Review

Barriers to effective EMS to emergency department information transfer at patient handover: A systematic review

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ABSTRACT

Background: Handovers of care are necessary, yet a vulnerable time for patient safety. They can either reduce the risk of medical error during transitions of care or cause direct medical or financial harm to patients due to poor communication.
Objective: To review (1) observational studies that quantify the frequency of transfer of specific data points or clinician retention of information provided in prehospital verbal handoff to assess the state of EMS-to-ED handoffs; (2) surveys and interviews of prehospital and ED staff perceptions of the handover process and any perceived barriers to optimal handover found therein; (3) interventional studies that have aimed to improve the quality of EMS to ED handoffs.
Methods: A systematic review of the literature was performed using Pubmed, Web of Science, Google Scholar, and Cochrane Database of Systematic Reviews and by hand-searching references of relevant articles. Articles were selected that focused on verbal and/or written handover of patient care from EMS to ED providers and that addressed the above goals. Qualitative data was extracted from the articles and assessed using thematic synthesis.
Results: 78 articles were identified for full text review, 60 of which met inclusion criteria. Four categories of barriers emerged on thematic synthesis: educational, operational, cultural, and cognitive. Within these categories, 12 initial descriptive themes and 9 suggested interventions were identified.
Conclusions: Descriptive themes of disrespect & disinterest, environmental factors, redundancy, poor recall, conflicting goals and perspectives, technological issues, information degradation, information loss, lack of standardization, lack of training, delays, and lack of feedback were identified as barriers to effective EMS to ED handovers. Three categories of interventions were identified across the included interventional studies, namely technological, educational, and changes to cultural customs.

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1. Introduction

Patient safety is one of the most essential challenges health care systems face, as it prevents human and systematic errors from causing harm to the very patients seeking help within these systems. The World Health Organization and Joint Commission have identified poor communication as the leading root cause of reported sentinel events, and hence named improving communication during handovers a top patient safety priority [1]. The handovers that occur at these transitions often consist of both verbal and written information, which can help guide medical decision making. Despite the importance of the exchange of information that occurs at care transitions, relatively little research has been done specifically on EMS handovers, which face distinct

challenges such as interprofessional interactions, environment, and stress [2].

Oftentimes, prehospital providers perform assessments and interventions before a patient has arrived to the hospital. Frequently, the information they hold about how a patient appeared on initial presentation - which may be drastically different than their presentation at the ED - is useful for appropriately triaging a patient's acuity. Furthermore, the descriptions that EMS is able to provide about the environment the patient was found in can provide important clues to medical or traumatic complaints. Handovers by EMS endeavor to exchange such information, as well as allow providers to advocate for their patients, coordinate care, and transfer accountability [3,4,55].

Due to the importance of handovers and the frequency with which EMS handovers occur daily, there have already been multiple review articles of this topic [2,5-8]. These have aimed to identify a minimum data set for EMS handovers, challenges specific to EMS handovers, gaps in evidence, and difficulties in handing over deteriorating patients. However,

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since the last general review written in 2014, none have examined recent observational and qualitative studies of EMS-to-ED handovers, the recent interventions trialed to improve upon them, or how this new evidence relates to prior. As such, the aims of our study are to review: (1) observational studies that quantify the frequency of transfer of specific data points or clinician retention of information provided in prehospital verbal handoff to assess the state of EMS-to-ED handoffs; (2) surveys and interviews of prehospital and ED staff perceptions of the handover process and any perceived barriers to optimal handover found therein; (3) interventional studies that have aimed to improve the quality of EMS to ED handoffs.

2. Methods

2.1. Data sources and search strategy

We conducted a systematic review of barriers to effective EMS to ED handoffs with the goal of reviewing observational and qualitative data to identify barriers, as well as objective data about potential interventions to minimize the impact of those barriers.

Studies were eligible for inclusion if they were in English and were published during the period from 2000 to 2019, as the level of training and scope of practice of prehospital care has evolved significantly in the last 20 years.

Searches were performed of Pubmed, Web of Science, Google Scholar, and Cochrane Database of Systematic Reviews using combinations of the following MeSH and search terms: EMS, emergency medical services, handoff*, handover*, emergency medical technician, paramedic, quality improvement, patient handoff, continuity of patient care. For example, the specific search used for the Pubmed database was: emergency medical services [mh] OR emergency medicine [mh] AND patient handoff [mh] OR continuity of patient care [mh] AND quality improvement [mh] AND handoff* [all fields] OR handover* [all fields]. The other database searches were adapted from this original search due to the unavailability of MeSH terms.

Inclusion criteria were defined as studies focused on handoffs of care (both verbal and written portions) from prehospital providers to ED staff (nurses or physicians) within the setting of the ED. Only peer reviewed studies, written in English, published in the last 20 years were included (Table 1). Exclusion criteria were defined as studies focused on interfacility transfers of care, transfers of care initiated by ED providers (physicians or nurses), handoffs involving students, transfers of care occurring outside of the ED (e.g. telemedicine, prehospital BLS to prehospital ALS), and health informatics studies focused on transfer of only multimedia images (e.g. prehospital ECG).

Table 1
Inclusion and exclusion criteria

Inclusion criteria	Exclusion Criteria
Handover from prehospital providers (EMS) to ED (nurses or physicians)	Interfacility transport handovers with direct admission to a hospital ward or unit that is not the ED
Face-to-face handovers or written documentation related to those handovers within the setting of the ED	Handovers initiated by other providers in the ED (RN to RN or physician to physician)
Peer-reviewed empirical research or literature review	Students being involved in the handover process
Language other than English	Transfers of care that occur outside of the emergency department (e.g. telemedicine consultations, transfers between EMS providers of differing levels of care)
Published between 2000 and 2019	Health informatics studies focused on transfer of only multimedia images (e.g. prehospital ECG)
	Discussion papers, anecdotal, opinion pieces, dissertations

2.2. Data collection and analysis

Due to the heterogeneity of the included studies and the qualitative methods they utilized, statistical analyses of significance were not possible. As the aim of this study was largely to examine data from qualitative interviews and observational studies, no formal critical appraisal forms were used, rather a consideration for the sampling of interviewees and whether the study's methodology was appropriate for assessing the objectives outlined above. A thematic synthesis methodology was used for data extraction and analysis, as outlined by Thomas and Harden [9]. This methodology was selected due to its intended use in systematic reviews of qualitative data. Data was extracted from the results sections of included studies, and documented verbatim into Microsoft OneNote software. The data synthesis was performed in three stages with some overlap: the verbatim findings of the primary studies were coded line-by-line; these free codes were organized into related areas to construct descriptive themes across studies; from these descriptive themes, analytical themes were developed.

