Aus der Kinderklinik und Kinderpoliklinik im Dr. von Haunerschen Kinderspital

Klinik der Ludwig-Maximilians-Universität München

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# Evaluation of postsurgical patient handovers at the interface between the operating room and the pediatric intensive care unit

Dissertation

zum Erwerb des Doktorgrades der Zahnmedizin

an der Medizinischen Fakultät der

Ludwig-Maximilians-Universität München

vorgelegt von

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aus

Ebersberg

Jahr

2023

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| Tag der mündlichen Prüfung: | 29. September 2023 |

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## Zusammenfassung

Postoperative Patientenübergaben[1] finden größtenteils nicht standardisiert statt und sind bei unzureichender Teamarbeit und ungünstigen Rahmenbedingungen im klinischen Setting fehleranfällig. Der Fokus unserer Studie lag auf Patiententransfers vom Operationssaal an die pädiatrische Intensivstation. Wir führten eine prospektive Interventionsstudie durch, um die Auswirkungen einer checklistenbasierten Intervention auf die Vollständigkeit von Patienteninformationen, die technische Ausrüstung und Aspekte der Teamarbeit zu evaluieren. Für die Datenerhebung wurde ein Mixed-Methods-Design mit strukturierten Beobachtungen von Übergaben im postoperativen Bereich und standardisierten Fragebögen zur Selbstbeurteilung für die beteiligten Berufsgruppen verwendet. Während der Ausgangserhebung erfolgte die Evaluation des nicht standardisierten Ist-Zustandes der Patientenübergaben. Anhand der Ergebnisse wurde der idealtypische Ablauf einer postchirurgischen Übergabe in multidisziplinärer Zusammenarbeit definiert und ein Übergabeprotokoll entwickelt, dessen Einfluss in der Folgestudie beobachtet wurde. Die Ergebnisse der 31 Übergaben der Ausgangserhebung, mit den resultierenden 103 Bewertungsbögen, wurden mit den 30 Übergaben und 110 Bewertungsbögen der Folgestudie verglichen. Wir konnten eine Verbesserung bei der Vollständigkeit der technischen Ausrüstung vor der Patientenübergabe feststellen sowie ein gesteigertes Niveau an Aufmerksamkeit der Teammitglieder. Die Präsenz der Beschäftigten der Kinderchirurgie nahm leicht zu, Patientenübergaben fanden dennoch häufig ohne einen Vertreter dieser Berufsgruppe statt. Die gleichzeitige Anwesenheit der beteiligten Berufsgruppen verdoppelte sich im Vergleich zur Ausgangserhebung. Die Ergebnisse deuten darauf hin, dass die Standardisierung des Übergabeprozesses einen positiven Effekt auf den Informationsaustausch und die Teamarbeit ausüben kann.

[1] Zur Vereinfachung und einfacheren Lesbarkeit wird im gesamten Lauftext nur die männliche Form verwendet, die weibliche und weitere Formen sind selbstverständlich eingeschlossen.

## Abstract

Postsurgical patient handovers are largely unstandardized task and error-prone if insufficient teamwork and unfavorable surrounding conditions occur in the clinical setting.

The focus of our study was on postsurgical patient handovers from the operating room (OR) to the pediatric intensive care unit (PICU). We conducted a prospective intervention study to assess the impact of a checklist-based intervention on the completeness of patient information, equipment preparation and teamwork characteristics. A mixed methods research design with structured observations of handovers in the designated area and standardized provider self-reports through questionnaires were used for data collection.

The results of the 31 patient handovers of the baseline study, with the resulting 103 ratings of involved providers were compared to the 30 handovers and 110 ratings of the follow-up study. During the baseline study, the non-standardized actual status of postsurgical patient handovers was assessed. Based on the results, an ideal-typical handover process was defined in multidisciplinary cooperation and the handover protocol developed, the influence of which was subsequently observed in the follow-up study.

We witnessed an improvement in the completeness of technical equipment preparation prior to patient handovers. The presence of team members from pediatric surgery increased slightly, but patient handovers still took place without a representative of this professional group in more than half of the cases. There was an improvement in the attention levels of all team members involved. The strongest change in the handover process could be determined with the simultaneous presence of participating team members, with a doubling value compared to the baseline study. The results indicate the positive effect of standardization of the handover process on the efficiency of information exchange and teamwork.

# 1 Background

## 1.1 Patient handovers (Definition, meaning, importance)

Patient handovers are defined as “the transfer of professional responsibility and accountability for some or all aspects of a patient or a group of patients to another person or professional group on a temporary or permanent basis” (Committee, 2004, p. 7). The passing of information to the receiving team is vital to the patient’s safety and continuity of care. Patient handovers can be structured into specific stages (Craig et al., 2012):

1) Equipment and theoretical preparation.
2) Arrival of patient, providing and receiving team.
3) Safe transitioning of patient.
4) Information handover (Medical history, surgical, anesthesiological).

