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Research Article

Learning from CIRS to optimise patient safety in handovers

Lernen aus CIRS zur Verbesserung der Patientensicherheit in Übergaben

Abstract

Introduction: Handovers are a central process for ensuring information continuity in patient care and, therefore, possess a major influence on patient safety as errors due to poor handovers can lead to life-threatening events. Education to improve handovers and ensure safe patient care can be supported by using critical incident reporting systems (CIRS). The aim of the study is to perform a content analysis of a national CIRS-database with regard to identifying adverse events in handovers situations and to derive competencies for the development of continuing education from these findings.
Methods: A meta model served as a research framework to merge the empirical findings with the London protocol of analysing critical events and the Canadian framework of safety competencies. Relevant cases to be investigated were searched in a freely accessible German CIRS database.
Results: A total of 253 case descriptions were found and analysed. Team factors emerged as the most frequently reported influencing factors following the analysis of the London protocol. Communication errors and missing information as well as a lack of appropriate standards and processes appeared to be the main reasons for critical events to occur. Most of the events happened in units involving surgery and intensive care. A mapping of patient safety competences with the reasons for critical events was conducted in order to determine the practical, concrete and handover related competencies.
Conclusion: Data from a CIRS database and theoretical frameworks can be combined to extract meaningful information about patient safety risks in handover situations. The results are useful for developing curricula to improve handovers based on patient safety competencies.

Keywords: handover, patient safety, CIRS, education, meta model

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Zusammenfassung

Einleitung: Übergaben spielen eine wichtige Rolle zur Sicherstellung der Informationskontinuität in der Patientenversorgung und üben damit einen großen Einfluss auf die Patientensicherheit aus. Fehler in der Durchführung von Übergaben können lebensbedrohliche Ereignisse nach sich ziehen. Weiterbildung und Schulung zur Verbesserung von Übergaben können durch den Einsatz von Critical Incident Reporting Systemen (CIRS) unterstützt werden. Ziel der Studie ist es, eine Inhaltsanalyse einer nationalen CIRS-Datenbank im Hinblick auf die Identifizierung von unerwünschten Ereignissen im Rahmen von Übergaben durchzuführen und daraus Kompetenzen für die Entwicklung der Fortbildung abzuleiten.
Methoden: Ein Metamodell diente als Forschungsrahmen, um die empirischen Ergebnisse mit dem London-Protokoll zur Systemanalyse klinischer Zwischenfälle und den Patientensicherheitskompetenzen des Canadian Patient Safety Institute zusammenzuführen. Die zu untersu-

chenden Fälle wurden in einer frei zugänglichen deutschen CIRS-Datenbank recherchiert.
Ergebnisse: Insgesamt wurden 253 relevante Fälle gefunden und analysiert. Teamfaktoren erwiesen sich als die am häufigsten berichteten Einflussfaktoren gemäß dem London-Protokoll. Kommunikationsfehler und fehlende Informationen sowie das Fehlen geeigneter Standards und Prozesse waren die Hauptgründe für das Auftreten kritischer Ereignisse. Die meisten Ereignisse traten auf chirurgischen und intensivmedizinischen Stationen auf. Um die praktischen, konkreten und übergabebezogenen Kompetenzen zu bestimmen, wurde ein Mapping der Patientensicherheitskompetenz mit den Gründen für das Auftreten kritischer Ereignisse durchgeführt.
Diskussion: Daten aus einer CIRS-Datenbank und theoretische Rahmenwerke können kombiniert werden, um aussagekräftige Informationen über die Patientensicherheitsrisiken in Übergabesituationen zu gewinnen. Die Ergebnisse sind nützlich für die Entwicklung von Curricula zur Verbesserung von Übergaben auf der Grundlage von Patientensicherheitskompetenzen.

Schlüsselwörter: Übergabe, Patientensicherheit, CIRS, Weiterbildung, Metamodell

Introduction

With the publication of the report "To err is human. Building a better health system" by the Institute of Medicine (IOM) [1] in 1999, patient safety gained steadily increasing visibility and has led to numerous initiatives and projects worldwide over the past 20 years [2], [3]. While there are various definitions of patient safety, it is a common understanding that patient safety is a condition in which adverse events rarely occur (e.g. "freedom from accidental injury" [1]). Amongst the situations potentially leading to unsafe situations, handovers between different shifts, wards and departments are well-known to be one of the most error-prone and unsafe processes in health care. Hereby, handovers play a critical role because they provide mechanisms of transferring *"professional responsibility and accountability for some or all aspects of care for a patient, a group of patients, to another person or professional group on a temporary or permanent basis"* [4]. This requires the transmission of correct and relevant information [4], [5], [6], [7], [8] to establish informational continuity [9] between teams.
As numerous studies have shown, errors and barriers due to poor handovers can lead to

- (life-threatening) adverse events [10], [11] and patient injury [12], [13] as a result of incorrect or inappropriate treatment [14],
- a delay in diagnosis and treatment caused by delivery errors [5], [15], [16], [17], omissions [14] or disturbances of the workflow [18], all of them having an impact on both patient [19] and employee satisfaction [18], [19],
- potentially economic consequences due to longer hospital stays [5], and
- increased health expenditure [6].