While doing line-by-line coding of named barriers, we added to our existing codes as necessary, and multiple codes were applied to certain lines. Before completing line-by-line coding, we examined all the text which had a given code to check whether interpretation was consistent and to see whether additional coding was needed. Codes were grouped into a hierarchical tree structure based on their similarities and differences, resulting in descriptive themes. Finally, these descriptive themes were analyzed to address the concerns of our review directly, namely identification of barriers to patient care and specific interventions trialed to minimize their impact. This synthesis process allowed for the translation of concepts from one study to another. This final stage is regarded as the most controversial in qualitative research, as it is dependent on the judgment and insights of the reviewers. However, as LT worked as a prehospital provider in both volunteer and paid positions in rural and urban areas of the US prior to attending medical school and WB has served as an emergency physician and an EMS operational medical director, the reviewers training and experiences were felt to offer appropriate judgment and insight.

3. Results

Titles and abstracts of the 906 non-duplicated articles from these databases were screened by a single reviewer (LT) with consultation of a second reviewer (WB) for any uncertainty of meeting inclusion criteria from Table 1 (Fig. 1). Hand-searching of reference lists of eligible studies was also undertaken (including relevant reviews identified by the search strategy), which identified 30 of the articles for full text review. In total, 78 articles were reviewed in full text. Searching ceased when no new studies were found through this method. 18 articles were excluded after full text review and 60 met inclusion criteria on full text review.

Articles were published between 2001 and 2019, with 68.3% ($n = 41$) published after 2010 (Table 2). 90% ($n = 54$) of articles were from Australia, Europe or North America. No studies were controlled trials, and the majority used mixed methods ($n = 13$). The majority of studies ($n = 46$) took place in the general ED setting and did not specify exclusion of resuscitation rooms, while a minority ($n = 11$) took place specifically in trauma or resuscitation rooms. Three of the included studies were conducted in a simulated environment. One of these used a computer simulation model of a staffing intervention, and the other two of which observed EMS providers giving handover in simulated scenarios.

On line-by-line coding of the extracted data from these studies, 34 initial codes were made and are presented at the ends of the peripheral arrows in Fig. 2. From these initial codes, 12 descriptive themes emerged, each identifying a specific barrier to effective EMS-to-ED handover. These barriers were described as: disinterest and disrespect, environmental factors, redundancy, poor recall, technological issues, conflicting goals and perspectives, information degradation,
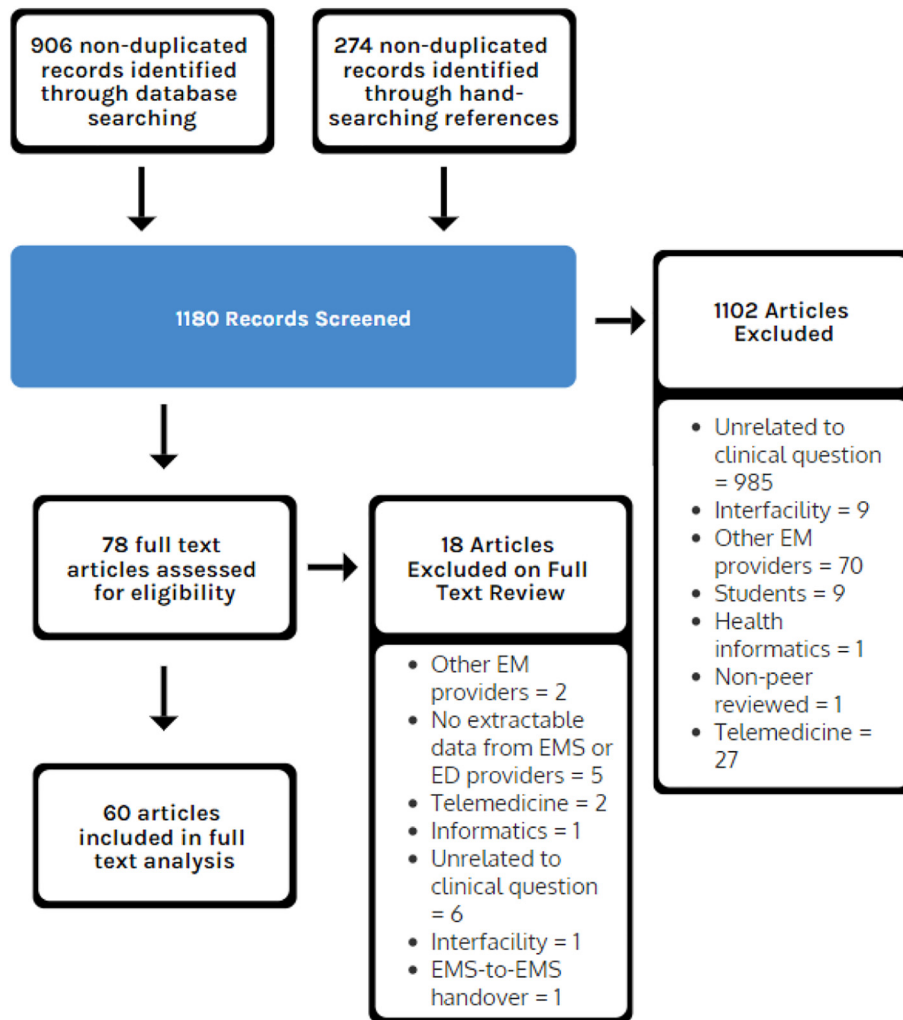
Fig. 1. Flow diagram of the review process.

information loss, variation and lack of standardization, lack of training, delay, and lack of feedback.