Patients are handed over several times a day when there is a change of shift on the wards, following medical procedures and surgeries, after patients are admitted, discharged, or transferred from the hospital. During the transfer of a patient, there is both a transfer of information and responsibility for the patient's well-being. Increasingly multidisciplinary treatment concepts in modern medicine and rotating shift patterns with three or more shifts daily, lead to rising handover numbers (Chang et al., 2010; Craig et al., 2012). With information being handed over several times a day and the constant change of responsible medical personnel, handovers are error-prone and information losses can quickly occur. Thus, creating the risk of potentially endangering the patient with each transfer (Agarwal et al., 2012; Arora et al., 2005; Cohen et al., 2012; Zavalkoff et al., 2011). Handovers are consistently identified as a safety risk by leading healthcare organizations (Bigham et al., 2014). There is growing consensus in patient safety research that properly performed patient handovers are an important prerequisite for adequate interprofessional collaboration and high-quality clinical care. Despite this knowledge, most handovers in everyday clinical practice do not take place in a standardized manner and are subject to high variability with the risk of being unreliable

(Bomba & Prakash, 2005; Catchpole et al., 2010; Manser & Foster, 2011; Nagpal et al., 2010; Pezzolesi et al., 2010; Rehm et al., 2021; Riesenberg et al., 2009; Smith et al., 2008).

## 1.2 Postsurgical patient handovers

More than 313 million surgeries are performed worldwide yearly (Meara & Greenberg, 2015), generally followed by a handover from the operating team to the receiving unit. Postsurgical handovers represent the time frame and process by which the patient leaves the operating room and arrives at the site of their postoperative care, such as inpatient ward, recovery room, or intensive care unit (Møller et al., 2013). During postoperative handovers, health care providers from a wide variety of professional backgrounds meet ad hoc (Rehm et al., 2021). Ideally, the professional groups represented during a postsurgical handover are split into the providing and receiving team. The providing team usually consists of a surgeon, anesthetist and nurse anesthetist, while the receiving team is represented by a physician and nurse. Postsurgical patient handovers typically take place near or in front of the operating room or the recovery room, mostly in a distraction loaded environment and under time pressure, while the patient is in a vulnerable state (Smith et al., 2008). A substantial amount of information must be exchanged in a relatively short time frame about the patient's identification and medical history, the surgical and anesthesiological procedures as well as postoperative care and further treatments. It is specific to post-surgical handovers that there is not only an exchange of information, but also a physical transfer of the patient and the technical equipment, resulting in a window of reduced monitoring (Chenault et al., 2016; Segall et al., 2012). These transfers put postsurgical patients more at risk of handover mistakes (Nagpal et al., 2011). While information is being shared and received, the patient's condition must be monitored to identify potential complications or deteriorations that may arise (Møller et al., 2013). Unshared information can lead to avoidable errors in the subsequent patient treatment (Botti et al., 2009). Furthermore, postoperative complications show to have a greater impact on patient recovery than preoperative risk factors

(Khuri et al., 2005). With the majority of complications arising within three days following the surgery (Thompson et al., 2003).

## 1.3 Impact factors on postsurgical handovers

### 1.3.1 In general

Previous research investigates various environmental, process based and personal factors that impact the quality of postsurgical handovers: Manser and colleagues (2010) emphasize the multidimensional character of handover quality, with key components for effective and safe handovers being clear information transfer, shared understanding of the information being conveyed and a focused atmosphere. The working atmosphere in hospitals is often characterized by frequent staff changes, staff shortages, time pressure, high volume of work and complex information, interruptions and recurring disturbances from alarms, phone calls and emergencies. Since most postsurgical patient handovers are unstandardized, they are particularly vulnerable to the surrounding conditions and internal impact factors can have a negative effect on handover quality (Segall et al., 2016). Avoidable complications in postoperative patient care can be the consequence of flawed and insufficient information exchanges during postsurgical handovers (Manser et al., 2013). Therefore, it is particularly important to identify and understand negative impact factors and framework conditions to minimize their influence on the quality of the handover process.

### 1.3.2 Surrounding Conditions: Time pressure and interruptions

Time pressure consistently accompanies medical professionals involved in the handover process. As an example, in the hospital of our study the local PICU staff receives a call from the OR as soon as the patient is ready to be handed over post-surgery. The receiving team then makes their way to the OR. During their absence, the care of the patients on the ward has to be maintained by a smaller number of staff. The receiving team's aim subsequently is to minimize the duration of their absence. The providing team on the other hand, due to

strictly timed operating room schedules, is often under time pressure to attend the subsequent surgery, thus also interested in short and efficient patient handovers.