There are various methods to improve handovers [20], [21], [22], [23], like standardising the process or using checklists such as SBAR [24] and derivates [25]. Due to the increasing spread of electronic health records, using electronic handover systems is also gaining in importance and can contribute to improving the handover process [20], [26]. Apart from these techniques and instruments, it is well-known that education plays a critical role [5], [12], [27], [28], [29] to impart the necessary knowledge and skills. This importance is also underlined by the fact that, in recent years, a series of initiatives to improve the quality of handovers have been launched [4], [30], [31] or are part of initiatives to improve patient safety and the quality of health care [32], [33], [34], [35]. Education is not only important regarding the handover procedure, but also in terms of developing the necessary digital skills needed to use electronic health records and other tools for handovers, like the handoverEHR, a specific tool to improve communication in handover situations [36]. Examples include general digital competencies for keeping clinical records, but also data protection and data security [37].
Another path to patient safety education is enabled by critical incident reporting systems (CIRS). They have been used in the aerospace industry for decades as an instrument of learning and system improvement [38] and have been implemented worldwide in health care to learn from incidents and near misses to improve patient safety [39], [40], [41]. CIRS serves, on the one hand, as a kind of "early warning system" for the detection of risks and, on the other hand, as an analytical instrument for dealing with risks and for risk avoidance. Two types of CIRS can be distinguished: internal systems, which are limited to a specific institution, and external systems with a multidisciplinary or specialist orientation, which are available to a specific group of users on a supra-regional basis [42], such as CIRSmedical in Germany [43]. Hospital CIRS

are usually part of quality and risk management. This is where the systematic analysis of reported cases, e.g. based on the London Protocol [44] usually take place. These analyses can lead to the development of prevention strategies or problem solutions as well as their communication within the institution. This can serve as a catalyst for organisational learning. In the case of inter-institutional CIRS, there is the additional possibility of learning from other institutions and derive strategies for one's own organisation [45]. In order to formalise this learning process, CIRS cases must be translated into practical competencies customised for a specific situation. This has not yet been done according to our knowledge.

While guidelines and recommendations for competencies to improve patient safety are usually worded in general terms to cover as many situations as possible, CIRS embrace a multitude of specific cases of varying situations and thereby illustrate threats to patient safety, such as handover situation. In order to benefit from the virtues of both approaches, i.e. guidelines and CIRS cases, to enable learning, a meta model for embedding both sources would help in marrying consensus based high level recommendations with empirical case reports.

Therefore, the aim of this study is

1. to tap the content of a CIRS database based on the research framework for critical events, and
2. drawing on these findings to derive high priority patient safety competencies for handover situations which illustrate and break down the general patient safety key competencies for this particular situation.

These competencies will then be used to develop case vignettes for continuing education programs to improve patient safety in handovers. The design of the vignette as well as the curriculum will not be part of this study.

The following three research questions (RQ) served to extract relevant information about handovers from a national CIRS:

- RQ 1: What were the main influencing factors and reasons for the critical event?
- RQ 2: In which particular handover situations were critical events most frequently reported?
- RQ 3: Which patient safety competencies were involved in situations leading to critical incidents?

Methods

Research framework: the meta model of critical events

The present study aimed at merging empirical findings with theoretical frameworks. Therefore, we used a meta model as a research framework for this study (Figure 1). In a first step, the theoretical framework for analysing critical incidents was employed to generally classify and systematise cases in the CIRS database (RQ 1) in a deductive manner. In addition, the database was used to empirically extract, identify and cluster reasons (RQ 1) and situations (RQ 2) for critical events from the cases (inductive approach) to enrich the findings of the deductive analysis. The consolidated findings were then inspected through the lens of a competency framework to generally identify relevant key competencies and customise them to fit the handover situation (RQ 3).

Database and search

Case reports were searched in the freely accessible German CIRS database CIRSmedical, which is an anonymous reporting and learning system for critical medical events. CIRSmedical was launched in 2005 and is maintained by the two major federal associations of physicians, the Kassenärztliche Bundesvereinigung (National Association of Statutory Health Insurance Physicians) and the Bundesärztekammer (German Medical Association). CIRSmedical is a network in which different CIRS are integrated [43]. It is fed from a total of more than 130 institution-related and inter-institutional CIRS databases. Health professionals have the possibility to enter case reports directly into CIRSmedical [46].

At the time of the search (07–26–2018), 5,998 case reports in the German language were registered in the database. The German general term "Übergabe" (in English "handover", "handoff", "transfer", "sign-out") served as the keyword in the free text research to obtain the most comprehensive and relevant hits and to cover all the different situations where patient information is exchanged due to changing responsibility for the care of the patients. In the following, the term "handover" is used as a translation for "Übergabe". A total of 340 case reports were identified to contain the term "Übergabe". These reports were mainly available as structured free text and in some cases as structured standardised information. Case reports were available as pdf documents and had to be manually transferred to an Excel sheet in order to be able to conduct the analyses. Information from the following fields were included:

- Case number and title
- Responsible department (standardised data)
  - general medicine, ophthalmology, surgery, gynaecology/obstetrics, geriatrics, skin and sexually transmitted diseases, otolaryngology, internal medicine, paediatrics and youth medicine, neurology, orthopaedics, pharmacy, psychiatry, psychotherapy, radiology, urology, another specialty (free text)
- Where did the event take place? (standardised data)
  - practice, emergency service/rescue service, home visit, nursing/retirement home, pharmacy, other place (free text)
- In which unit did the event occur? (standardised data)
  - induction of anaesthesia, transport, outpatient pain clinic, emergency room, operation room, functional/diagnostic room, emergency team intervention, post-op, intensive care unit (ICU)/intermediate care unit (IMC), normal ward, recovery room, premedica-