3.1. Interventions

Three categories of interventions were identified: technological, educational, and changes to cultural customs. In total, 17 types of interventions were suggested or trialed across the included articles (Fig. 3). Specifically, 9 intervention types were trialed across 12 included articles: multimedia usage, prealert innovation, partial return to paper forms, simplified ePCR, pocket mnemonic cards, staffing changes, mnemonics, feedback, simulation education, web-based education, and multidisciplinary collaboration. Five interventions were suggested by multiple qualitative studies, but no interventional study was found having trialed it: EMR integration, data collection automation, patient involvement, cross-monitoring the handovers of others, and using readback.

There were six single-center observational studies that counted the frequency with which various key handover items were reported. There was insufficient overlap in the data for any sophisticated analysis, but reported ranges of data points that overlapped in two or more studies are reported in Table 3.

4. Discussion

While our initial codes led to the twelve themes outlined above, on synthesis there was interplay between the discrete themes, and the interventions identified often addressed multiple themes. For this reason and to ease discussion, the twelve themes were organized into four categories of barriers with some overlap: educational, operational, cultural, and cognitive (Table 4).

4.1. Cognitive barriers

Four cognitive barriers were identified across the 60 studies: environmental factors, poor recall, information degradation, and information loss. These barriers were identified by initial codes in 20 out of the 60 articles (33%).

There were two types of interruptions described by the included studies. The first involved interruptions by providers uninvolved in the handover exchange, which occurred for unrelated matters. The second involved interruptions to verbal handover by the receiving provider asking for either clarification, information that hadn't been provided yet, or for information that had already been reported.

Among the included observational studies, there is a wide range of frequencies at which these interruptions are reported. On the low end, Yong et al. in 2008 observed 621 handovers of 311 ambulance arrivals and found that in 90% of them there were little or no interruptions observed. In contrast, Sumner et al. [14] ($n = 68$) and Manser et al. [15] ($n = 126$) measured interruptions to be present in 51% and 50% of handovers, respectively. All of the observations by Sumner et al. [14] were made in the pediatric resuscitation room, and they measured that 65% of the interruptions observed were questions from the

Table 2
Characteristics of included studies

Characteristic		N	%
Year	2000–2005	4	6.6
	2006–2010	15	25
	2011–2015	23	38.3
	2016–2019	18	30
Country	Austria	1	1.7
	Australia	11	18.3
	Canada	2	3.3
	Denmark	1	1.7
	Germany	1	1.7
	Italy	2	3.3
	Middle East	5	8.3
	Norway	2	3.3
	South Africa	1	1.7
	Spain	1	1.7
	Sweden	2	3.3
	The Netherlands	3	5
	UK	14	23.3
	USA	14	23.3
Design	Qualitative interviews	11	18.3
	Survey	7	11.7
	Observational	10	16.7
	Interventional	12	20
	Mixed methods	13	21.7
	Systematic review	4	6.7
	Literature review	3	5
Setting	General ED	46	76.7
	Resuscitation room	11	18.3
	Simulation center	3	5

physician team leader asking for information not yet provided. Survey data also found interruptions to be a common occurrence. In a survey of 308 EMS providers, ED nurses, and ED physicians in 2016, Jundi et al. [16] found 82% of respondents reported frequent interruptions to communication during handovers.

> "*I notice with myself that if it's quiet in triage, I receive report in a completely different manner. I ask more questions. When I am busy, I just listen to what they have to say and that's it!*" – ED nurse [17].

Across the interventional studies included, none trialed environmental changes to minimize the impact of these factors. After interviewing paramedics and trauma team members, Evans et al. [18,19] suggested that ED trauma bays with structural modifications to reduce sound reverberations may be beneficial to handover quality. Average noise levels in EDs have been reported to be 70–80 dB with certain machines like portable X-ray creating 90 dB, analogous to walking next to a highway when a large truck passes [20]. Without improving these working conditions, clear communication without distractions will continue to be very challenging.

> "*It's not necessarily the ambulance's fault because they get interrupted a lot by our doctors so you'll find that a handover's half complete because the doctors will go 'alright that's enough'*" – ED nurse, Evans et al. 2010

Two interrelated barriers that came up frequently were information degradation and information loss. We defined information degradation as misunderstandings and discrepancies in verbal and written reports that resulted from a lack of a shared cognitive picture about the patient and their history. In contrast, information loss was defined as information that was handed over, but not documented or recalled by the provider. Certainly, both of these barriers pose a threat of medical errors.

Several included studies described the phenomenon of "Chinese whispers", a result of redundancy of handovers where information passes from patient to EMS provider to triage nurse to the ED nurse or doctor who would ultimately care for the patient [21-23]. Over the course of these various exchanges of information, interviewed providers described a process of information degradation where

misunderstandings arose from either incorrectly interpreting or incorrectly recalling the information provided by patients or another provider. This degradation of information was also found in documentation. On a review comparing EMS documentation to ED documentation of the same patient cases, Murray et al. [24] found that 26 out of 100 resuscitation room patient encounters had discrepancies in documentation between the two sets of providers. These fell into various categories, including information about the previous medical history of the patient, timings of events bringing them to the hospital, frequency of the event occurring, patient allergies, and patient medications. The inaccurate reporting of such information could lead to costly errors and patient harm.

In a study aiming to measure information loss, Evans et al. [18,19] found that 9% of data was verbally handed over by paramedics, but not documented in their PCR or the trauma team's note. They noted that discrepancies such as patient allergy status and site of injury had the potential to result in patient harm. In addition, they found that normal findings were commonly undocumented by staff, which introduced risk for error should a patient deteriorate with no baseline available for comparison. Similarly, in an observational study by Carter et al. [10], it was found that only 72.9% of the key prehospital data points that were transmitted by EMS were documented by the receiving hospital staff. For example, elements such as prehospital hypotension, GCS score, and other prehospital vital signs were often not recorded. Another study by Knutsen and Fredriksen [25] measured how often certain data points from prehospital documentation were included in the ED admission note, and found no >30% of parameters made the cut. Lost information from that study included abnormal vitals, medications administered, mechanism of injury, and prehospital interventions. No studies were found that attempted to link prehospital information loss to patient safety events.

