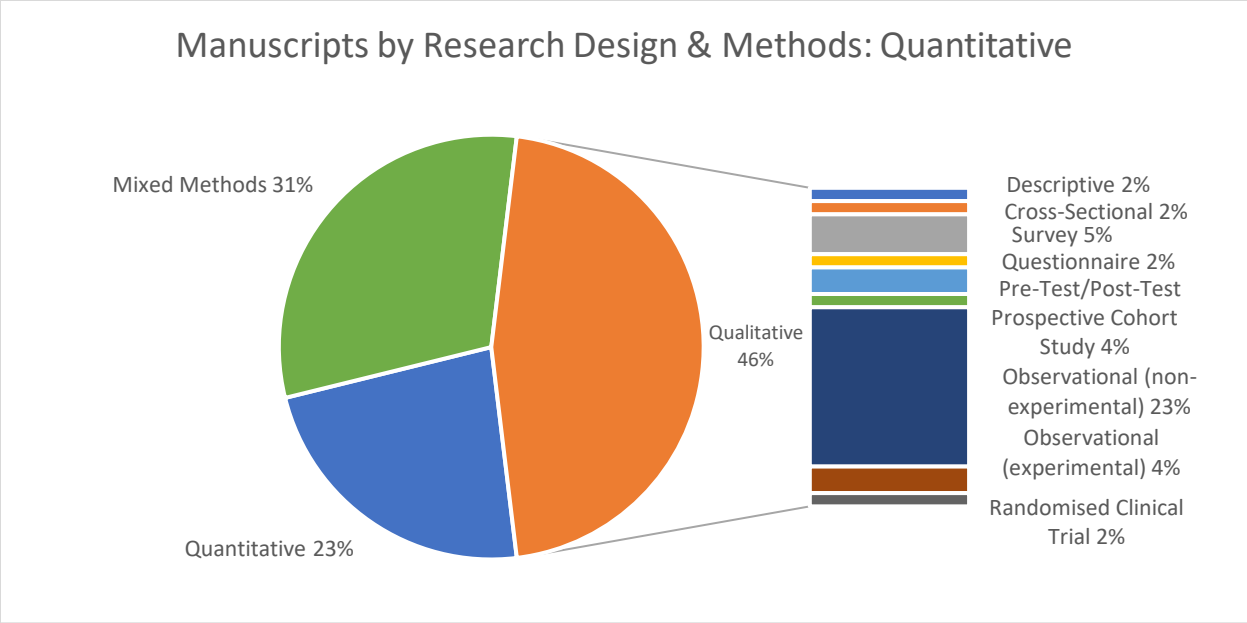


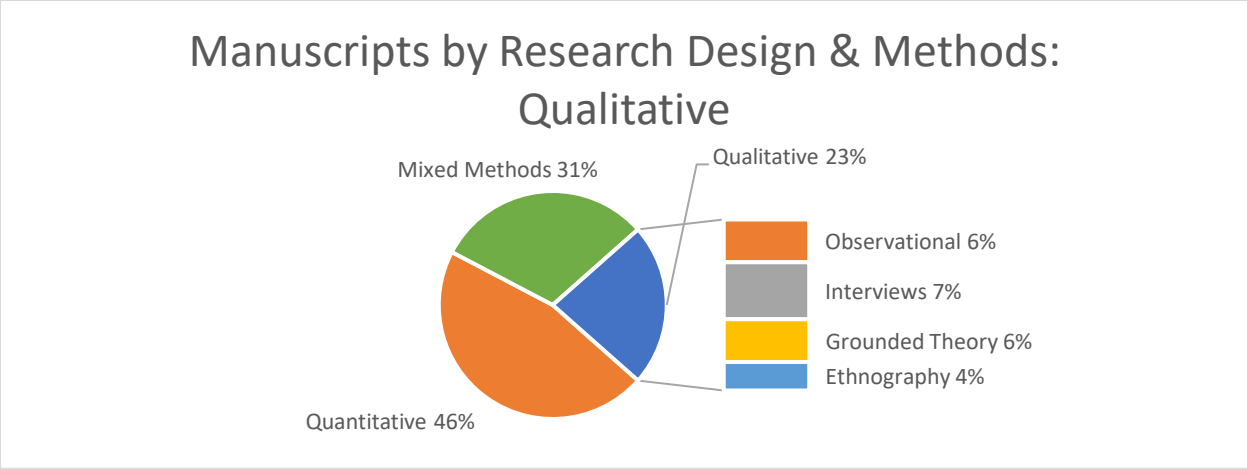


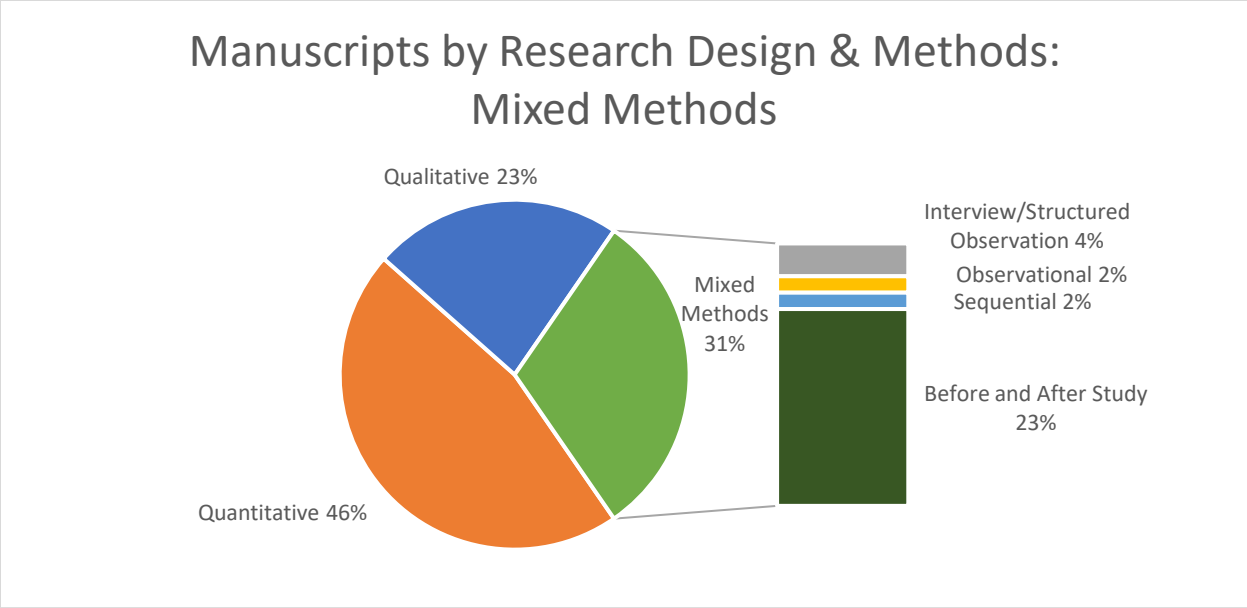


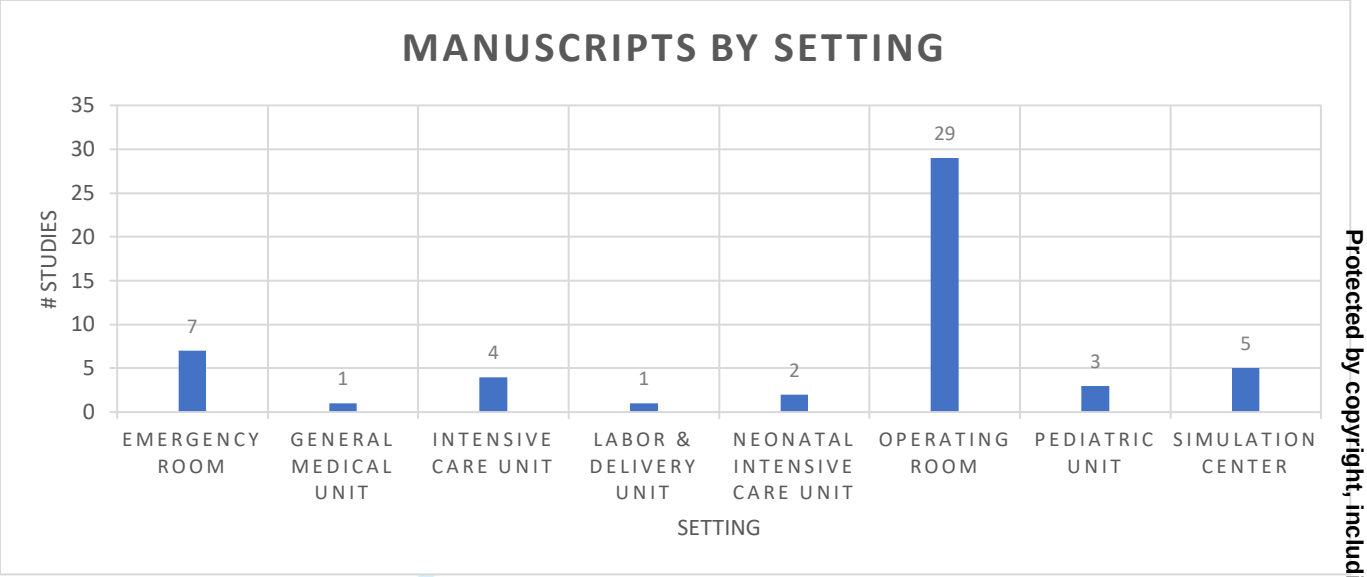


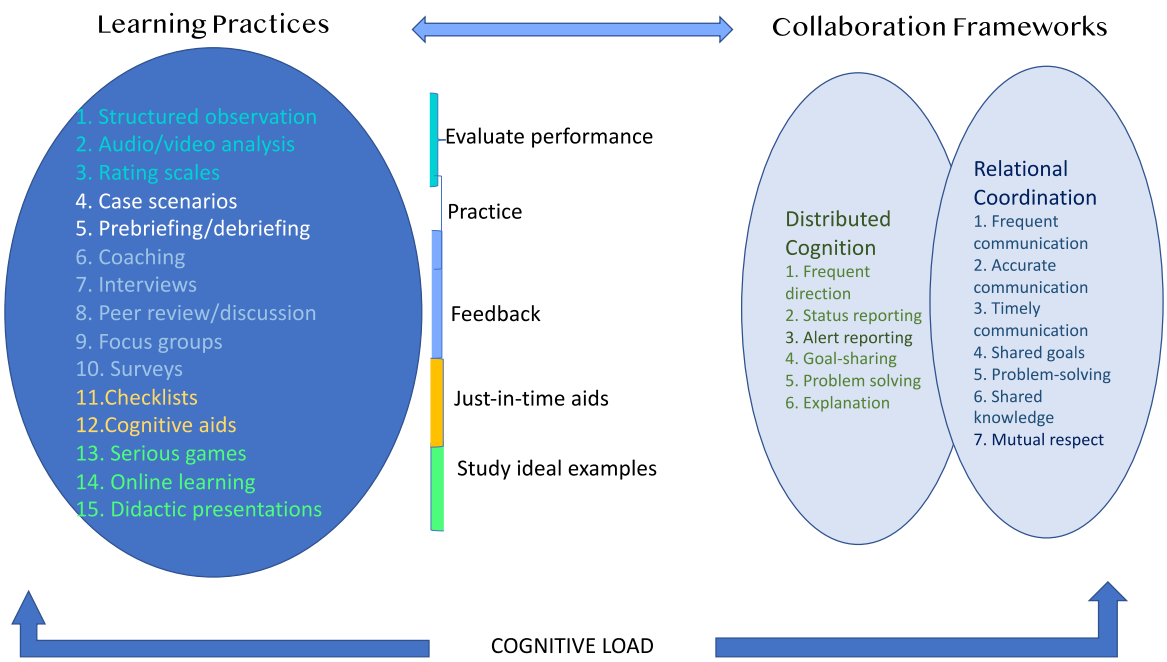












Appendix 1. Data Extraction Tool

Hidden Dynamics in Healthcare; Learning Practices that Optimize Expert Dyad Performance in Acute Care Settings: A Scoping Review 2016-2020

Scoping Review Details

- Name of Reviewer
- Date of Review

EVIDENCE SOURCE DETAILS & CHARACTERISTICS

1. Citation details: author/s, title, journal, volume, issue, pages
2. Year of publication
3. Location. (please fill in by looking at affiliation of first author)
4. What was the setting of the study?
5. Number of participants enrolled in study
6. What was the profession of the participants enrolled in the study?

DETAILS/RESULTS EXTRACTED FROM SOURCE OF EVIDENCE.

1. Which learning practices were identified?
2. How were learning practices conducted?
3. How was learning measured?
4. Was there a specific guide for future learning?
5. What was the research design?
6. Was there agreement or controversy from the authors about the efficacy of the learning practices?
7. Were specific learning practices suggested to optimize future learning?
8. Were there gaps identified to the uptake of effective learning practices?