Weigl et al. (2014) demonstrate an association of the frequency of interruptions with a decrease in quality of teamwork and increased frustration levels among medical staff. Particularly nurses are dissatisfied with unstandardized handovers, as they are occupied by the care and positioning of the patient during the ongoing information exchange, which itself involves communication, leading to noise and distractions. Frequently there is no window for remaining questions and nurses are not included in the communication process. During patient handovers there are numerous sources potentially leading to interruptions. While focusing on the information transfer during the handover the team's attention needs to be on the patient's stable circulatory situation, ensured through monitoring and visual assessment. Alarms from the monitors, ventilator or a restless patient awaking from anesthesia lead to an interruption in the transfer of information. Other factors that may be the source of distractions and interruptions are the handover location, beeper calls and disruptions by colleagues. The handover location can vary greatly depending on the hospital's structural conditions. Handovers being executed in the corridor outside of the operating room are accompanied by frequent public traffic. Medical personnel and cleaning staff passing by and executing their work next to the handover can significantly increase noise levels. Reducing external distractions can result in a better understanding of crucial patient information and less information omission (Agarwal et al., 2012).

### 1.3.3 Technical skills, nontechnical skills and human factors during patient handovers

The quality of handover processes depends largely on the technical and nontechnical skills of the medical personnel involved (Manser et al., 2009). Technical skills relate to procedure specific skills such as medical knowledge and the use of technical equipment. The nontechnical skills represent the core characteristics of the human factors. These include cognitive (situational

awareness, decision making, problem solving), social and personal competencies (communication, teamwork, leadership), which in combination with the technical skills influence the effectiveness and safety of handover executions (Pezzolesi et al., 2013). In the medical field the focus is often primarily on technical skills and the development of improvement options in this regard, such as checklists and protocols (Catchpole et al., 2007). Nontechnical skills necessary to perform a patient handover effectively are mostly deemed self-explanatory and dependent on the skills and discretion of the medical personnel involved. Medical staff scarcely receives information and training regarding the importance of the handover process as well as inherent theoretical and practical implementations (Arora et al., 2005). Since efficient and safe patient handovers require teamwork to be more than just information transfer, it is important to pay attention to the nontechnical skills and human factors (Manser & Foster, 2011). Deficient staff training to the correct implementation of handovers in combination with missing standardization of the handover execution, has a negative impact on compliance with high clinical standards of patient care (Manser & Foster, 2011). A crucial nontechnical skill can be seen in situational awareness, which emerges as a cognitive ability that involves “the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future” (Endsley, 1988, p. 97). The participating team members must keep an overview and understanding of the dynamic environment and complex situation in which the patient handover is taking place while executing sensitive tasks at the same time (Weigl et al., 2020).

### 1.3.4 Communication

The Joint Commission’s (USA) National Patient Safety Goal 2E from 2007 and International Patient Safety Goal 2 from 2017, highly suggests improving effective communication during patient handovers through handover standardization. Nevertheless, information transfer in postsurgical handovers is frequently conducted verbally in an unstandardized manner and protocols

and documentations are rarely used. Agarwal et al. (2012) observe information omission of up to 43% during patient handovers solely conducted verbally, a finding consistent with previous study results (Greenberg et al., 2007; Smith et al., 2008). Communication is a factor with influence on the quality of the handover process. Patient handovers are not a simple act of communication, but a compound exchange of essential patient information. Patient information must be handed over on an interdisciplinary basis, often conducted under time pressure and with elevated levels of distractions. The quality of patient handovers eventually depends on the content of the conversation. Communication during handovers consists of the information conveyed by the providing team and the information heard by the receiving team. To improve the handover process, it is important to understand the causes of communication errors and their impact on patient safety (Cook et al., 2000). The shared content may be missing essential data and be formulated too vaguely (Johnson & Arora, 2016). Consequently, leaving room for interpretation by the receiving team. Chang et al. (2010) discover 60% of patient handovers to be missing most important patient information according to the receivers, whereas the providers strongly believe the opposite to be true. This can result from providers overestimating the receivers' understanding of shared content (Chang et al., 2010). Misinterpreted content can break the continuity of information transmission (Breuer et al., 2015). Leading to hesitant decisions in patient care or unnecessarily repeated examinations and treatments. Potentially culminating in inefficient, suboptimal patient care and harm (Arora et al., 2005). Through interviewing surgeons about possible causes of errors in patient treatment, faulty communication is found to be a leading system factor in more than two thirds of the cases (Gawande et al., 2003). Hierarchical structures, professional affiliation and cultural differences are also known to build communication barriers (Agarwal et al., 2012). With the medical staff receiving insufficient or no training in terms of handover communication, variability in the execution and quality in communication needs to be expected (Arora et al., 2005).

Successful communication during patient handovers enables a complete transfer and understanding of the important patient information and thus efficient and error-free postoperative care (Huth et al., 2021). Even though the receiving team is usually provided the patient's anesthesiological and surgical protocols, it is significantly more time consuming to scan these documents for crucial information than to receive valuable data verbally during the handover process. Sufficient information transfer during patient handovers ensures the team reacts instantly in case of an emergency in the postoperative care setting (Møller et al., 2013).

Studies implementing tools, such as checklists or protocols, to standardize patient handovers show to improve interdisciplinary communication (Huth et al., 2021). Addressing the most central content of patient information in a structured way leads to an increase in information flow (Lupei et al., 2021; Muensterer et al., 2021). Standardization is associated with a decrease in hierarchical structures, with team members being less hesitant to ask questions regarding unclear or missing information (Muensterer et al., 2021; Vergales et al., 2015). Frequently, checklists enable room for free communication and questions, which leads to improved levels of communication (Agarwal et al., 2012).