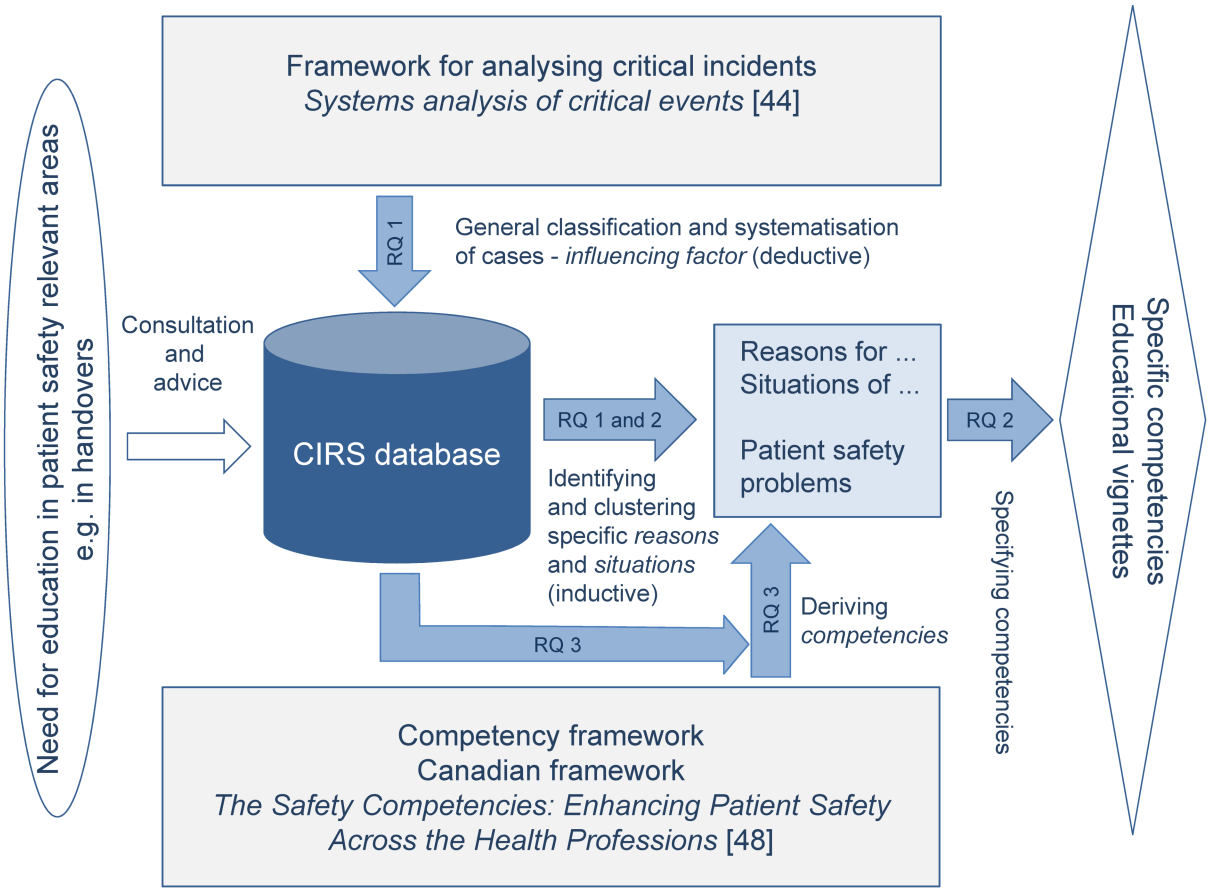

Figure 1: Meta model of learning from CIRS databases (RQ=research question) (unfilled shapes are not part of this study; oval shape=literature, diamond shape=next step)

tion outpatient clinic, acute pain service, other unit (free text)
- In which context did the event take place? (standardised data)
  - prevention, diagnostics, non-invasive measures (diagnostics/therapy), invasive measures (diagnostics/therapy), organisation (intersection/communication), other context (free text)
- Important concomitant circumstances (free text)
- What has happened? (free text)
- What was particularly good? (free text)
- What was particularly unfavourable? (free text)
- What are possible reasons for this event and how could it have been avoided? (free text)

CIRSmedical is fed from several databases that use different data entry forms. Therefore, the information listed above was not always completely available in the case reports.

After an initial review of the cases, 87 reports were found to be irrelevant because they did not concern a transfer or handover situation or were duplicates. A total of 253 case reports were finally included in the analysis (Figure 2) of which 218 reported negative events and 35 cases positive events.

RQ 1: What were the main influencing factors and reasons for the critical event?

In order to answer research question 1 and to determine the possible causes of a critical incident in handover situations, a two-step analysis was performed: first a deductive analysis based on a framework, and second an inductive analysis identifying the reasons from the case studies themselves.

In the first step, the framework of contributing factors influencing clinical practice developed by Taylor-Adams and Vincent served as a guide for classifying and systematising the case reports (Table 1). These factors are part of the London protocol, a systematic approach for guiding system analysis of clinical incidents [44]. A critical event is usually triggered by several factors. In this study, however, only the main contributing factor was extracted from the case reports. The mapping of the case reports to the main factor type and contributory influencing factors was performed by three persons in a cascading manner, i.e. the first person (NE, senior researcher) mapped the cases to the factors and noted ambiguities, then the second person (student research assistant, nurse) checked the mapping results and tried to resolve the ambiguities. Regarding the factor types, there was an agreement in about 83% of the cases and concerning the influencing