	Article	Year of Publicatio	Location of Study	Setting : Acute Care	Number of Participants	Profession of Participants	Research Design	Learning Practices
1	Boyd, M., Cumin, D., Frampton, C., Merry, A., Webster, C., Weller, J., & Nakarada-Kordic, I. (2016). Assessing the similarity of mental models of operating room team members and implications for patient safety: a prospective, replicated study. *16* , 1-11.	2016	Australasia	Operating Room	120	Anesthesiologists, Surgeons, Nurses	Quant/Non-experimental/descriptive	Serious games
2	Cabral RA, Eggenberger T, Eller K, Gallison BS, Newman D. Use of a Surgical Safety Checklist to Improve Team Communication. AORN J 2016;104(3);206-216.	2016	North America	Operating Room	114	Surgeons, nurses, Surigcal technologists	Quant/non-experimental/ pre-test/post-test	Checklist
3	Conn LG, Haas B, Cuthbertson BH, Amaral AC, Coburn N, Nathens AB. Communication and culture in the surgical intensive care unit: boundary production and the improvement of patient care. Qual Health Res. 2016;26(7):895-906.	2016	North America	Intensive Care unit	43	Surgeons, Intensivists, Nurses	Qual/ethnography	Structured observation/interviews
4	Di Renna, T., Crooks, S., Pigford, A.-A., Clarkin, C., Fraser, A. B., Bunting, A. C., . . . Boet, S. (2016). Cognitive Aids for Role Definition (CARD) to improve interprofessional team crisis resource management: An exploratory study. *JOURNAL OF INTERPROFESSIONAL CARE, 30*(5), 582-590. 1179271	2016	North America	Operating Room	128	Anesthesiologists, Surgeons, Nurses	Mixed Methods - sequential	Use of cognitive aids
5	Duclos, A., Jl, P., Piriou, V., Occelli, P., Denis, A., Bourdy, S., . . . Group, I. S. (2016). Cluster randomized trial to evaluate the impact of team training on surgical outcomes. *The British journal of surgery TA - TT -, 103*(13), 1804-1814.	2016	Europe	Operating Room	Operating Room Teams from 31 hosptials	Anesthesiologists, Surgeons, Nurses & Quality Managers	Quant/Experimental /Randomized Clinical Trial	Case scenarios/ checklists
6	HärgestamM, HultinM, Brulin C, et al. Trauma team leaders' non-verbal communication: video registration during trauma team training. Scand JTrauma Resusc Emerg Med 2016;24:37.	2016	Europe	Emergency Room	18 Trauma Teams - 108 participants	Physicians, Nurses, Enrolled Nurses	Quant/non-experimental/ Observational	Structured Observation/Video analysis
7	Hilton, G., Daniels, K., Goldhaber-Fiebert, S., Lipman, S., Carvalho, B., & Butwick, A. (2016). Checklists and multidisciplinary team performance during simulated obstetric hemorrhage. International Journal of Obstetric Anesthesia, 25(1), 9–16 doi:10.1016/j.ijoa.2015.08.01	2016	North America	Labor and Delivery	140	Anesthesiologists, Obstetricians, Nurses, Surgical Technicians	Quant/non-experimental/ Observational	Checklists
8	Kemper PF, de Bruijne M, van Dyck C, So RL, Tangkau P, Wagner C. Crew resource management training in the intensive care unit. A multisite controlled before–after study. BMJ Qual Saf 2016; 25: 577–587.	2016	Europe	Intensive Care unit	474	ICU Physicians, Nurses, Managers	Mixed Methods - Before and after study	Didactic presentations/Structured observation/
9	Leenstra, N. F., Jung, O. C., Johnson, A., Wendt, K. W., & Tulleken, J. E. (2016). Taxonomy of Trauma Leadership Skills: A Framework for Leadership Training and Assessment. *ACADEMIC MEDICINE, 91*(2), 272-281.	2016	North America	Operating Room	207 procedures	Emergency physicians, Trauma surgeons, anesthesiologists Emergency nurses,	Qual/grounded theory	Interviews
10	Singer, S. J., Molina, G., Li, Z., Jiang, W., Nurudeen, S., Kite, J. G., . . . Berry, W. R. (2016. Relationship Between Operating Room Teamwork, Contextual Factors, and Safety Checklist Performance. *JOURNAL OF THE AMERICAN COLLEGE OF SURGEONS, 223*(4), 568-U557.	2016	Europe	Intensive Care Unit	2100	Nurses, physicians (medicine/peds/surgery).	Mixed Methods - Before and after study	Checklists/Structured Observation/Coaching
11	Tiferes J, Hussein AA, Bisantz A ed al. The Loud Surgeon Behind the Console: Understanding Team Activities During Robot-Assisted Surgery. J Surg Educ. 2016;73:504-512.	2016	North America	Operating Room	89	Surgeons, Physician Assistants, Nurses.	Quant/non-experimental/ Observational	Structured Observation
12	Weld LR, Stringer MT, Ebertowski JS, et al. TeamSTEPPS improves operating room efficiency and patient safety. Am J Med Qual. 2016;31:408–414.	2016	North America	Operating Room	1481 cases	Anesthesiologists, Nurse Anesthesiologists, Surgeons, Physician Assistants, Nurses.	Mixed Methods - Before and after study	Prebriefing and debriefing
13	Weller JM, Cumin D, Civil ID, et al. Improved scores for observed teamwork in the clinical environment following a multidisciplinaryoperating room simulation intervention. N Z Med J 2016;129:59–67	2016	Australasia	Simulation Center-University	120	Anesthesiologists, Surgeons, Nurses	Mixed Methods - Before and after study	Case scenarios
14	Weller J, Civil I, Torrie J, et al. Can team training make surgery safer? Lessons for national implementation of a simulation-based programme. N Z Med J 2016;129:9–17.	2016	Australasia	Operating Room	48	Anesthesiologists , Surgeons, Nurses, Anesthetic Techs	Qual/interviews	Interviews