There were two other ways described through which information was lost: failure to provide information in verbal handover and poor recall. Many of the studies we reviewed reported the frequency with which various data points were given in handovers [10-14,26,56]. Overall, the ranges reported varied widely and indicated substantial room for improvement. What many studies noted to be standard data (e.g. vital signs, medical history, physical exam) varied greatly in how often they were reported by EMS (Table 4). Of course, the other issue with interpreting this data is that it often does not account for whether the specific data point was relevant to the patient presented. Indeed, as pointed out by Sarcevic and Burd [22], information is often missing in handovers as EMS crews may skip information that is "irrelevant", "non-contributory" or normal.

Two of the included studies aimed to measure receiving clinician recall of information provided in handover. Scott et al. [27] interviewed physicians within an hour after paramedic verbal trauma reports, and found that they correctly recalled information 36% of the time overall. They found recall to be worse in higher acuity patient handovers, and that physicians were most likely to recall crash scene information over information about the patient or prehospital care. In addition, Scott et al. [27] implemented a web-based educational intervention designed to enhance paramedic communication skills midway through their study, but found no statistically significant difference between pre- and post-intervention recall (33% vs. 38%, $p = 0.16$). Similarly, Talbot and Bleetman [28] measured ED staff recall before and after implementing a standardized DeMIST mnemonic handover, and found information was correctly recalled 56.6% of the time during their pre-intervention phase and 49.2% of the time post-intervention. However, they also had a small sample size ($n = 18$), which did not allow for statistical significance calculations.

To address the issues of information loss and degradation, Owen et al. [21] suggested developing a shared language between prehospital and ED providers to facilitate creation of a shared cognitive picture of the patient. Continuing educational efforts to teach prehospital providers medical terminology, illness scripts, and physical exam
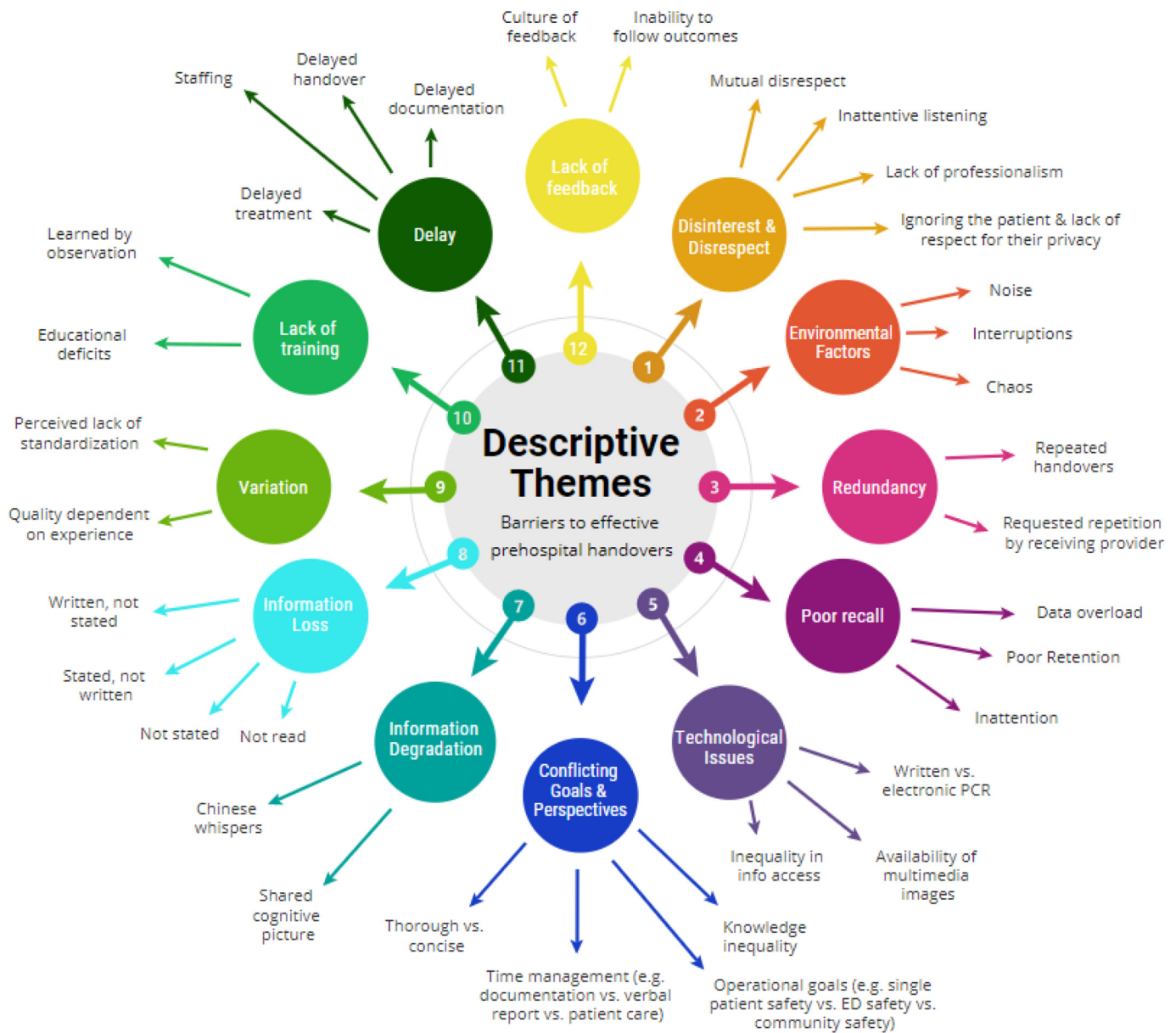
Fig. 2. Descriptive themes with their initial codes radiating out from them at the periphery.

techniques might allow prehospital providers to better describe what they are seeing and why it does (or does not) worry them in a concise, easily followed manner. Similarly, providing prehospital providers with structured feedback could potentially improve their handover presentations and hone their diagnostic skills. This could be attempted by sharing what receiving clinicians found concerning out of handover information, what other information might be helpful to provide in the patient's scenario, and diagnoses to consider.