### 1.3.5 Leadership

Leadership can be defined as the endeavor to influence and guide the actions of a person or a group to accomplish common goals (Hjortdahl et al., 2009). Patient handovers are characterized by a spontaneous and temporary collaboration of representatives of multiple professional groups. The team composition of the personnel on site mostly varies with each patient handover, potentially leading to challenges in team interactions. For a structured and efficient exchange of information, it is beneficiary to have a team leader (Bigham et al., 2014). Good leadership during a patient handover is demonstrated through having an easily identifiable team leader, non-hierarchical, making and receiving clear announcements, a structured process and a sequential handover. Poor or unidentifiable leadership can negatively

impact teamwork and ultimately handover quality (Catchpole et al., 2007; Weigl et al., 2020). In other professional areas where utmost levels of precision have to be performed under time pressure, such as Formula 1 and aviation, the team leader is clearly defined (Catchpole et al., 2007). During patient handovers in healthcare leadership is often unclear and therefore carried out by the anesthetist in charge of monitoring the patient during surgery until the departure of the receiving team.

### 1.3.6 Postsurgical patient handovers from the OR to the PICU

Postsurgical handovers in our study stretch from pediatric patients leaving the operating room, until their arrival at the pediatric intensive care unit. Particularly complex cases necessitate a transfer of patients directly from the operating room to the intensive care unit to ensure close monitoring. The staff involved in the handover consists of the providing team with pediatric surgeon, anesthetist and nurse anesthetist and the receiving team with a pediatric intensive care specialist and pediatric nurse. The providing team is responsible for transporting the patient and equipment from the operating room or recovery room to the transfer location, while monitoring the mechanical ventilation and circulatory stabilization (i.e., vasodilators, catecholamines). Upon the arrival of the receiving team, the patient along with the technical equipment must be transferred for a second time to the intensive care's patient bed and connected to their portable equipment, while ventilation is often carried out manually (Catchpole et al., 2007). Transfer of information, gained during long hours of surgery, is frequently initiated during the physical patient transfer, creating a demanding situation for the receiving team, who is largely unfamiliar with the patient (Segall et al., 2012). Postsurgical transfers to the PICU are voluminous and particularly error prone for a variety of reasons (Zavalkoff et al., 2011). Shortly after surgery, patients are vulnerable and there is the risk of complications arising from the anesthesia or operation performed (Møller et al., 2013; Wheeler et al., 2018). During the patient handover a large amount of information must be passed on in an extremely detailed and complete manner. Teamwork between surgeons, anesthetists, nurses and intensive care

specialists can be insufficient due to different expectations regarding the information to be shared (Mukhopadhyay et al., 2018). Postsurgical handovers require multitasking and task switching between information exchange, patient transfer and monitoring, accompanied by time constraints and frequent interruptions (Shah et al., 2019). In addition, interventions to support patient handovers, such as checklists and/or protocols are scarce (Krimminger et al., 2018). The amount of studies dealing with patient handovers at the interface from the operating room to the pediatric intensive care unit, display the consistent interest in postoperative handovers due to their importance and complex role in the pediatric treatment process (Agarwal et al., 2012; Breuer et al., 2015; Catchpole et al., 2007; Chenault et al., 2016; Craig et al., 2012; Joy et al., 2011; Karakaya et al., 2013; Kaufman et al., 2013; Kim et al., 2012; Northway et al., 2015; Vergales et al., 2015; Zavalkoff et al., 2011). With the work environment on pediatric intensive care units frequently being highly stressful, errors resulting in patient harm cannot be ruled out (Kamath et al., 2016). Postoperative complications pose a higher risk to patient outcomes than preoperative or intraoperative factors (Khuri et al., 2005). Unshared information during postsurgical handovers is connected to avoidable errors and incidents on intensive care units (Botti et al., 2009; Lingard et al., 2004; Nagpal et al., 2010). It is therefore essential for involved medical professionals to attempt to ensure complete and error-free postsurgical patient handovers (Heinrich, 2021, p. 23).

### 1.3.7 Checklist based interventions to improve postsurgical handovers from the OR to the PICU

Patient handovers are recognized and identified as a high-risk factor for patient safety (Abraham et al., 2021). Various approaches to improve the handover process and to emphasize the importance of the topic are made (Manser & Foster, 2011).

Segall et al. (2012) summarize several recommendations in their meta-analysis of the existing research to potentially improve the handover process:

- Structured information exchange and patient handover
- Standardization through checklists and protocols
- Execution of patient care before information transfer
- Presence of all team members simultaneously
- Staff training on team skills and communication.

Handover interventions in the scientific literature and research are often based on the common goal of optimizing the handover process. While executing studies there is the option of either focusing on just one intervention or using a combination of several interventions (bundle interventions), i.e., checklists and a protocol, with ultimately analyzing their joint effects. According to the meta-analysis of Abraham et al. (2021), the majority of postsurgical handover studies use a combination of process-based protocols and communication/transfer checklists, mainly paper based.