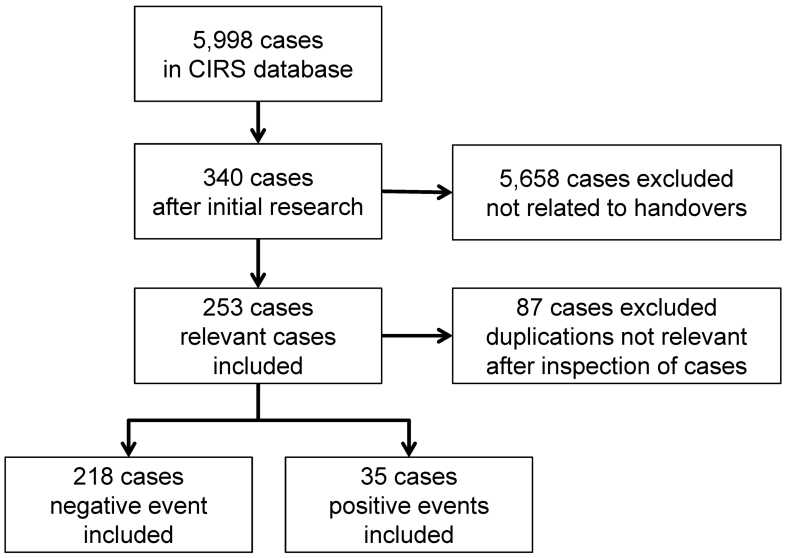

Figure 2: Flow diagram of database research

Table 1: Framework of contributory factors influencing clinical practice [44]

Factor types	Contributory influencing factor
Patient factors	Condition (complexity and seriousness) Language and communication Personality and social factors
Task and technology factors	Task design and clarity of structure Availability and use of protocols Availability and accuracy of test results Decision-making aids
Individual (staff) factors	Knowledge and skills Competence Physical and mental health
Team factors	Verbal communication Written communication Supervision and seeking help Team structure (congruence, consistency, leadership etc.)
Work environmental factors	Staffing levels and skills mix Workload and shift patterns Design, availability and maintenance of equipment Administrative and managerial support Physical environment
Organisation and management factors	Financial resources and constraints Organisational structure Policy, standards and goals Safety culture and priorities
Institutional context factors	Economic and regulatory context National health service executive Links with external organisations

factor in about 79% between these two persons. Finally the third person (UH, professor for medical and health informatics) evaluated these results and tried to finalise the mapping results. In case of discrepancies, all three persons convened to come to a conclusion.

In the second step, the reasons of the critical incidents that appeared in a handover situation were identified from free text material using qualitative content analysis [47] methods. The texts were summarized by one of the authors (NE, senior researcher). Afterwards, inductive categories and subcategories were derived from the

summaries after a group discussion was held among the authors (NE, UH). In this step, the handover situation was analysed.

RQ 2: In which particular handover situations were critical events most frequently reported?

Safety relevant transfer and handover situations were identified utilising information from the following fields in the case reports: "unit in which the event occurred", "type of care", "reporting type of health professional" and "day on which the event occurred". The context and the type of health professionals involved had to be derived from the case descriptions. "Most critical" was defined by the frequency that this particular situation was mentioned in the case reports.

RQ 3: Which patient safety competencies were involved in situations leading to critical incidents?

To answer research question 3, the Canadian framework of safety competencies *The Safety Competencies – Enhancing Patient Safety Across the Health Professions* developed by the Canadian Patient Safety Institute [48] was used to derive key competencies. The framework contains the following six domains of patient safety competencies with their definitions:

- Domain 1: Contribute to a Culture of Patient Safety
  "A commitment to applying core patient safety knowledge, skills and attitudes to everyday work."
- Domain 2: Work in Teams for Patient Safety
  "A commitment to applying core patient safety knowledge, skills and attitudes to everyday work."
- Domain 3: Communicate Effectively for Patient Safety
  "Promoting patient safety through effective health care communication."
- Domain 4: Manage Safety Risks
  "Anticipating, recognizing and managing situations that place patients at risk."
- Domain 5: Optimise Human and Environmental Factors
  "Managing the relationship between individual and environmental characteristics in order to optimize patient safety."
- Domain 6: Recognise, Respond to and Disclose Adverse Events
  "Recognizing the occurrence of an adverse event or close call and responding effectively to mitigate harm to the patient, ensure disclosure, and prevent recurrence."

Each domain includes elements (knowledge, skills, attitudes), key competencies and enabling competencies. Patient safety competencies were assigned to the case reports using the reasons of the critical incidents identified empirically from the cases (see RQ 1 step two). After mapping the reasons to the key competencies of the domains, competencies related to the handover situation were derived by NE and UH amending and specifying the original key competencies with handover related needs.

Results

RQ 1: What were the main influencing factors and reasons for the critical event?

Analysing the 253 relevant case reports resulted in 218 (86.2%) case descriptions of negative and 35 (13.8%) of positive events. The positive events reported comprised situations in which the handover situation actually led to the detection of prior errors (n=29/82.9%) or was explicitly found to be useful for education and training (n=6/17.1%). Analysing the 218 cases with critical events according to the framework proposed by Taylor-Adams and Vincent [44] resulted in the picture that is reflected in Table 2 (two left columns). Team factors were by far the most frequently mentioned influencing forces and contributed in 120 (55.0%) of the 218 cases to the safety relevant event. Among these 120 reports, "verbal communication" was mentioned in 95 cases (79.2%), by far the largest proportion of cases, "written communication" in 15 cases (12.5%) and "the team structure" in 10 cases (8.3%). The second most common factor type were task and technology factors with 40 cases (18.3%), broken down into the influencing factors "availability and use of protocols" (n=24/60.0%), "task design and clarity of structure" (n=15/37.5%) and "availability and accuracy of test results" (n=1/2.5%). Work environmental factors could be identified as primary factor type in 26 cases (11.9%). Hereby, "design, availability and maintenance of equipment" was the most frequently reported influencing factor (n=10/38.5%). "Competence" (n=13/61.9%), "knowledge and skills" (n=7/33.3%) and "physical and mental health" (n=1/4.8%) were influencing factors in individual (staff) factors (n=21/9.6%). All other factors were only reported in a few cases.