15	Yu, D., Lowndes, B., Thiels, C. et al. Quantifying Intraoperative Workloads Across the Surgical Team Roles: Room for Better Balance?. World J Surg 40, 1565–1574 (2016). https://doi.org/10.1007/s00268-016-3449-6	2016	North America	Operating Room	192	physicians, nurses, Surgical Technicians	Quant/non-experimental/ Observational	Structured Observation
16	Avgerinos, E., & Gokpinar, B. (2017). Team Familiarity and Productivity in Cardiac Surgery Operations: The Effect of Dispersion, Bottlenecks, and Task Complexity. *19*, 19-35.	2017	North America	Emergency Room	112	Nurses, physicians, respiratory therapist, PCA, paramedic, social worker	Quant/non-experimental/ Observational	Structured Observation
17	Calder, L. A., Mastoras, G., Rahimpour, M., Sohmer, B., Weitzman, B., Cwinn, A. A., . . . Parush, A. (2017). Team communication patterns in emergency resuscitation: a mixed methods qualitative analysis. *International Journal of Emergency Medicine TA - TT -, 10*(1), 1-9.	2017	North America	Operating Room	not known	physicians, nurses, Surgical Technicians	Mixed Methods Observational	Interviews/Case scenarios/Structured Observation
18	Carpenter, J. E. (2017). Medical Team Training Improves Team Performance LK - https://maastrichtuniversity.on.worldcat.org/oclc/7160490186. *journal of bone and joint surgery.American volume TA - TT -, 99*(18), 1604-1610.	2017	North America	Operating Room	55	Anesthesiologists, Surgeons, Nurses	Mixed Methods - Before and after study	Debriefing/case scenario/Structured observation
19	Cavuoto, L. A., Hussein, A. A., Vasan, V., Ahmed, Y., Durrani, A., Khan, S., . . . Guru, K. A. (2017). Improving Teamwork: Evaluating Workload of Surgical Team During Robot-assisted Surgery. *UROLOGY, 107*, 120-125.	2017	Europe	Simulated Operating Room	120	Anesthesiologists, Surgeons, Nurses	Quant/non-experimental/ Questionnaire	Survey
20	Cumin, D., Skilton, C., & Weller, J. (2017). Information transfer in multidisciplinary operating room teams: a simulation-based observational study. *BMJ QUALITY & SAFETY, 26*(3), 209-216.	2017	North America	Simulated Operating Room	34/42	Anesthesiologists, Surgeons, Nurses	Quant/non-experimental/ Observational	case scenarios/video analysis
21	D'Agostino, T. A., Bialer, P. A., Walters, C. B., Killen, A. R., Sigurdsson, H. O., & Parker, P. A. (2017). A Communication Training Program to Encourage Speaking-Up Behavior in Surgical Oncology. *AORN Journal TA - TT -, 106*(4), 295-305.	2017	North America	Simulated Operating Room	26	Anesthesiologists, Surgeons	Mixed Methods - Before and after study	Case Scenarios/ didactic training/ focus groups/debriefing
22	Doumouras, A. G., Hamidi, M., Lung, K., Tarola, C. L., Tsao, M. W., Scott, J. W., . . . Yule, S. (2017). Non-technical skills of surgeons and anaesthetists in simulated operating theatre crises. *British Journal of Surgery TA - TT -, 104*(8), 1028-1036.	2017	Europe	Operating Room	150	Anesthesiologists, Surgeons, Nurses	Qual/observational	Case Scenarios/ Rating Scale
23	Erestam, S., Haglind, E., Bock, D., Andersson, A. E., & Angenete, E. (2017). Changes in safety climate and teamwork in the operating room after implementation of a revised WHO checklist: a prospective interventional study. *PATIENT SAFETY IN SURGERY, 11*.	2017	Australasia	Operating Room	99	Anesthesiologists, Surgeons, Nurses	Quant/non-experimental/ Observational	Checklists/Structured Observation/Didactic/ Survey
24	Frasier LL, Pavuluri Quamme SR, Becker A, et al. Investigating teamwork in the operating room: engaging stakeholders and setting the agenda. JAMA Surg. 2017;152:109e111.	2017	North America	Operating Room	23	Anesthesiologists, Surgeons, Nurses, Surgery Residents, Operating Room Technicians, Anesthetist Technicians	Qual/grounded theory	Focus groups/audio recording.
25	Gillespie, B. M., Steel, C., Kang, E., Harbeck, E., Nikolic, K., Fairweather, N., & Chaboyer, W. (2017). Evaluation of a Brief Team Training Intervention in Surgery: A Mixed-Methods Study. *AORN Journal TA - TT -, 106*(6), 513-522.	2017	Asia	Operating Room	217	Anesthesiologists, Surgeons, Nurses, Surgery Residents, Operating Room Technicians, Anesthetist Technicians	Mixed Methods - Before and after study	survey/Structured observation/interviews/ checklists
26	McComb SA, Lemaster M, Henneman EA, Hinchey KT (2017) An evaluation of shared mental models and mutual trust on general medical units: implications for collaboration, teamwork, and patientsafety. J Patient Saf 13(4):237–242	2017	North America	General Medical Units	79	Physicians, Nurses,	Quant/non-experimental/ survey	Survey
27	Mousavi, E., Aarabi, A., Mojdeh, S., & Mehraban, M. A. (2017). HEALTHCARE PROVIDERS ATTITUDE REGARDING EFFECTIVENES OF HEALTHCARE TEAM IN OPERATING ROOM. *PHARMACOPHORE, 8*(6, S).	2017	Europe	Emergency Room	29	Surgeons, Emergency physicians , Nurses,	Quant/non-experimental/ survey	Survey
28	Raley, J., Meenakshi, R., Dent, D., Willis, R., Lawson, K., & Duzinski, S. (2017). The Role of Communication During Trauma Activations: Investigating the Need for Team and Leader Communication Training. *JOURNAL OF SURGICAL EDUCATION, 74*(1), 173-179.	2017	North America	Operating Room	226	Surgeons, Nurses	Quant/non-experimental/ Observational	Survey/Structured observation/Rating scales
29	Siems A, Cartron A, Watson A, McCarter R, Levin A. Improving pediatric rapid response team performance through crew resource management training of team leaders. Hosp Pediatr 2017; 7: 88–95	2017	North America	Pediatric Unit	37 cases	Physicians, Nurses, Nurse Practicitioners Respiratory Therapist	Mixed Methods - Before and after study	Didactic presentations/Structured observation/Rating Scale