Patient handovers executed without the use of a handover checklist or protocol tend to lead to a loss of information and a high level of variance regarding the information being shared (Rehm et al., 2021; Siddiqui et al., 2012). Standardizations are an effective method to create a shared understanding of a situation (Manser et al., 2009). Previous studies using standardized checklists show a significant decrease in information loss and technical errors as well as improved teamwork and communication, culminating in higher patient safety (Craig et al., 2012; Joy et al., 2011; Zavalkoff et al., 2011). Increase in provider satisfaction can be noticed, as well as reduced amounts of interruptions and distractions during the handovers (Bigham et al., 2014). By implementing a protocol for handovers from the OR to the cardiac PICU at each bedside in combination with staff training and task allocations, Catchpole and colleagues (2007) succeed in improving teamwork and reducing technical errors, without increasing the duration of the handover process, which is an important aspect given the inherent time pressure. However, the statistical and

clinical heterogeneity of the various studies must be considered when interpreting the results (Abraham et al., 2021; Agarwal et al., 2012).

Checklists entail important topics and key points that should ideally be processed in the given order so that crucial information or steps are not missed (Muensterer et al., 2021). In other professional areas requiring the highest levels of precision, checklists are already used in a targeted manner, such as Formula 1 and aviation (Catchpole et al., 2007). If successfully established, checklists can facilitate communication between those involved in patient handovers by structuring and visualizing the crucial patient data. Additionally, checklists that establish a set time frame for questions to be asked show to flatten hierarchical structures (Agarwal et al., 2012; Gillespie & Marshall, 2015; Weinger, 2021).

Since requirements, work processes and circumstances in everyday clinical practice may vary greatly in hospitals and different countries, the majority of pediatric handover intervention studies initially analyze the current handover status in the respective clinic in a baseline study, using various methods.

Breuer et al. (2015) identify existing challenges during postsurgical pediatric handovers using an online survey distributed to the participating professional groups. Further options for baseline assessment contain personal interviews with medical professionals (Zavalkoff et al., 2011) or direct observations by an expert combined with questionnaires regarding the patient handover, distributed to participating providers (Heinrich, 2021, pp. 29-30)

Subsequently, the development of an intervention is carried out through multidisciplinary cooperation of participating professional groups, followed by the implementation and observation in a follow-up study (Agarwal et al., 2012; Bigham et al., 2014; Breuer et al., 2015; Riley et al., 2017; Sochet et al., 2016; Zavalkoff et al., 2011). Sochet et al. (2016) introduce a multidisciplinary checklist with clear expectations aimed at information exchange and a structured timeline for the postsurgical patient handover, handed out to all stakeholders at the onset of the handover process. Evaluation of the collected checklists shows increased attendance of participating team members, reduced handover duration as well as improved information exchange. Riley

et al. (2017) establish an illustration depicting an ideal room set up with staff positioning and placement of technical equipment in addition to a standardized checklist to clearly separate equipment set up from information exchange. Malenka et al. (2018) hand out copies of the handover checklist to all participating team members prior to the patient handover to create awareness for information that is expected to be shared. Completeness of shared information is then rated by an observer using a protocol. Rehm et al. (2021) compare the effectiveness of an electronic checklist to an already established paper-based checklist, with no difference in staff satisfaction or shared information being shown. Following the implementation of a handover checklist, Chenault et al. (2016) conducted a third observation regarding its sustainability. Technical errors as well as loss of information are still significantly reduced compared to the preintervention results.

Despite the increasing number of checklist-based intervention studies in the postoperative pediatric field and their positive results, the majority of conducted handovers in everyday clinical practice are still not standardized. Interventions are adhered to or accepted only to a limited extent and data regarding the durability of the improvement is minimal. The majority of studies specifically analyzing patient handovers from the operating room to the pediatric intensive care unit are conducted in the USA (Agarwal et al., 2012; Breuer et al., 2015; Catchpole et al., 2007; Chenault et al., 2016; Joy et al., 2011; Kamath et al., 2016; Karakaya et al., 2013; Kaufman et al., 2013; Malenka et al., 2018; Nakayama et al., 2012; Northway et al., 2015; Riley et al., 2017; Sochet et al., 2016; Vergales et al., 2015). The existing studies largely focus on specific medical areas such as cardiovascular or cardiothoracic surgeries (Agarwal et al., 2012; Chenault et al., 2016; Kamath et al., 2016; Karakaya et al., 2013; Rehm et al., 2021).

It is questionable whether interventions applied in specific medical fields and their results can be applied to other clinical settings (Møller et al., 2013). Therefore, studies covering a broader range of pediatric surgical specialties are needed, particularly in the European health care system.