Indeed, multiple studies suggested structured feedback to improve the quality of handovers. A deficit in the amount of feedback offered to EMS providers was described by Thakore and Morrison [29], who on surveying ED providers learned 33% felt they could give feedback to ambulance crews on their management of patients and 23% felt they could give feedback on the handover received. Meisel et al. [30] completed 7 focus groups at national EMS conferences and found that participants valued increased feedback about their patients' status and presumptive diagnosis during the handoff to improve their clinical skills and capacity to advocate for patients. Interviewed EMTs also believed their skills would improve if they had an integrated medical record that allowed them to follow up on their patient's hospital course [31].

Only one included study implemented a formal feedback program and measured outcomes. Choi et al. [32] had hospital administrators provide EMS with feedback on their performance in stroke care, specifically whether the crews asked and documented 5 key questions related to stroke care and performed 5 key interventions, as well as giving providers follow up information on the patient's hospital course. During their 21 month post-intervention period, they saw statistically significant improvement in all 5 key documentation points as well as 4 out of 5 of the key interventions.

Nevertheless, there are also risks to placing more emphasis on field diagnoses by prehospital providers. In qualitative interviews of ED and prehospital nurses in Sweden, Bruce and Suserud's [33] informants commented that "there is a risk that the preliminary medical diagnoses will follow the patient without new, proper evaluation being made". In addition, this potential for incorrect field diagnoses could delay appropriate care if not corrected. Notably, this risk was concerning to providers in a system that had nurses as ambulance providers; one would expect this risk would be heightened if providers with less medical training were forming these diagnoses. As such, there would need to be emphasis on these being provisional diagnoses. Ultimately, benefits
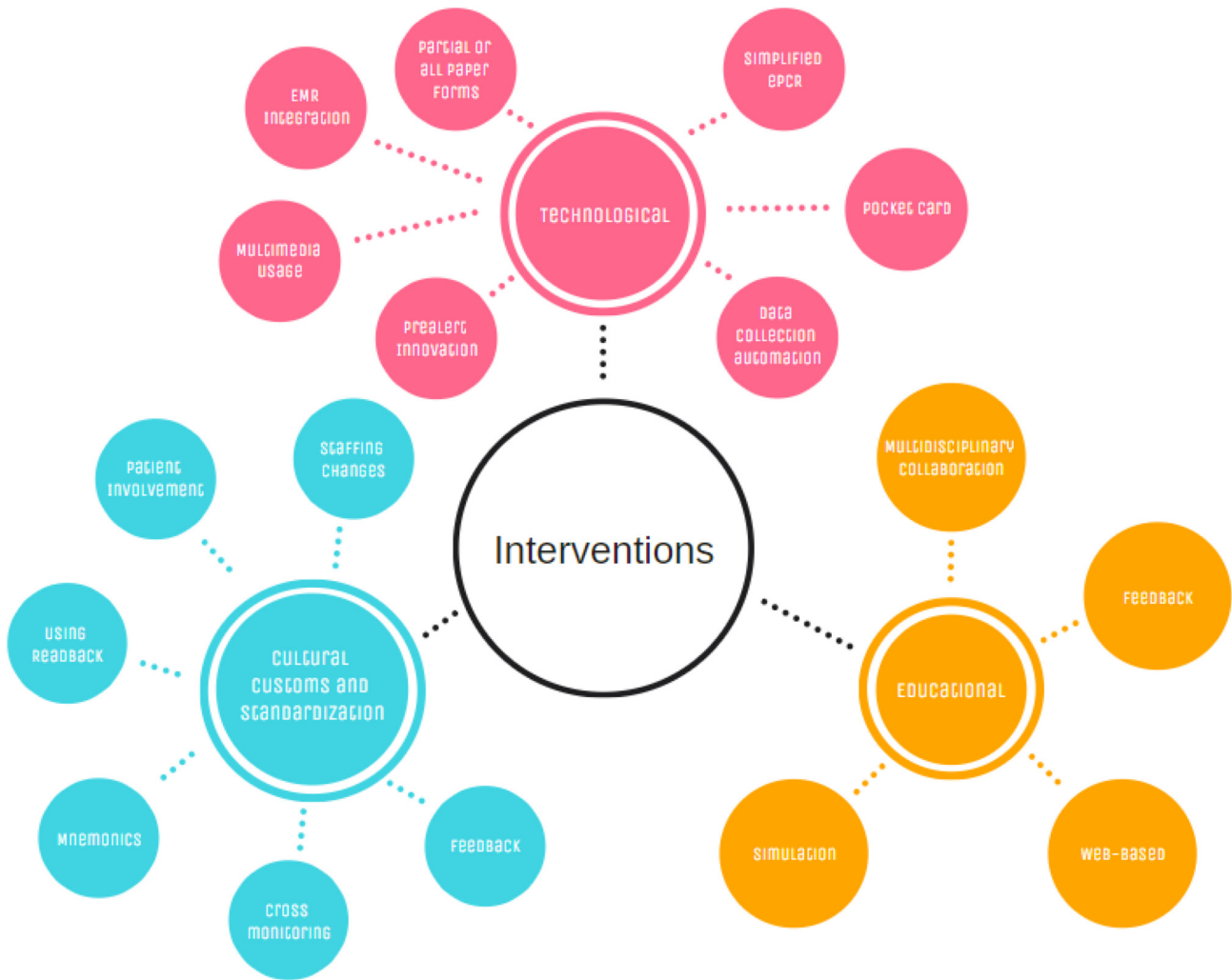
Fig. 3. Specific interventions trialed or suggested across the included studies, categorized into 3 groups: technological, educational, and cultural customs and standardization.

to improving prehospital providers' ability to form field diagnoses such as improved communication and management, likely outweigh these risks.

Information loss also could be combated by improving the availability of EMS patient care reports. Oftentimes these reports are delayed and not available to providers at the time they are making diagnostic and treatment decisions [62]. Yong et al. [12] surveyed clinicians and discovered only half of them referred to ambulance records, although

they perceived the information as useful. They also measured that ambulance documentation was not available in 78% of handovers observed. Having these reports available as a reference could also prevent errors occurring secondary to poor recall and information degradation. Indeed, interviews of ED providers by Sujan and Spurgeon in 2015 found providers desired timely documentation to lessen their reliance on verbal handovers.

4.2. Cultural barriers

Three cultural barriers were identified across the 60 studies: disrespect & disinterest, conflicting goals & perspectives, and standardization. These barriers were identified by initial codes in 29 out of the 60 articles (48.3%).