30	Bui, A. H., Guerrier, S., Feldman, D. L., Kischak, P., Mudiraj, S., Somerville, D., . . . Leitman, I. M. (2018). Is video observation as effective as live observation in improving teamwork in the operating room? *Surgery, 163* (6), 1191-1196.	2018	North America	Operating Room	N/A	Anesthesiologists, Surgeons	Quant/experimental/ Observational	Structured Observation/Video analysis/Feedback
31	Esce, A., Rodeberg, D. A., Rothstein, D. H., Browne, M., & Wakeman, D. D. o. S. L. V. M. C. A. P. (2018). Prevalence and Perceptions of Team Training Programs for Pediatric Surgeons and Anesthesiologists. *JOURNAL OF SURGICAL RESEARCH, 232* , 559-563.	2018	Europe	Operating Room	N/A	Surgeons, Physician Assistants, Nurses, OR Techs	Quant/non-experimental/ survey	Survey
32	Haerkens MH, Kox M, Noe PM, Van DHJ, Pickkers P. Crew Resource Management in the trauma room: a prospective 3-year cohort study. Eur J Emerg Med 2018	2018	Europe	Emergency Room	80	Anesthesiologists, Nurses , ED Physician	Quant/non-experimental/ prospective cohort study	Rating Scale/case studies/video review/didactic
33	Heath, C., Luff, P., Sanchez-Svensson, M., & Nicholls, M. (2018). Exchanging implements: the micro-materialities of multidisciplinary work in the operating theatre. *Sociology of Health & Illness, 40* (2), 297-313.	2018	North America	Operating Room	9	Surgeons, Physician Assistants, Nurses.	Qual/grounded theory	Video-analysis/peer discussion
34	Raheem, S., Ahmed, Y. E., Hussein, A. A., Johnson, A., Cavuoto, L., May, P., . . . Guru, K. A. (2018). Variability and interpretation of communication taxonomy during robot-assisted surgery: do we all speak the same language? *BJU International, 122* (1), 99-105.	2018	Europe	Pediatrics	281	Nurses, Physician Assistants	Quant/non-experimental/ Observational	Video-analysis/peer discussion
35	Schmutz, J. B., Lei, Z., Eppich, W. J., & Manser, T. (2018). Reflection in the heat of the moment: The role of in-action team reflexivity in health care emergency teams. *Journal of Organizational Behavior, 39* (6), 749-765.	2018	North America	Operating Room	50	Surgeons, Nurses	Quant/non-experimental/ Observational	case scenarios/video analysis
36	Sharma, K., Morgan, A. L., Mackinnon, S. E., & Stroud, J. (2018). The Whiteboard Technique: Personalized Communication to Improve Operating Room Teamwork. *ANNALS OF SURGERY, 268* (2), 225-227.	2018	Europe	Simulation Center-University	3	Anesthesiologists, Nurses , ED Physician	Quant/experimental/ Observational	Checklists/Structured Observation/ Survey
37	Tisserand, L. (2018). High Fidelity Simulation: From Simulation to Debrief, Assessing Leadership and Followership Management. *Hacettepe Universitesi Egitim Fakultesi Dergisi-Hacettepe University Journal of Education, 33* , 134-155.	2018	Europe	Emergency Room	70	Nurses, ED attendings and medicine residents	Qual/observational	Didactic presentations/Case scenario /debriefing
38	Truta, T. S., Boeriu, C. M., Copotoiu, S. M., Petrisor, M., Turucz, E., Vatau, D., & Lazarovici, M. (2018). Improving nontechnical skills of an interprofessional emergency medical team through a one day crisis resource management training. *MEDICINE, 97* (32), e11828.	2018	Europe	Emergency Room	70	Nurses, ED attendings and medicine residents	Quant/non-experimental/ Observational	Didactic presentations/Case scenario /debriefing
39	Truta, T. S., Boeriu, C. M., Lazarovici, M., Ban, I., Petrisor, M., & Copotoiu, S. M. (2018). Improving Clinical Performance of an Interprofessional Emergency Medical Team through a One-day Crisis Resource Management Training. *Journal of Critical Care Medicine, 4* (4), 126-136.	2018	Europe	Operating Room	1396	Anesthesiologists , Surgeons, Nurses, Anesthetic Techs	Mixed Methods - Before and after study	Didactic presentations/Case scenario /debriefing/rating scale
40	Widmer, L. W., Keller, S., Tschan, F., Semmer, N. K., Holzer, E., Candinas, D., & Beldi, G. (2018). More Than Talking About the Weekend: Content of Case-Irrelevant Communication Within the OR Team. *World Journal of Surgery : Official Journal of the International Society of Surgery/Société Internationale de Chirurgie, 42* (7), 2011-2017	2018	Europe	Pediatric Unit	96	Pediatric Nurses, Pediatric Residents, Pediatric Physicians	Quant/non-experimental/ Observational	Structured Observation
41	Coolen, E., Draaisma, J., & Loeffen, J. (2019). Measuring situation awareness and team effectiveness in pediatric acute care by using the situation global assessment technique. *EUROPEAN JOURNAL OF PEDIATRICS, 178* (6), 837-850.	2019	North America	Operating Room	9	Anesthesiologists, Surgeons, perfusionist	Mixed Methods - Before and after study	Rating Scale/case scenario
42	Dias, R. D., Zenati, M. A., Conboy, H. M., Clarke, L. A., Osterweil, L. J., Avrunin, G. S., & Yule, S. J. (2019). Dissecting Cardiac Surgery: A Video-Based Recall Protocol to Elucidate Team Cognitive Processes in the Operating Room. *ANNALS OF SURGERY*.	2019	North America	Operating Room	60	Anesthesiologists , Surgeons, Nurse Practitioners	Mixed Methods-interviews/structured observation	structured observation /Interviews
43	Frasier, L. L., Pavuluri Quamme, S. R., Ma, Y., Wiegmann, D., Leverson, G., DuGoff, E. H., & Greenberg, C. C. D. o. P. H. U. o. W.-M. M. W. (2019). Familiarity and Communication in the Operating Room. *JOURNAL OF SURGICAL RESEARCH, 235* , 395-403.	2019	Europe	Operating Room	15	Surgeons, Nurses	Mixed Methods-interviews/structured observation	Audio-video analysis/interviews/surveys
44	Grade MM, Tamboli MK, Bereknyei Merrell S, Mueller C, Girod S. Attending surgeons differ from other team members in their perceptions of operating room communication. J Surg Res. 2019;235:105e112.	2019	North America	Operating Room	54	Anesthesiologists , Surgeons, Nurses, Surgical Technicians	Qual/interviews	Interviews/ peer discussion

45	Henaux, P.-L., Michinov, E., Rochat, J., Hémon, B., Jannin, P., & Riffaud, L. (2019). Relationships Between Expertise, Crew Familiarity and Surgical Workflow Disruptions: An Observational Study. *World Journal of Surgery : Official Journal of the International Society of Surgery/Société Internationale de Chirurgie, 43*(2), 431-438.	2019	North America	Intensive care, Neonatal intensive care unit	50	Nurse Practitioners, Nurses, Neonatologists	Qual/observational	Audio-video analysis
46	Salih, Z. N. I., & Draucker, C. B. (2019). Facilitators of and barriers to successful teamwork during resuscitations in a neonatal intensive care unit. *Journal of Perinatology, 39*(7), 974-982.	2019	North America	Intensive Care Unit	35	Nurses, Nurse Practitioners, Therapists, Physician Assistants, ICU Physician, Nephrologist	Qual/interviews	Case Scenarios/debriefing/audio-video recording
47	Clapp, J. T., Diraviam, S. P., Lane-Fall, M. B., Szymczak, J. E., Muralidharan, M., Chung, J. J., . . . Fleisher, L. A. (2020). Nephrology in the Academic Intensive Care Unit: A Qualitative Study of Interdisciplinary Collaboration. *AMERICAN JOURNAL OF KIDNEY DISEASES, 75*(1), 61-71.	2020	North America	Neonatal Intensive Care	65	Nurses, Therapists, Neonatologists	Qual/ethnography	structured observation /Interviews
48	Eckels, M., Zeilinger, T., Lee, H. C., Bergin, J., Halamek, L. P., Yamada, N., . . . Quinn, J. (2020). A Neonatal Intensive Care Unit's Experience with Implementing an In-Situ Simulation and Debriefing Patient Safety Program in the Setting of a Quality Improvement Collaborative. *Children-Basel, 7*(11).	2020	North America	Emergency Room	60	Surgeons, Emergency physicians	Mixed Methods - Before and after study	Case Scenarios/debriefing/online learning
49	Hall, C., Robertson, D., Rolfe, M., Pascoe, S., Passey, M. E., & Pit, S. W. (2020). Do cognitive aids reduce error rates in resuscitation team performance? Trial of emergency medicine protocols in simulation training (TEMPIST) in Australia. Human resources for health, 18(1). doi:10.1186/s12960-019-0441-x	2020	North America	Operating Room	22	Anesthesiologists, Surgeons, Nurses	Mixed Methods - Before and after study	Case scenarios/ checklists/video-analysis/survey
50	Shi, R., Marin-Nevarez, P., Hasty, B., Roman-Micek, T., Hirx, S., Anderson, T., . . . Lau, J. N. (2020). Operating Room In Situ Interprofessional Simulation for Improving Communication and Teamwork. *The Journal of surgical research, 260*, 237-244. doi:10	2020	Australasia	Operating Room	3800	Anesthesiologists , Surgeons, Nurses, Anesthetic Techs	Qual/interviews	Interviews/survey
51	Jonsson, K., Hultin, M., Hargestam, M., Lindkvist, M., & Brulin, C. (2021). Factors Influencing Team and Task Performance in Intensive Care Teams in a Simulated Scenario. *Simul Healthc, 16*(1), 29-36.	2021	Europe	Operating Room	45	Anesthesiologists, Surgeons, perfusionist	Quant/non-experimental/cross-sectional	Survey/Case scenarios/video-analysis
52	Ridley, C. H., Al-Hammadi, N., Maniar, H. S., Ben Abdallah, A., Steinberg, A., Bollini, M. L., . . . Avidan, M. S. (2021). Building a Collaborative Culture: Focus on Psychological Safety and Error Reporting. *Ann Thorac Surg, 111*(2), 683-689.	2021	North America	Operating Room	73	Anesthesiologists , Surgeons, Nurses, Anesthetic Techs	Quant/non-experimental/ prospective cohort study	Survey/didactic learning