Main outcome measures of existing studies focus on the assessment of handover quality, with regard to patient safety/outcome, completeness of transmitted information and technical errors as well as handover duration (Møller et al., 2013). While these points represent key characteristics of patient handovers, the complexity and dynamics are not fully represented (Manser & Foster, 2011). Only few studies analyze team performances with regard to non-technical skills (Catchpole et al., 2007; Joy et al., 2011; Weigl et al., 2020). The potential impact of standardization on non-technical skills needs to be further investigated. The completeness of information transmitted is mostly assessed by an observer during the handover, however, it remains unclear how much information is being received and understood by the receiving team for further treatment on the PICU.

Our intervention study aims to standardize and investigate all postsurgical patient handovers to the multidisciplinary PICU. We examine the influence of a checklist-based intervention on the quality and completeness of the technical equipment preparation, team set-up and the completeness of transmitted information. In addition, we focus on the impact of standardization on team performance characteristics during patient handovers, with comparison of assessments of the expert and the providers, to analyze potential variances in perception. Moreover, by subsequently handing a questionnaire to the intensive care specialist, we are attempting to identify potential missing or unclear information as well as the quality and completeness of shared information during the patient handover.

# 2 Questions of our study

Overall, this study aims to evaluate the effects of a handover improvement intervention and to compare handover assessments between baseline and follow-up assessment.

Specifically, this investigation in pediatric care evaluates the impact of a participative improvement project for postsurgical patient handovers with implementation of a handover checklist over time for the following outcomes:

1) Quality of equipment preparation and team set-up before handover
2) The volume and quality of the information and contents conveyed (i.e., patient information, anesthesiological and surgical information)
3) Team performance characteristics, both expert- and provider rated (i.e., leadership, teamwork, communication, workspace, equipment, and situational awareness)
4) Completeness of medical patient information for further treatment on the PICU (rated by receiving PICU physician).

# 3 Methods

## 3.1 Study design

We applied a prospective evaluation study on postsurgical patient handoffs to identify the participative, systemic change of postsurgical patient handovers after implementation of a handover checklist. Data collection at either time points (i.e., baseline as well as follow-up) was carried out using a combination of various approaches: A mixed methods research design was conducted with structured observations of handovers from the operating room (OR) to the pediatric intensive care unit (PICU) and standardized provider self-reports through questionnaires. The data collection period of the baseline study ran from August 2017 until April 2018. Data collection for the follow-up study started three years later in April of 2021 and lasted until May of 2022.

Ethical approval was granted by the Ethics Board of Medical Faculty, Ludwig-Maximillians-University Munich (17-155). Prior to the study, the participants were informed in writing and verbally through team meetings. All employees signed a letter of informed consent. Participation was on a voluntary basis. The anonymous questionnaires were matched through serial numbers of observed handovers, as well as date of the observation. No personal patient information was collected.

## 3.2 Hospital setting and postsurgical patient handoffs

The study was conducted in an academic pediatric hospital in Germany with a total of 211 beds, 119 pediatric beds with 61 additional beds for pediatric surgery. Being highly specialized, it covers all fields of pediatric care and is one of the largest hospitals of its kind in Europe, with around 41,500 outpatients and 6,000 inpatients per year.

The PICU incorporates fourteen intensive care beds with ventilators, including isolation units for burn patients, immunosuppressed or infectious children and fully equipped units to ensure continuous neuromonitoring. Treatment for all emergency and intensive care subspecialities ranging from infancy to adolescence is provided. The expert medical staff consists of approximately 40 nurses, four senior physicians, four pediatric intensive care specialists as

well as four residents, who are continuously responsible for securing medical supplies through rotating shifts.

The study focused on postsurgical handoffs from the operating room to the pediatric intensive care unit. The receiving PICU Team consists of an intensive care specialist as well as a pediatric nurse. The providing team is generally represented by a pediatric surgeon as well as the anesthesia team, consisting of anesthetist and nurse anesthetist. 30 minutes prior to the handover the receiving team is informed through the OR anesthetist by phone about the foreseeable end of the surgery and approximate handover time. Hence preparation of the hospital bed as well as of the technical equipment, necessary for transportation, is carried out. Equipment includes blood pressure cuffs and a monitor, syringe pumps, ECG machine, oxygen tank and a ventilator. The intensive care specialist on duty informed the observer by phone once the patient was taken into the OR and again 30 minutes prior to the handover. As soon as the patient was ready for pick up, the receiving team with transport equipment and the observer headed to the transfer area. Due to the lack of a designated transfer area patient handoffs mainly take place in the narrow hallway between the entrance to the sterile OR and the anesthetic recovery room. Thus, distraction levels during daytime handoffs are high and medical staff as well as cleaning staff regularly pass by, leading to a significant amount of background noise. If a patient requires further monitoring before transfer to the PICU, handoffs take place in the anesthetic recovery room. Septic procedures lead to handoffs in front of the entrance to the septic operating room.