Out of the 253 case reports examined, there were 218 negative events (86.2%) explicitly referring to a safety critical event during the handover process. These events, hereinafter referred to as the "reasons for critical incidents", could be clustered around the categories *communication (dissemination of information)* (n=108/49.5%), *processes/standards* (n=71/32.6%), *documentation* (n=33/15.1%) and *medical equipment* (n=6/2.8%) (Table 3). Incomplete or insufficient (n=52/48.1%) or missing information (n=51/47.2%) was the most frequently reported cause mentioned in the category *communication (dissemination of information)*. In three cases, the information was incorrect, and in two cases, it was disregarded. The category *processes and standards* embraced non-compliance to standards (n=40/56.3%), disruptions of processes and deviations from process protocols (n=24/33.8%), and the absence of processes

Table 2: Mapping contributory influencing factors according to Taylor-Adams and Vincent [44], which were found in the cases in a deductively manner, and reasons for safety incidents, which were inductively identified from the content of the cases (n=218)

Factor types (No. of cases)	Contributory influencing factor (No. of cases)	Reasons for critical incident extracted from the case reports (No. of cases)
Deductive approach		**Inductive approach**
Team factors (n=120/55.0%)	Verbal communication (n=95/79.2%)	Communication (dissemination of information) (n=77/81.1%) Documentation (n=11/11.5%) Processes/standards (n=7/7.4%)
	Written communication (n=15/12.5%)	Documentation (n=11/73.3%) Communication (dissemination of information) (n=4/26.7%)
	Team structure (congruence, consistency, leadership etc.) (n=10/8.3%)	Processes/standards (n=7/70.0%) Communication (dissemination of information) (n=3/30.0%)
Task and technology factors (n=40/18.3%)	Availability and use of protocols (n=24/60.0%)	Processes/standards (n=20/83.3%) Documentation (n=3/12.5%) Communication (dissemination of information) (n=1/4.2%)
	Task design and clarity of structure (n=15/37.5%)	Processes/standards (n=7/46.7%) Communication (dissemination of information) (n=5/33.3%) Medical equipment (n=3/20.0%)
	Availability and accuracy of test results (n=1/2.5%)	Processes/standards (n=1/100.0%)
Work environmental factors (n=26/11.9%)	Design, availability and maintenance of equipment (n=10/38.5%)	Processes/standards (n=8/80.0%) Communication (dissemination of information) (n=1/10.0%) Medical equipment (n=1/10.0%)
	Workload and shift patterns (n=9/34.6%)	Processes/standards (n=5/55.6%) Communication (dissemination of information) (n=3/33.1%) Documentation (n=1/11.1%)
	Staffing levels and skills mix (n=5/19.2%)	Processes/standards (n=3/60.0%) Documentation (n=1/20.0%) Communication (dissemination of information) (n=1/20.0%)
	Physical environment (n=1/3.8%)	Communication (dissemination of information) (n=1/100.0%)
	Administrative and managerial support (n=1/3.8%)	Communication (dissemination of information) (n=1/100.0%)
Individual (staff) factors (n=21/9.6%)	Competence (n=13/61.9%)	Communication (dissemination of information) (n=7/53.8%) Documentation (n=4/30.8%) Processes/standards (n=2/15.4%)
	Knowledge and skills (n=7/33.3%)	Processes/Standards (n=3/42.9%) Medical equipment (n=2/28.6%) Documentation (n=1/14.3%) Communication (dissemination of information) (n=1/14.3%)
	Physical and mental health (n=1/4.8%)	Processes/standards (n=1/100.0%)
Organization and management factors (n=9/4.1%)	Policy, standards and goals (n=5/55.6%)	Processes/standards (n=3/60.0%) Communication (dissemination of information) (n=2/40.0%)
	Organisational structure (n=3/33.3%)	Processes/standards (n=2/66.7%) Communication (dissemination of information) (n=1/33.3%)
	Safety culture and priorities (n=1/11.1%)	Processes/standards (n=1/100.0%)
Patient factors (n=2/0.9%)	Language and communication (n=2/100.0%)	Processes/standards (n=1/50.0%) Documentation (n=1/50.0%)

Table 3: Reasons for critical incidents in handovers and related subcategories found in CIRSmedical (n=218)

Reason for critical incident extracted from the case reports	Number of cases	Subcategory	Number of cases
Communication (dissemination of information)	n=108 (49.5%)	Incomplete/insufficient information	n=52 (48.1%)
		Missing information	n=51 (47.2%)
		Incorrect information	n=3 (2.8%)
		Disregarding information	n=2 (1.9%)
Processes/standards	n=71 (32.6%)	Non-compliance process/standard	n=40 (56.3%)
		Disruptions/deviations in process	n=24 (33.8%)
		Missing process/standard	n=7 (9.9%)
Documentation	n=33 (15.1%)	Disregarding documentation	n=13 (39.4%)
		Incomplete/insufficient documentation	n=12 (36.4%)
		Missing documentation	n=7 (21.2%)
		Incorrect documentation	n=1 (3.0%)
Medical equipment	n=6 (2.8%)	Incorrect usage	n=5 (83.3%)
		Limited functionality/out of order	n=1 (16.7%)

Table 4: Selected case reports illustrating poor and unsafe handovers extracted from CIRSmedical and then summarised