> "*What often ends up happening is you get this ongoing ramble … and you feel a bit rude because a couple of minutes into it you put your stethoscope on and go, yeah okay, fine.*" – ED physician, Evans et al. (2010)

We identified four related codes of mutual disrespect, inattentive listening, lack of professionalism, and ignoring the patient and the patient's privacy. From these codes emerged the descriptive theme of disrespect and disinterest as a barrier. In several studies, EMS providers voiced a perceived lack of interest by ED staff during their handovers [17,29,30,34–37,55]. As described by an EMS provider interviewed by Meisel et al. in 2014 "you lose [the receiving staff's] attention real

Table 3
Range of reported frequencies of handover data in observed handovers [10-14,26]

Reported information	Range of frequencies reported in handover
Age	56–82%
Chief complaint	78–98.9%
Past medical history	63–88%
Home medications	46–81%
Allergy	32.6–72%
Pertinent physical examination findings	47–63%
Assessment of change in condition	31–60%
Scene description	23–58%
Treatment and Interventions	44.5–81%
Peripheral IV	55–60%
Complete set of vitals	57–76.9%
HR	60–79.5%
BP	31–84%
RR	53–74%

Table 4
Descriptive themes organized into categories of barriers.

Educational barriers	Operational barriers	Cultural barriers	Cognitive barriers
Information loss	Environmental factors	Disrespect & disinterest	Environmental factors
Variation & lack of standardization	Redundancy	Redundancy	Poor recall
Lack of training	Technological issues	Conflicting goals & perspectives	Information degradation
Lack of feedback	Conflicting goals & perspectives		Information loss
	Delays		

quick and the busier they are, the worse the problem". Nursing staff acknowledged this to be true, stating that there is an asymmetry in workload during the time of handover: whereas EMS has one patient and one task, nursing often has many competing demands [21]. Multiple studies noted that inattentive listening was observed to be concurrent with ED staff examination of the patient. Consequently, in some cases, paramedics spoke of keeping the patient on their stretcher while giving verbal handover as they felt it increased the chance that the receiving staff would "stop and listen" [21].

However, there was also an obvious disconnect between the goals of the EMS providers and the goals of the ED staff that contributed to perceived disinterest. Whereas EMS providers often try to ensure that their handovers are thorough, ED staff stated "that an effective handover was succinct and structured, containing only vital information" [18,19].

> "*I have my education and in the ambulance they have another. We don't have the same need for information because we have different starting points and different levels of competence … What information do the nurses need and do* [*EMS providers*] *have the understanding that they will handover to somebody with a higher level of competence*?" – ED nurse, [17]

This disconnects between providers also results from an asymmetry in knowledge. Since many EMS providers have limited medical training, it can be difficult for them to know what information the patient has shared with them is most "vital". Moreover, their lack of training on giving handovers further impedes them from prioritizing critical information. Thus, in some cases they report back everything that they judge may have relevance due to fear of failing to pass on a clinically significant finding that may delay or alter treatment. This can lengthen the duration of handover, and contributes to the disinterest and disrespect EMS providers perceive during handovers. Several other elements of disrespect during handovers were described in an observational study by De Lange et al. [34] based in South Africa. Specifically, they noted the use of languages not everyone present understood, a lack of greeting, inattentive listening, exclusion of EMS from the conversation with the patient, and frequently non-involvement of the patient and their significant other. Disrespect towards patients in prehospital handovers was otherwise unstudied. Ultimately, disrespect between providers discourages EMS and runs the risk of their contributions feeling unvalued, giving them less incentive to improve their handovers.

As early as 2001, Thakore and Morrison suggested that to address ED staff inattention it may be beneficial to either designate an ED team member to receive report while others examine the patient or postpone examining a stable patient. They also suggested providing a structured method of feedback to allow EMS providers the opportunity to learn what is most helpful to the receiving team. Similarly, Owen et al. [21] suggested interdisciplinary training using simulated scenarios as a potential remedy to disrespect, lack of teamwork, and lack of understanding of each others' roles and needs.

> "*You know we're all in it to make the patient better, so I think that, that, if you feel like you're part of the health care team, it makes the whole transition go easier as opposed to you're the delivery guy, sign for the package and I'll leave.*" – EMS provider, Meisel et al. (2014)

Standardization of handovers using mnemonics has also been suggested to enable providers to have a shared method of structuring information

[53,56,59–61]. Theoretically, this intervention could also make handovers more concise, create a shared mental model, allow receiving providers to follow along with ease, and tailor handover to the data points receiving providers are most interested in. A survey of nurses matched with observational data found that the use of handover instruments with a clear structure correlated with nurses having greater satisfaction with EMS communication [38]. Ideally, this could translate to a more engaged listener.

Interestingly, in an observational study of trauma resuscitations, Evans et al. [18,19] suggested treating EMS handover similarly to a "time out" in surgery, where a checklist-guided safety pause occurs. While 6 of the included studies implemented mnemonic standardization, only two studies by Iedema et al. [39] and Fitzpatrick et al. [40] utilized a physical checklist for use at the bedside. On follow up observations, Iedema et al. [39] found that there was a larger volume of information provided in each handover despite a reduction in handover duration, fewer questions from ED staff, and fewer repetitions by both parties. Similarly, on follow up in the 2018 study by Fitzpatrick et al., they found that many handover data points (mostly vital signs) were more consistently provided in handover, and that ED staff found handover to be subjectively more standardized, and to have fewer repetitions and interruptions. Neither study made direct measure of the level of engagement or attention by receiving providers. Furthermore, no mnemonic standardization studies were identified that had post-intervention follow ups longer than 2–16 weeks.

The other four mnemonic standardization studies included had mixed results. Uniquely, Ebben et al. [41] utilized an e-learning program teaching DeMIST format and had an 88.6% participation. However, they actually saw a statistically significant increase in the number of questions and interruptions occurring on follow up observation handovers and no improvement in DeMIST usage. Talbot and Bleetman [28] also saw no change in DeMIST usage after a training intervention. However, their study had low participation (~40%) and low sample size that did not allow for statistical analysis. In contrast, Dojmi Di Delupis et al. [35] offered lectures and a series of high fidelity simulations for training to teach ISBAR with a four month follow up. They saw a statistically significant increase in handovers including provider introductions, patient introductions by name and age, chief complaint, past medical history, allergies, heart rate, blood pressure, and ISBAR format usage. They did not see a significant increase in inclusion of provider assessment, patient home medications, treatments and interventions, oxygen saturation, temperature, blood sugar, or provider recommendations.