### 3.3 Handover checklist

During the baseline study postsurgical patient handovers were executed in an unstandardized manner and the current handover situation was assessed without interfering in workflows through a trained observer (see attachment 1 and 2). Based on the findings of the baseline study, an ideal-typical process of standardized postsurgical patient handovers was defined through interdisciplinary cooperation between representatives of surgery, anesthesia,

pediatric intensive care medicine, pediatric nursing and the representatives of the research group. This consensus was achieved via repeated inter professional meetings. Standardization of patient handovers was then attempted through the development and establishment of a multidisciplinary handover checklist, used as a communication tool, representing the central content of communication for the individual participating professional groups.
The checklist provides a structured and logical framework for teamwork and timeline during patient handovers, expectations of verbal data exchange for each discipline and encourages time for questions prior to the departure of the receiving team. Since our intervention was carried out in a teaching hospital with frequent staff changes, the checklist itself was designed to be self-explanatory. A wall poster was created from the developed checklist, which was placed in the corridor in designated handover areas such as in the corridor in front of the entrance to the operating room and in front of the aseptic operating room (see attachment 5). The intervention itself and intention of the study were regularly brought to discussion in staff meetings by the intensive care specialist guiding the study.

## 3.4 Sample

### 3.4.1 Sample of handoffs and the teams

We used a convenience sample approach for each wave. Handoffs of intubated as well as non-intubated postoperative pediatric patients from infancy to adolescence were included. Surgery indications covered all pediatric fields. Included handovers were surgical interventions lasting longer than 30 minutes. To ensure regular staffing only daytime handovers from 8am until 6pm were included (Weigl et al., 2020). All doctors and nurses taking part in transfers were considered eligible.
For initial skill adaption training of the observer, five postsurgical patient handovers from February 2021 until April 2021 were monitored in the presence of an experienced observer to familiarize the observer with the evaluation sheets and the observation in the designated clinical setting. The two experienced observers were a senior human factors researcher and a leading

pediatric intensive care specialist, both of whom had taken part in the execution and design of the baseline study.

Following the training period, 30 handovers were observed from April 2021 until April 2022, for the follow-up assessment. In the data gathering period four handovers were missed due to time shortages or missing notification of the observer regarding the ongoing patient handover. Throughout our research period scheduled surgeries were cancelled or postponed frequently due to the Covid-19 pandemic. During postsurgical patient handovers one member of each of the following five professions is supposed to be present:

- Pediatric surgeon
- Anesthetist
- Nurse anesthetist
- Pediatric intensive care specialist
- Pediatric nurse

### 3.5 Data collection procedure

Before the handover, the trained observer accompanied the receiving PICU team to the transferring area, documenting equipment preparation prior to the arrival of the providing team. Physical patient transfer was mostly executed preceding the handover, meaning the physical handover from the OR bed and equipment (i.e., ventilator, monitors) onto the PICU's patient bed and equipment. Once both teams were present and situations allowed, they were informed about the handover being included in the study.

During the handover, the observer monitored all activities with adequate distance, neither taking part in it nor disrupting the process. The presence of all participating team members was documented directly before the start of information exchange and throughout the duration of the handover process (see attachment 1). Team members leaving before the end of the patient handover led to exclusion from provider self-reports, since evaluation of the entire handover process would not have been accurate. Conveyed information was checked off as presented on the observer's evaluation sheet. Unmentioned content was classified as missing or non-applicable. Afterwards,

the teams' nontechnical skills were evaluated by the observer. While the patient was taken to the PICU by the receiving team, providing team members filled in the paper-based survey rating nontechnical skills during the handover. Ideally, once the receiving team had ensured the patient's primary care on the PICU, both pediatric nurse and pediatric intensive care specialist filled the same survey in and returned it directly to the observer. An additional questionnaire was handed out to the intensive care specialist for evaluation of completeness of the received information. With patient safety being the focus at all times and due to time shortages, staff questionnaires often could not be filled out shortly after the handover and were later returned to the observer through internal mail.

## 3.6 Measures and instruments

### 3.6.1 Observational measures of handover performance

Postsurgical patient handovers were observed applying standardized team performance evaluation tools based on the established original version by Catchpole et al. (2007). The questionnaire was composed of three parts:

1) Evaluation of equipment tasks and preparation prior to information exchange
2) Completeness of patient information (general, surgical, anesthesiological)
3) Evaluation of nontechnical skills.

1) Equipment tasks were documented before and during the physical patient transfer to the receiving team's patient bed, monitors, syringe pumps and ventilator, including setting of alarms and adequate placement of surgical drains. Ideally being completed before information exchange, ensuring a disturbance free handover window with a stable patient. Prior to the start of handover information exchange equipment completeness as well as presence of all participating receiving and providing team members was documented through the observer (see attachment 1).

2) Patient information was divided into three categories. General patient information included name, age, medical history, allergies, name of the surgical procedure and current state of the patient. Anesthesiological information contained history and complications during anesthesia, given medication and fluid management. Surgical information included surgical history and complications, blood loss, placement of surgical drains, further antibiotic and anticoagulant treatment, dietary requirements, and necessary postoperative examinations.
The observer documented the observational content in 1) and 2) on the evaluation sheet as “given”, “not given” or “non applicable” for each handover. No further information was collected and the identity of the patient as well as the participants remained anonymous (see attachment 1).