	Reviews			
	Author	Article type	Population	Main Ideas/Recommendations
1	1.Eddy K, Jordan Z, Stephenson M. Health professionals' experience of teamwork education in acute hospital settings: a systematic review of qualitative literature. JBI Database System Rev Implement Rep 2016;14(4):96–137.	Systematic Review	Interprofessional Healthcare Teams	1. All members of a team should be encouraged by their managers to partiipate in teamwork education in order to foster a positive culture of teamwork 2. Facilitators of teamwork education should understand how successful teams function and consider these factors 3. Facilitators of teamwork education should explore participant learning needs and experience level 4. Facilitators of teamwork education should provide learning opportunites that are practical, authentic and foster constructive debriefing and reflection 5. High fidelity simulation should be considered for the training of teamwork skills 6. Managers should harness the new confidence and motivation of staff and ensure opportunities to apply new skills into daily practice.
2	Ford, M. Menchine, E. Burner, S. Arora, K. Inaba, D. Demetriades, B. Yersin, Leadership and teamwork in trauma and resuscitation, West. J. Emerg. Med. 17 (5) (2016) 549e556.Ford	Narrative Review	Interprofessional Healthcare teams- Trauma	Future efforts should focus on better defining, teaching, and assessing leadership and trauma team organization and definitively equating improvements in processes of care with improved patient outcomes
3	Gjeraa, K., Spanager, L., Konge, L., Petersen, R. H., & Østergaard, D. (2016). Non-technical skills in minimally invasive surgery teams: a systematic review. Surgical Endoscopy : And Other Interventional Techniques 30(12), 5185-5199.	Systematic Review	Minimally Invasive Surgery (MIS) Teams	1. Non-Technical Skills (NTS) of MIS Teams imrpove workflow and prevent errors. 2. Working in fixed team improves workplace climate. 3. Communication in MIS Teams related much more to equipment and patient related topics than open surgery. 4. Future studies should focus on identifying which NTS skills are most important from the perspective of the whole team. 5. Training for NTS should include simulation, debriefing and followup in the clinical setting
4	Hughes AM, Gregory ME, Joseph DL, et al. Saving lives: a meta-analysis of team training in healthcare. J Appl Psychol 2016;101:1266–304.	Meta-analysis Review	Interprofessional Healthcare Teams	Participation in healthcare team training promotes learning which in turn induces training on the job, which improves results. Team training is effective across various team compositions. Recommendation for health practitioners to implement team training
5	Husebø, S. E., & Akerjordet, K. (2016). Quantitative systematic review of multi-professional teamwork and leadership training to optimize patient outcomes in acute hospital settings. Journal of Advanced Nursing TA - TT -, 72(12), 2980-3000. doi:10.1111/jan.13035 LK	Quantatative Systematic Review	Interprofessional Healthcare Teams	Training program interventions provide healthcare personnel with the opportunity to practice teamwork and leadership skills that can have an impact on patient safety, safety culture and patient outcomes.Managers should recognize that building a safety culture adjacent to implementing teamwork and leadership training interventions is essential. Further research to strengthen design, methodology and descriptions of interventions is required
6	Shams, A., Ahmed, M., Scalzitti, N. J., Stringer, M., Howard, N. S., & Maturo, S. (2016). How Does TeamSTEPPS Affect Operating Room Efficiency? OTOLARYNGOLOGY-HEAD AND NECK SURGERY, 154(2), 355-358.	Retrospective database review.	Interprofessional Healthcare Teams - Surgery	Although Team Steps is a highly acclaimed evidence-based method improving patient safety and teamwork, more study is needed to determine if it can decrease sentinel events and other preventable medical errors.
7	Lucas A, Edwards M. Development of crisis resource management skills: a literature review. Clin Simul Nurs 2017;13(8):347–358	Narrative Review	Interprofessional Healthcare Teams	Future studies comparing and correlating the achievement of targeted outcomes to the use of validated or unvalidated evaluation methods may illustrate gaps in study design and further guide tool selection for future educators. Other implications for future research may include a focus on evaluating performance of CRM behaviours inactual clinical areas. For this to be possible, a focus on teaching CRM concepts to a broader audience, making it part of health care culture in a way that is similar to aviation culture, is needed. Simulation education would need to be a standard in crisis education for all disciplines, along with an emphasis on team
8	Paradis, E., Pipher, M., Cartmill, C., Rangel, J. C., & Whitehead, C. R. (2017). Articulating the ideal: 50 years of interprofessional collaboration in Medical Education. Medical Education TA - TT -, 51(8), 861-872.	Narrative Review	Interprofessional Healthcare Teams	In order to meet goals of meaningful collaboration leading to higher-quality care, it behoves us as a community of educators and researchers to heed the ways in which we teach, think and write about interprofessional collaboration, interrogating our own language and assumptions that may be betraying and reproducing harmful care hierarchies.
9	Rutherford, J. S. (2017). Monitoring teamwork: a narrative review. Anaesthesia TA - TT -, 72(S1), 84-94.	Narrative Review	Interprofessional Healthcare Teams - anesthesia	team monitoring takes place both implicitly and explicitly in the anaesthetic environment. No single optimal model of teamwork monitoring for all situations was identified, but targeted teamwork training appears to have a positive impact on both teamwork and
10	Jones CPL, Fawker-Corbett J,Groom P, et al. Human factors in preventing complications in anaesthesia: a systematic review. Anaesthesia 2018;73(Suppl 1):12–24.	Systematic Review	Interprofessional Healthcare Teams	Recognition of human factors is now firmly embedded into clinical anaesthetic practice, and has been highlighted in several recent national reports and guidelines. We have reviewed the current literature and described the human factor components of teamwork, communication and situation awareness; we have also commented on human error. The importance of human factors in clinical practice has been highlightedusing the example of complex trauma
11	Larsen, T., Beier-Holgersen, R., Meelby, J., Dieckmann, P., & Ostergaard, D. (2018). A search for training of practising leadership in emergency medicine: A systematic review. Heliyon, 4(11).	Systematic Review	Interprofessional Healthcare Teams - emergency	For many years multiple taxonomies and leadership assessment tools have been developed but failed to come to terms with workable leadership training. Despite there being no clear definition, the literature describes lack of leadership as highly detrimental to performance during a critical, clinical situation and performance as very variable.
12	Low XM, Horrigan D, Brewster DJ. The effects of team-training in intensive care medicine: a narrative review. J Crit Care 2018;48:283–9.	Narrative Review	Interprofessional Healthcare Teams - intensive care	Team-training has been studied in multiple ICU team types, with crew resource management (CRM) and TeamSTEPPS curricula commonly used to support teaching via simulation. Clinical skills taught have included ALS provision, ECMO initiation, advanced airway management, sepsis management and trauma response skills. Teamtraining in ICU is well received by staff, facilitates clinical learning, and can positively alter staff behaviors. Few clinical
13	Rosenman, E. D., Fernandez, R., Wong, A. H., Cassara, M., Cooper, D. D., Kou, M., . . . Grand, J. A. (2018). Changing Systems Through Effective Teams: A Role for Simulation. Academic Emergency Medicine, 25(2), 128-143.	Narrative Review	Interprofessional Healthcare Teams	Continued collaboration between educators and researchers from EM and the team sciences is critical to advancing this work. Finally, we emphasize the importance of using a translational science approach to evaluate simulationbased team training, and to further elucidate the relationship between training and systems-level outcomes.
14	Salas, E., Zajac, S., & Marlow, S. L. (2018). Transforming Health Care One Team at a Time: Ten Observations and the Trail Ahead. GROUP & ORGANIZATION MANAGEMENT, 43(3), 357-381.	Narrative Review	Interprofessional Healthcare Teams	Measurement remains a challenge and there will be numerous opportunities in the future to gather additional types of data to bolster our understanding of the effect of health care team training. The multilevel, multidisciplinary, longitudinal, and rigorous studies currently needed (O'Dea 374 Group & Organization Management 43(3) et al., 2014) will undoubtedly require substantial resources (e.g., time, monetary investment, multidisciplinary knowledge); however, they will continue to advance and improve our understanding one team at a time.
15	Alshyyab, M. A., FitzGerald, G., Dingle, K., Ting, J., Bowman, P., Kinnear, F. B., & Borkoles, E. (2019). Developing a conceptual framework for patient safety culture in emergency department: A review of the literature. The International Journal of Health Planning and Management, 34(1), 42-55.	Systematic Review	Interprofessional Healthcare Teams - emergency	By using Plan-Do-Study-Act cycle, evaluation of the current status of safety culture components identified in the framework can be performed. Hence, appropriate strategies for improvementof safety culture in ED may be generated. Secondly, further research should be conducted to assess the relationship between patient safety culture in ED and staffing levels using objective data for staffing ratios and health care professionals' workload may assist with safety culture improvement. Thirdly, there are already existing instruments that measure the elements and concepts in the inner and outer context of proposed framework. Researchers and practitioners should identify the most commonly used and evaluate them for their validity and reliability. This will help them to prioritise and evaluate proposed actions and anticipate their impact on patient safety and the safety culture in general in EDs.
16	Aufegger, L., Shariq, O., Bicknell, C., Ashrafian, H., & Darzi, A. (2019). Can shared leadership enhance clinical team management? A systematic review. LEADERSHIP IN HEALTH SERVICES, 32(2), 309-335.	Systematic Review	Interprofessional Healthcare Teams	To design, develop and validate a shared leadership assessment tool that allows for rigorous evaluation of the degree of "sharedness" in leadership using for instance a social network analysis approach to understand the degree of density and centralization of shared leadership behavior in the team, medical organizations will be able to create specific and objective training opportunities across health professionals in a variety of settings. This would facilitate a culture that encourages and recognizes individual and team controbutions as well as accomplishments across expertise and seniority
17	Gross, B., Rusin, L., Kiesewetter, J., Zottmann, J. M., Fischer, M. R., Pruckner, S., & Zech, (2019) A.Crew resource management training in healthcare: a systematic review of intervention design, training conditions and evaluation. BMJ OPEN, 9(2).	Systematic Review	Interprofessional Healthcare Teams	Practitioners and researchers need to agree on common terms and definitions regarding the meaning of healthcare crew resource management (CRM)Researchers should consider good practice for reporting intervention design and data evaluation. More research is needed to establish criteria for success in implementing CRM in healthcare organisations. Attention should be paid to both the intervention itself as well as the conditions of the surrounding organisational structure.