Case 1	Case 2
The emergency room gave notice to the anaesthesia registrar on duty about a patient in the trauma room. However, the process standard would have required the anaesthesia specialist registrar to be informed first-hand. Furthermore, the notice did not contain all the relevant information. The registrar on duty realised that the anaesthesia specialist had to be informed and called him. He also informed the anaesthesia nurse. Both arrived with some delay and the registrar immediately started the handover based on the minimal information he had received about the patient. Again, the process standard was disregarded because not all the relevant persons for the handover were present. While the patient was handed over, people did not pay attention but rather communicated among themselves and worked on the patient. During this huddle, even more information got lost.	*After arterial surgery, the patient was accompanied by the ward registrar to the post-anaesthesia care unit. The intensive care physician on duty for this unit was not available at this time because it was a busy time of the day with many patients needing to be looked after. The ward registrar, therefore, decided to handover the patient not face-to-face but rather only left a short handover report. As the patient's condition deteriorated developing a heart rate of more than 130 bpm the nurse in charge informed the intensive care physician to see this patient which did not happen because he was still busy with other patients. After some time, it became obvious that the condition of the patient had become worse (decreasing blood pressure) and the registrar on-call duty had to be called. Upon arrival, he noticed that the trunk was already marbled, lactate was by far too high and the base excess highly negative. The patient had to be admitted to the intensive care unit without delay and needed acute volume therapy.*

or standards (n=7/9.9%). The *documentation* category referred to either incomplete or insufficient content (n=12/36.4%) or to the fact that hints in the documentation were not observed (n=13/39.4%). In other cases, relevant information was not documented at all (n=7/21.2%) or incorrectly recorded (n=1/3.0%). The improper use of a medical device (n=5/83.3%) or the use of a device out of order or with limited functionality (n=1/16.7%) also contributed to a critical incident.

Table 2 shows the mapping of the contributory influencing factors to the reason for the safety incident in handovers. In 15 cases (12.5%), for example, the contributory influencing factor was written communication. The results of qualitative content analysis revealed that in 11 out of these cases (73.3%), *documentation* was the reason for the critical incident and in 4 cases (26.7%) it was *communication (dissemination of information)*. The right column in Table 3 shows the subcategory of the reasons and therefore provides more information and more specific details to the rather general system of influencing factors. Table 4 summarises two cases reported in CIRSmedical database that illustrate how communication rules and process standards were disregarded in a crucial situation (case 1) and demonstrate that written handovers were insufficient to call attention in a way that was urgently needed (case 2).

RQ 2: In which particular handover situations were critical events most frequently reported?

In order to answer this question, information about the unit in which the event occurred, the type of care could be taken directly as structured information from the fields in the CIRSmedical case reports ("In which unit did the event occur?").

Table 5 shows in which units the critical incident had occurred. The majority (93 cases/42.7%) of the 218 cases were reported to happen in the units involved in surgery (induction of anaesthesia, operating room, post-op, recovery room) and 47 cases (21.6%) in the intensive care unit and intermediate care. Critical events in the units involved in surgery were for example the wrong identity of patients, an allergy that was not handed over and not documented in the anaesthetic protocol and a medication mistake. In the cases from the intensive care unit and intermediate care, it was reported that for example handovers did not take place and no documentation was carried out. In another case, the electronic health record contained unclear and ambiguous abbreviations, so that no clear transfer was possible.

Table 5: Unit where the event occurred (n=218)

Unit where the event occurred	Number of cases
Units involved in surgery	n=93 (42.7%)
Intensive care unit/intermediate care	n=47 (21.6%)
Emergency department/emergency medical service	n=12 (5.5%)
During transport	n=11 (5.0%)
General ward	n=7 (3.2%)
Diagnostic or treatment unit	n=7 (3.2%)
Other unit	n=5 (2.3%)
Outside the hospital	n=2 (0.9%)
Not specified	n=34 (15.6%)

In 12 cases (5.5%) it was a transfer that took place in the emergency care area (e.g. the rescue team could not carry out a medical handover because no doctor was available) and in 11 cases (5.0%) during patient transport, where for e.g. the health records were mixed-up. A critical event during a handover on a normal ward and in the functional/diagnostic room was described in 7 reports (3.2%). In these cases, inter alia, responsibilities were not clearly communicated during the handover and instructions were not followed. In 5 CIRS reports (2.3%) the transfer took place in another area (e.g. delivery room) and in 2 reports (0.9%) outside the hospital. In 34 cases (15.6%), the information was not given.

RQ 3: Which patient safety competencies were involved in situations leading to critical incidents?

In order to be able to assign the key competencies of the Canadian framework of safety competencies to the case reports, a mapping of these competencies with the reasons for critical incidents and the related subcategories had to be carried out first (Table 6). Due to the fact that the descriptions of the reasons and the key competencies differed strongly in the level of abstraction, it was not always possible to assign a subcategory to only one domain and key competency. Following the mapping, competencies were derived to link the patient safety key competencies with the peculiarities of handover situations and break down the key competencies into practical, concrete and handover related competencies.

In the following, the results are presented as an example for the category *communication (dissemination of information)*. Communication was divided into the subcategories: missing information, incorrect information, incomplete/insufficient information and disregarding information. In order to prevent these errors in handovers, patient safety competencies must be improved or acquired that belong to Domain 2 “Work in Teams for Patient Safety” and Domain 3 “Communicate Effectively for Patient Safety”. In Domain 2 the following key competence was found important: “Health care professionals are able to participate effectively and appropriately in an interprofessional health care team to optimise patient safety”. This key competence was specified for handovers (Table 6, right column). Referring to Domain 3, the following key competence was regarded relevant: “Health care professionals are able to demonstrate effective verbal and nonverbal communication abilities to prevent adverse events.” This key competence was specified as well.