Similarly, Yegane et al. [42] offered a 1 h course and pamphlets outlining ISBAR with a 3 week follow up. They saw ISBAR compliance increase from 0% to 65.3%. Likewise, they saw a statistically significant increase in reporting on patient name and age, reason for call, history of patient illness, past medical history, home medications, allergies, and treatments. They did not see a significant increase in provider introductions, patient assessment, vital signs, or provider recommendations. These standardization studies were heterogeneous in methodology with short follow up periods, making it difficult to assess the utility of standardization in combating disinterest, poor recall, information degradation, and information loss.

4.3. Operational barriers

Five operational barriers were identified across the 60 studies: environmental factors, redundancy, technological issues, conflicting goals &

perspectives, and delays. These barriers were identified by initial codes in 32 out of the 60 articles (53.3%).

Redundancy arose as a theme from 2 initial codes: repeated handovers and requested repetitions by receiving providers. In a survey of EMS and ED providers in 2007 by Jenkin et al., the most common reason for repetitions was that the provider who would be caring for the patient was not present during the initial handover. Cuk et al. [31] reported the average number of times that EMS providers had to give their handover was 3.5 times, which on observation in a 2012 study by Bost et al. was corroborated with paramedics handing off information to ED registration, the ED triage nurse, and the ED attending nurse. In critically ill patients in the resuscitation room, Bost et al. [43] noted that there were often further repetitions of specific points for the ED physician and specialist physicians. There is an obvious inefficiency to this process, but also as far as we know an unstudied variability in how much information is provided in each of these repeated handovers.

Several interventions have been suggested that may have an impact on reducing repetitions. Several technological interventions have been suggested that have the potential to cut down on reliance on verbal handover, as they would provide written references for certain data points (e.g. EMR integration, simplified ePCRs, paper forms, and data collection automation). Staffing interventions have the potential to increase the number of repetitions if they add a triage nurse or the potential to reduce the number of repetitions if they guarantee handover with the attending nurse [57]. By altering environmental factors, inattention may be reduced and the number of repetitions due to providers requesting clarification may also be reduced.

"*Patient record data collected at health centres should also be available online to ambulance personnel*" – [33]

On interviewing paramedics and emergency physicians about needs and requirements of electronic health records, Rohrer [44] concluded that two way transfer of information between EMS and ED staff through an integrated EMR could be beneficial for several reasons. For paramedics, much of the patient care report could auto-populate (e.g. medications, allergies, past medical history), saving them time documenting which could instead be devoted to patient care. It also could allow them access to important medical documents such as DNRs and medical history for altered or unresponsive patients, which could have the potential to change management on scene. For ED staff, it would likely allow earlier access to ePCRs as paramedics would not have to waste time re-entering data that was already recorded elsewhere. Currently with non-integrated systems, an analysis of over 22,000 EMS transports in California found that prehospital providers were spending on average 39 min after arrival at the hospital filling out electronic patient care reports (ePCRs) [23]. By easing the process of documentation for paramedics, their care reports would be available to assist providers in medical decision making and ambulances would be available for service to their community sooner.

Altuwaijiri et al. [45] interviewed paramedics and ED staff in the UK and found that providers felt that handover documentation was easier prior to the development of ePCRs. Paramedics commented that the substantially fewer data fields on written PCRs allowed for faster completion. ED staff participants endorsed rarely using ePCRs for a variety of reasons, including delays in accessibility, quantity and quality of information varying greatly, and difficulty accessing them through their computer system.

"*I really need the information at patient's side. I can't go searching all over for it.*" – ED physician, [46]

A 2013 survey of >200 ACEP emergency physicians found that the majority of respondents felt that prehospital documentation was an important resource (45.6% rated very important and 43.0% rated important), yet 79.6% of physicians reported ePCRs were available <50% of the time prior to medical decision making [47]. Although handwritten prehospital PCRs were more readily available (77.6% of respondents reported available >50% of the time), legibility and accuracy were reported concerns. As such, their study concluded that strategies should be devised to improve the overall accuracy of PCRs and assure that electronic prehospital PCRs are delivered to the receiving ED in time for consideration in ED medical decision making.

"*I don't have time to enter all that [PCR] information. If I have a choice between stopping profuse bleeding and messing around with a laptop, the choice is pretty obvious*" – Paramedic, [46]

There were only two included articles that included a technological intervention, both done by the same group and trialing the same intervention in two US states [23,48]. Schooley et al. [23] developed a smartphone application for EMS to capture and transmit digital images, digital audio and video about patients and incident information prior to arrival to the hospital. Unlike an ePCR, it had no mandatory data fields and allowed providers greater flexibility. For instance, typical usage included audio clips of EMS giving a brief verbal handover, demographic data which allowed for patient's registration to be expedited, a baseline set of vitals, and digital images or videos from the scene (e.g. MVC vehicle damage, medication bottles, patient injuries or physical exam findings). The median time it took paramedics from clicking start to clicking send was 103 s. ED staff was able to access the uploaded data via web browsers. On follow up interviews, ED nurses noted that the reports were less disruptive to their workflow as they allowed for asynchronous communication. They also felt that the ability to pre-register patients streamlined the care process, and that the images allowed them to see the evolution of a patient's condition and response to prehospital treatment. ED physicians appreciated that it avoided the Chinese whispers phenomenon and helped them to rely less on memory. Other benefits that were noted on follow up included the ability to ensure patients were routed to a hospital with appropriate resources and the ability to recruit specialists sooner (e.g. for burns, hand injuries, etc.). Challenges included data transmission speeds, distracting images, inability to transcribe audio into a PCR, and little perceived benefit for short transport times. While this was an interesting intervention in that it shortened documentation and made it available to providers sooner, it also did not allow for the same quality assurance data as traditional patient care reports.