18	Kumar, H., Morad, R., & Sonsati, M. (2019). Surgical team: improving teamwork, a review. Postgraduate Medical Journal, 95(1124), 334-339	Narrative Review	Interprofessional Healthcare Teams - Surgery	This review has highlighted several attributes of an ideal team and fundamental areas in which teamwork can be improved in practice. This includes, but is not limited to, team communication and behaviour training, reducing staff turnover times by staggering shifts, and organising more permanent or 'fixed teams. A formal cost–benefit analysis of enrolling such schemes for developing surgical teams would also be helpful to inform this field of enquiry. The studies mentioned in the review provide good evidence to warrant enrolment of such trials; however, they require further investigation to ascertain transferability to other healthcare organizations
19	Lyman, B., Jacobs, J. D., Hammond, E. L., & Gunn, M. M. (2019). Organizational learning in hospitals: A realist review. JOURNAL OF ADVANCED NURSING, 75(11), 2352-2377.	Realist Review	Interprofessional Healthcare Teams	Researchers must develop valid, reliable instruments that more accurately and comprehensively reflect the range of factors associated with organizational learning. Developing and consistently using such instruments would help build a more coherent body of knowledge related to organizational learning in hospitals
20	Neuhaus, C., Lutnæs, D. E., & Bergström, J. (2019). Medical teamwork and the evolution of safety science: a critical review. Cognition, Technology & Work, 22(1), 13-27.	Narrative Review	Interprofessional Healthcare Teams	Despite the need for measurements and evaluation, the continuous integration of social and cultural aspects in teamwork research will most likely enrich the current discourse for a more humanistic and complete understanding of what happens in healthcare teams. Recognizing power dynamics at the workplace in an effort to understand team processes and guide the serious allocation of resources will certainly address current challenges faced by frontline medical staff more thoroughly than the application of normative frameworks. Before rating their 'sharpness', we should harness their narratives and listen to their current needs.
21	Schmutz, J. B., Meier, L. L., & Manser, T. (2019). How effective is teamwork really? The relationship between teamwork and performance in healthcare teams: a systematic review and meta-analysis. BMJ OPEN, 9(9).	Systematic Review	Interprofessional Healthcare Teams	Good teamwork can be achieved by joint reflection about teamwork during clinical event debriefings, as well as team trainings and system improvement.The clinical context might play a role in how team members collaborate. The extent to which team members actually worked together during prior clinical practice might predict of how effectively they perform together. We encourage future studies to include outcome performance measures despite the effort required.
22	Etherington, N., Larrigan, S., Liu, H., Wu, M., Sullivan, K. J., Jung, J., & Boet, S. (2021) Measuring the teamwork performance of operating room teams: a systematic review of assessment tools and their measurement properties. JOURNAL OF INTERPROFESSIONAL CARE	Systematic Review	Interprofessional Healthcare Teams - Surgery	OTAS and NOTECHS have acceptable measurement properties for assessing the teamwork of teams in intraoperative clinical settings and may be considered for future standardized use. However, both tools rely on the questionable assumption that the teamwork of a team is equivalent to the sum of individual performances. Future studies may investigate other assessment tools which consider the whole team as the unit of analysis along with the potential of these tools to provide healthcare providers with meaningful feedback in clinical practice.
23	Gregory, M. E., Hughes, A. M., Benishek, L. E., Sonesh, S. C., Lazzara, E. H., Woodard, L. D., & Salas, E. (2021). Toward the development of the perfect medical team: critical components for adaptation. Journal of Patient Safety, 17(2), 70.	Narrative Review	Interprofessional Healthcare Teams	Teamwork training is a learning strategy for systematically acquiring teamwork competencies requisite to effective team performance that has been found to be positively associated with improved team performance, task performance, and reduced medical errors.30 It is essential not to consider team training as a one-stop effort; rather, periodic retraining and refresher training should be provided. Furthermore, organizational and frontline leaders should
24	Sebok-Syer, S. S., Shaw, J. M., Asghar, F., Panza, M., Syer, M. D., & Lingard, L. (2021). A scoping review of approaches for measuring 'interdependent' collaborative performances. Med Educ.	Scoping Review	Interprofessional Healthcare Teams	Medicine is practiced in teams and interdependent collaborations exist within those teams; therefore, we need valid and reliable measures of interdependence to accurately assess trainees' competence in associated domains and provide them with feedback about the collaborative, team-based care they provide to patients.