Discussion

Summary

The analysis of CIRSmedical cases based on Taylor-Adams and Vincent’s framework of influencing factors [44] showed that team factors contributed by far the most frequently to critical events in the context of handovers, followed by task and technology factors, work environmental factors and individual staff factors. Among these team factors, verbal communication was reported most frequently to be associated with unsafe situations. The qualitative content analysis of the case descriptions confirmed these findings revealing that dissemination of information – missing information and incomplete/insufficient information – was the main reason for the critical events. The other reasons mentioned concerned the processes and standards which widely match with a variety of influencing factors according to the framework. Based on these results, key competences and specific skills needed to effectively manage handover situations could be derived. Consequently, the competencies for good communication and work in teams were found most relevant. Eventually, competencies from all domains of the Canadian competence catalogue were regarded as important for handovers. Pursuant to the CIRSmedical analysis, these competencies were needed the most in regular care delivered in the operating theatre and intensive care units, i.e. areas in which errors can quickly become life-threatening.

Table 6: Mapping of key competencies of the Canadian framework of safety competencies [48] to reasons for critical incidents/related subcategories and competencies specified for handover situations

Reason for critical incidents extracted from case reports	Subcategory	Domain and key competency [48]	Competencies customised for handovers
Communication (dissemination of information)	Missing information	**Domain 2: Work in Teams for Patient Safety:** Health care professionals are able to participate effectively and appropriately in an interprofessional health care team to optimise patient safety.	Health care professionals are able to participate effectively and appropriately in an interprofessional health care team to optimise patient safety *in particular regarding an understanding for the importance of quality control to avoid missing, incorrect and incomplete information and for the consequences of disregarding information in handover situations.*
	Incorrect information		
	Incomplete/ insufficient information	**Domain 3: Communicate Effectively for Patient Safety:** Health care professionals are able to demonstrate effective verbal and non-verbal communication abilities to prevent adverse events.	Health care professionals are able to demonstrate effective verbal and non-verbal communication abilities *in particular to ensure that the information is completely and correctly transferred and understood* to prevent adverse events *in handover situations*.
	Disregarding information		
Processes/ standards	Non-compliance process/ standard	**Domain 4: Manage Safety Risks:** Health care professionals are able to systematically identify, implement, and evaluate context specific safety solutions.	Health care professionals are able to systematically identify, implement, and evaluate context specific safety solutions *in particular with regard to the identification of reasons for non-compliance with handover and other processes and standards and their abolition*.
	Missing process/ standard	**Domain 1: Contribute to a Culture of Patient Safety:** Health care professionals are able to describe the fundamental elements of patient safety.	Health care professionals are able to describe the fundamental elements of patient safety *in particular the importance of handover and other processes and standards and how they can be implemented*.
	Disruptions/ deviations in process	**Domain 4: Manage Safety Risks:** Health care professionals are able to systematically identify, implement, and evaluate context specific safety solutions.	Health care professionals are able to systematically identify, implement, and evaluate context specific safety solutions *in particular to ensure compliance with handover and other processes and their smooth procedure*.
Documentation	Missing documentation	**Domain 2: Work in Teams for Patient Safety:** Health care professionals are able to participate effectively and appropriately in an interprofessional health care team to optimise patient safety.	Health care professionals are able to participate effectively and appropriately in an interprofessional health care team to optimise patient safety *in particular by using appropriate shared documentation to avoid missing, incorrect and incomplete information with the aim of achieving continuity of care across the team and in handover situations.*
	Incorrect documentation		
	Incomplete/ insufficient information	**Domain 3: Communicate Effectively for Patient Safety:** Health care professionals are able to apply communication technologies appropriately and effectively to provide safe patient care.	Health care professionals are able to apply communication technologies appropriately and effectively to provide safe patient care *in particular by using technologies such as Electronic Medical Records to ensure availability, completeness and accuracy of the documentation used in handover situations*.
	Disregarding documentation		

(Continued)

Table 6: Mapping of key competencies of the Canadian framework of safety competencies [48] to reasons for critical incidents/related subcategories and competencies specified for handover situations

Reason for critical incidents extracted from case reports	Subcategory	Domain and key competency [48]	Competencies customised for handovers
Medical equipment	Incorrect usage	**Domain 5: Optimise Human and Environmental Factors:** Health care professionals are able to appreciate the impact of human/technology interface on safe care.	Health care professionals are able to appreciate the impact of human/technology interface on safe care *in particular the correct use of medical equipment in conjunction with information technology*.
	Limited functionality/ out of order		
Positive impact of the handover	Detection of an error during or after handover	**Domain 6: Recognise, Respond to and Disclose Adverse Events:** Health care professionals are able to mitigate harm and address immediate risks for patients and others affected by adverse events and close calls.	Health care professionals are *particularly able to use handover situations* to mitigate harm and address immediate risks for patients and others affected by adverse events and close calls.
	Handover situation was used for training purposes	**Domain 1: Contribute to a Culture of Patient Safety:** Health care professionals are able to maintain and enhance patient safety through ongoing learning.	Health care professionals are able to maintain and enhance patient safety through ongoing learning, *in particular through the use of handover situations for the transfer of experience and knowledge*.