The conflict of being thorough vs. concise was a theme that arose from interview data commenting on verbal reports and written documentation. On the one hand, there is a drive for prehospital providers to "document or didn't happen" for legal and quality assurance purposes. Hence, providers weigh the brevity of their communications on a case by case basis, which often appears to be determined by patient acuity [3,4,55]. This leaves providers in a difficult position as the ideal of having thorough information exchange competes with EMS agency goals to have rapid ambulance turnaround times [63]. Ultimately, this results in a decision for prehospital providers to either prioritize safety of the individual patient or safety of the community that is relying on them to respond to incoming emergency calls [4]. At the same time, ED staff must weigh these same priorities, as well as safety of patients already in the department with those they are receiving.

Sujan, Spurgeon, and Cooke [4] theorized that EMS providers confront these conflicting goals on a case-by-case basis that is primarily guided by their experience, not their formal training. They noted that verbal communication was particularly important in these cases, as it allowed for a phenomenon they called "the secret handover" that was specific to time-crunched medics. Rather than following a handover protocol outlined by their agency that was intended to improve turnaround times, the secret handover, allowed medics to offer an additional, informal handover to the nurse who would be caring for the patient. This allowed the medic to express their genuine worries about

a patient, so that they could deal with the tensions of having to meet agency-designed time metrics while not compromising care.

"*Not everybody does their run reports right after the call. You have 24, 48 hours in Pennsylvania to get your run sheet in, so by that time the patient could have been discharged and long gone.*" – EMS provider, Meisel et al. 2014

In addition to the documentation delays outlined above, delays in handover and treatment were also noted with suggested staffing interventions to combat them. Handover delays are a common occurrence in many of the EMS systems studied [3,4,43,46,49-51]. These delays result in compromised safety for the community, as they can tie up emergency responders at the hospital. They also act as a contributor to burnout for EMS providers, as they can result in missed lunch breaks and prolonged shift durations [43].

Two included studies examined the role of ED staffing on handover delays. Clarey et al. [52] created a computer simulation measuring the relationship between a dedicated triage nurse (or multiple) and the duration of delays. They ran two models with ambulance arrival rates of either a constant ambulance arrival rate of 4 per hour or with daily fluctuations of arrivals based off of data from the UK's NHS trust. Their simulation estimated that with one triage nurse the average wait time for handover would be 19 min vs. 1 min with two nurses. However by their estimate with two triage nurses, only 38% of their time would actively be spent taking handover. Of course, there would also be inherent financial challenges in increasing staffing and need to fill gaps between handovers with other tasks.

This intervention was also tested by Greaves et al. [50] when they added a dedicated triage nurse for receiving handover in their department. They introduced the role of one triage nurse in the ED 24 h a day, 7 days a week. They saw a marginal decrease in median time to be seen from 34 min to 31 min ($p = 0.002$). They also saw lower rates of patients leaving without being seen by a provider, a lower admission rate, and a higher rate of patients discharged home. This is a very different result than the predicted average wait time for 24 h single triage nurse coverage from the simulation made by Clarey et al. [52], which predicted a 3 min average handover wait time. Likely this indicates that there are more factors at play (i.e. limited hospital capacity, insufficient ED or hospital provider staffing, etc.) than were taken into account by the simulated intervention.

4.4. Educational barriers

Four educational barriers were identified across the 60 studies: information loss, variation, lack of training, and lack of feedback. These barriers were identified by initial codes in 22 out of the 60 articles (36.6%).

As early as 2001, Thakore and Morrison reported that only 19.4% of ambulance staff reported having training on patient handover, and that 83% of those who reported not having training thought there was a need for such training. Survey and interview data since 2001 has showed mixed results on the availability of handover training in EMS curricula. A survey of a mix of 80 paramedics, nurses, and doctors found that 74% reported learning handover through "listening to a colleague", and found that paramedics were more likely than other providers to have had a formal course on handovers [37]. In an observational study that also surveyed paramedics, six out of 10 ambulance crews reported having received training on handovers [28]. Several of the included studies measured a poor quality of handovers at single centers through observational data on the frequencies with which typical handover data points were transmitted [10-14,26] (Table 4). This would support a continued need for quality improvement. No other educational interventional studies were identified aside from those outlined above, which focused primarily on teaching mnemonics for standardization.

5. Limitations

This study involved a qualitative review of available data on barriers to effective EMS handovers. Data was obtained from many small studies of mixed methodologies. Many of the included studies utilized qualitative interviews of both EMS and ED providers, as well as single center observational data. As such, the ability of the qualitative data obtained through these studies to be generalized is difficult to assess. However, as the process of patient handover is difficult to objectively assess, we argue that these studies provide an important initial survey of the current quality of EMS to ED handovers, as well as an initial assessment of suggested interventions for quality improvement. Moreover, throughout these studies it was voiced both by authors and the providers interviewed and surveyed that there is a perceived need and desire to improve the quality of these handovers.

6. Conclusions

In summary, no gold standard of EMS-to-ED handover is currently identifiable. The current body of literature has identified 12 significant barriers to effective EMS-to-ED handover, which can help guide quality improvement efforts. Each of those barriers has been described by multiple single-center interviews and surveys of groups of practitioners in several countries. No interventional studies to this point have demonstrated significant improvement in provider recall, and standardization is the only intervention that demonstrated a significant improvement in the volume of data transferred in handovers. Simplified patient care reports with the capability to include multimedia components are promising for their demonstrated ability to shorten provider documentation time, allow for an audible record for ED staff reference, as well as to make reports available earlier to ED staff, potentially decreasing risk for medical errors. While unstudied, suggestions of automated data collection using an integrated medical record shared between medical centers and EMS are promising for potential to decrease the time required for documentation and increase the availability of information to all providers. Formalized EMS feedback about their documentation and verbal reports has the potential to improve both the content of those reports and possibly their completion of key patient care interventions. Patient involvement in EMS handovers to the ED is an unstudied facet of handover in the current body of literature. Simulation was found to be a more effective educational intervention than web-based learning. Thus, standardized handovers supported by educational interventions and technological solutions to increase availability of EMS documentation are recommended. Well designed, longitudinal studies across multiple centers are needed, which focus on what improvements to EMS handovers effectively promote patient safety.

Declaration of competing interest

No conflict of interest has been declared by the authors.

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