	Commentaries	
	Author	Main Ideas/Recommendations
1	Leenders, R. T. A. J., Contractor, N. S., & DeChurch, L. A. (2016). Once upon a time: Understanding team processes as relational event net-works. Organizational Psychology Review,6, 92–115	Analyzing team process as relational events allows researchers to hypothesize and test fine-grained theoretical mechanisms and, perhaps even more importantly, derive specific findings that can inform the further development of more explicit time-sensitive theories.
2	Clapp JT, Diraviam SP, Fleisher LA. The "stranger effect" — a look at interactions between consultants and care teams through the lens of social science. N Engl J Med Catalyst. 2017.	Due to the dearth of scholarship examining the quality of interactions between medical teams and physician consultants, we don't know what an ideal collaboration looks like and what situations call for what type of interaction. In some cases, would it be advantageous to limit the contribution of a consulting physician to the performance of well-practiced procedures like intubation or dialysis?
3	Fernandez R, Shah S, Rosenman ED, et al. Developing team cognition: a role for simulation. Simul Healthc 2017;12(2):96–103.	As with any scientific endeavor, we recommend that clinicians, educators, and simulation experts partner with experts in teamscience to develop robust approaches to simulation-based training that targets team cognition constructs.
4	Harris, K. R., Eccles, D. W., & Shatzer, J. H. (2017). Team deliberate practice in medicine and related domains: a consideration of the issues. Advances in Health Sciences Education : Theory and Practice TA - TT -, 22(1), 209-220.	Following this, the authors propose that effective team performance depends at least in part on team members having similar models of the situation, known as a shared situation model. The authors then propose guiding principles for implementing team deliberate practice in medicine and describe how team deliberate practice can be used in an attempt to reduce barriers inherent in medical teams to the development of shared situation models.
5	Cooper JB. Critical role of the surgeon-anesthesiologist relationship for patient safety. Anesthesiology. 2018;129:402e405	Surveys, focus groups, observational studies, the critical incident method, or deep ethnography all could be used to shed light on what are the issues that make the surgeon–anesthesiologist dyad highly functional or highly dysfunctional.
6	Uhlig PN, Doll J, Brandon K, et al. Interprofessional practice and education in clinical learning environments. Acad Med. 2018;93(10):1441-1444.	There are many frameworks7 and models, but for us, the essential element is a spirit of collaboration and shared learning among health professionals, patients, and family members.
7	Halamek, L.P.; Cady, R.; Sterling, M.R. Using briefing, simulation and debriefing to improve human and system performance. Semin. Perinatol. 2019, 43, 151178.	Briefing, simulation and debriefing have been used successfully in these fields to address human and system weaknesses and are proving beneficial in healthcare in general and neonatal-perinatal medicine in particular. Continued implementation and refinement will only enhance the safe care of these most vulnerable of patients
8	9.Hill, N. M., & Fisher, D. M. (2019). Reinforcing collaboration and teamwork: the role of team communication and training. ANZ JOURNAL OF SURGERY, 89(7-8), 957-961.	Both briefing and debriefing are formal tools we can use to improve teamwork and collaboration in the perioperative setting. Simulation and other team training workshops are an opportunity to practice these communication tool in a safe environment.
9	Hartley, B. R., & Elowitz, E. (2020). Barriers to the Enhancement of Effective Communication in Neurosurgery. WORLD NEUROSURGERY, 133, 466-473	Communication education may be better incorporated, and more impactful, with refresher workshops throughout training and also following residency, when the neurosurgeon is actually out in practice.
10	Hartley, B. R., & Elowitz, E. (2020). Future Directions in Communication in Neurosurgery. WORLD NEUROSURGERY, 133, 474-482	Important themes include standardizing all elements of communication, including protocols, procedures, and policies; formalized, comprehensive education and training in all aspects for all participants at all levels; designing hospital systems and tools with communication principles in mind; implementing multimodal approaches to streamlining communication; and addressing issues at various strata in the medical system.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	
Limitations	20	Discuss the limitations of the scoping review process.	
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.