Validation of empirical findings

The empirical findings from the CIRSmedical database are not surprising and well backed by the literature. Poor communication belongs to the most frequent errors in handovers and is responsible in approximately 80% of critical events [49], [50], [51]: False [52] or inadequate [53] information is transferred, information is lost [52], [54] or not handed over [5], [12], [53], [54], [55], [56]. The quantity and quality of information, the variety of communication styles and the different expectations placed on communication also represent barriers to the exchange of information [20], [27]. A jargon-like language and inaccurate information can also lead to mistakes [52] as well as inconsistencies between the oral handover, medical record and observations [52], [57] when caused, for example, by missing or incomplete documentation [28]. Many of these errors are caused by a lack of standardisation [7], [20], [21], [58], which may also have led to the errors identified in this CIRS analysis in relation to the processes and standards. In addition to disturbances and interruptions during the handover procedure [18], [56], [59], inadequate environmental conditions such as inadequate premises [7] and lack of time [20], [27], [56] to conduct the handover can also exert a negative impact. A lack of teamwork, respect and blame can aggravate this effect [27]. It is well known that missing standards and process descriptions – as reflected in the CIRSmedical analysis – are causing problems in handovers and require measures to better structure and standardise handovers [20], [21], [22], [23] and thus to improve the transfer of information [23], [60], [61], [62]. In order to achieve all this, it is necessary to provide health professionals with the necessary skills for implementation. Lack of handover training is seen as a barrier to effective handovers [27], [28] and the importance of education and training in handovers to reduce errors, improve patient care and medical practice is described in the literature [5], [12], [27], [29], [63].

Limitations

The main drawback of many CIRS is their limited generalisability. In this sense, data from the CIRSmedical database were also found to be not representative and not suitable for systematic data analysis [64] mirroring the national state of affairs. The data available through CIRSmedical are too heterogeneous and do not cover all the institutions and situations in a consistent manner. As CIRSmedical is fed from different CIRS databases, each with different input screens, no uniform data structure and material is available. However, in our case, these flaws are of minor interest as there was no intention to study the prevalence of certain critical events. Moreover, the findings of the present study fit well into Taylor-Adams and Vincent's framework and were corroborated by the literature. In addition, the case reports could illustrate the safety relevant situations of handovers. After all, CIRSmedical is the best German CIRS database available. The number of cases reported in CIRSmedical is very small compared to other countries. Since its introduction in 2005, 6,749 cases have been recorded (status: 21.09.2020). In contrast, the National Reporting and Learning System (NRLS) of the National Health Service

(NHS) in England reported more than 500,000 incidents in the three-month period from July to September 2019 [65]. This high number of cases would allow a deeper and more detailed analysis of the handover situations. To be able to evaluate such large amounts of data as in England, it would have to be determined whether there are possibilities of automatic text evaluation or a corresponding tool would have to be developed based on our results.

Outlook: learning from CIRS

The findings suggest the development of handover competencies in all fields of the Canadian catalogue particularly concerning the domains of communication, work in teams, safety culture and management of safety. Handover training could, therefore, make use of concepts such as the sender-receiver communication models for raising awareness that information must be understood by the receiver and should be checked for correctness, completeness and up-to-dateness before being shared with colleagues in and across teams. In parallel, practical skills have to be developed to communicate accordingly, i.e. addressing the receiver in terms of terminology and content, deciding what is relevant and providing good case summaries [66]. This also means on the part of the receiver to be able to ask questions [67], listen actively and stand one's ground [20]. These skills go hand in hand with competencies on how and where to extract such information, in particular skills on how to utilise paper based and electronic records [68], [69]. Furthermore, this includes competencies for critical thinking, evaluating the information and realising that there are unsafe ways of managing information, e.g. usage of more than one patient record system [70]. The training should also concern methods for improving the information through better structure and standardisation, e.g. structuring information according to the Situation, Background, Assessment and Recommendation (SBAR) [60], [71], which leads to better communication capabilities, critical thinking [62] and fewer adverse events [60], [71]. These competencies and skills can be illustrated by the incidents reported – such as the ones presented in this study, i.e. typically negative examples, but also positive cases which demonstrate that handovers are essential for revealing errors.

Educational measures for improving handovers are useful in any kind of situation and location. However, they are particularly needed when patients are moved into and out of the operation room and intensive and intermediate care units as this study reveals.

In the case reports examined, information technology played no role or was only mentioned shortly. Nevertheless, due to the progressing technical developments, it is important to integrate digital competences into further training for handovers. This should be done with regard to the use of electronic health records [69], [72], [73] and other digital sources of information for handing over patients. However, digital competencies are also required when the training is offered as online or partly online courses.

The results of this study were recently used for the design of an online-training for nursing staff to improve patient handovers. The underlying didactic concept followed a problem-based learning approach, which uses a case vignette, a complex and realistic situation from everyday work, as a central element [74]. The topic of the vignette was informed by the reasons for critical incidents found in the present study and the problem task of the case vignette was developed accordingly. Currently, the findings of the testing and evaluation is being analysed, the results of which will be published at a later date.

Conclusion

The present study shows how empirical data from a CIRS database and theoretical frameworks can be combined to extract meaningful information about patient safety risks in handover situations. The model employed for this purpose was meant to root the dedicated findings from the CIRS case report analysis in the overarching framework of influencing factors affecting patient safety, hereby pinning down the breadth of the findings from the case reports for better systematisation. The resulting empirical categories for reasons of critical events in handovers could then be used to translate highly aggregated key competencies into handover specific competencies and situations. Providing this information promises to be very useful for the development of handover curricula in continuing education. Our approach of demonstrating how learning from CIRS data can be systematically conceptualised can also be transferred to other patient safety relevant processes and topics in the hospital.

Notes

Competing interests

The authors declare that they have no competing interests.

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