3) The third part contained the observer’s evaluation of the participants’ nontechnical skills during the handover (see attachment 2). Six categories were rated using a five-point Likert scale (1 = very poor, 5 = very good). The standardized team performance assessment tool used was specifically designed for the assessment of postsurgical patient handovers with multidisciplinary teams (Catchpole et al., 2007):

- Leadership: e.g., easy to identify team leader, clear structure
- Teamwork: e.g., mutual support, good coordination
- Cooperation and resource management: e.g., performance of designated tasks at the right time
- Communication and interaction: e.g., explicit, clear expression
- Workspace and equipment: e.g., adequate equipment, available when needed
- Situational awareness: e.g., monitors visible, recognition of patient state

### 3.7 Survey content

All participating team members present throughout the entire handover process received a paper-based survey consisting of two parts (see attachment 3):

1) Evaluation of nontechnical skills during the handover
2) Professional occupation and years of work experience

1) The evaluation of nontechnical skills executed during the handover was identical to the content rated by the observer (see paragraph 3.6.1., part 3). A scale ranging from one = “very poor” to ten = “very good” was used.

2) Furthermore, professional occupation and years of work experience were assessed. Occupation: e.g., nurse, anesthetist, pediatric surgeon. Years of occupation: e.g., less than five years, five to ten years, more than ten years.

The intensive care specialist who participated in the postsurgical handover received an additional questionnaire to evaluate the completeness and accuracy of the information given by the providing team (see attachment 4). The questionnaire was developed by the hospital’s intensive care specialists and specifically adjusted to the intensive care unit of the study. The content was identical to the information documented by the observer. Necessary information and instructions for further treatment on the intensive care unit were crossed off as “given”, “non given” or “non-applicable”.

### 3.8 Interviews

Subsequently to the follow-up’s data collection period an open-ended structured interview was conducted. The success of measures to improve patient safety can vary greatly in different clinical settings. The objective of the interview was to gain a deeper understanding concerning the implementation state and process since the start of the intervention in June 2018. Furthermore, the aim was to identify challenges in everyday clinical practice that can influence and potentially complicate the implementation of simple interventions. The group of surveyed participants consisted of two representatives from each care profession being active stakeholders in the process of postsurgical handovers, i.e., anesthesia, surgery, nursing, and

intensive care medicine. Written consent was obtained in advance and the participants remained anonymous.

A total of eight interviews were conducted face-to-face in April 2022, with an approximate duration of 20 minutes per interview. Answers were noted digitally, and no personal information was collected. The interview contained four questions to determine and specify context features (including barriers and facilitators for implementation) in the designated hospital to analyze the potential impact of such on the results of our study. The analysis of framework conditions should enable a clearer interpretation of results and replication of the intervention for further research.

### 3.9 Statistical Analysis

The completed questionnaires were entered into an Excel database and subjected to a quality control to rule out input errors. The statistical analysis of the data was divided into the following steps: Descriptive statistics of the study variables were calculated. The contents of the questionnaire and the observations were checked regarding their mean tendencies and variance (i.e., mean values and standard deviation). To answer the research question, inferential and multivariate analyses were carried out. One-way analyses of variance (ANOVA) were calculated for group comparisons, i.e., mean-difference test between pre- and post-intervention phases. Correlation analyses (according to Pearson, correlation index r) were used for the purpose of determining relationships. All analyses were performed with SPSS 29 (IBM Inc., Chicago). The level of significance was set at $p < 0.05$.

# 4 Results

## 4.1 Number of observed handovers and surveys

During the baseline study, 31 postsurgical patient handovers from the operating room to the pediatric intensive care unit were examined. Throughout those, 103 questionnaires provided by medical professionals participating in the patient handovers were collected (see table 1).

Table 1: Distribution of questionnaires, overall and per professional group (baseline study)

| **Professional group** | | **Target value of questionnaires** | **Actual value of returned questionnaires** | **Actual value (%)** |
|---|---|---|---|---|
| **Overall** | | 155 | 103 | 66,5% |
| **Providing team** | Anesthetist | 31 | 30 | 96,8% |
| | Nurse anesthetist | 31 | 13 | 41,9% |
| | Pediatric surgeon | 31 | 4 | 12,9% |
| **Receiving team** | Pediatric intensive care specialist | 31 | 31 | 100% |
| | Pediatric nurse | 31 | 25 | 80,6% |

The results of the baseline study were subsequently compared to the results of the follow-up study (see table 2).

Table 2: Distribution of questionnaires, overall and per professional group (follow-up study)

| **Professional group** | | **Target value of questionnaires** | **Actual value of returned questionnaires** | **Actual value (%)** |
|---|---|---|---|---|
| **Overall** | | 150 | 110 | 73,3% |
| **Providing team** | Anesthetist | 30 | 33 | 110% |
| | Nurse anesthetist | 30 | 11 | 36,7% |
| | Pediatric surgeon | 30 | 12 | 40% |
| **Receiving team** | Pediatric intensive care specialist | 30 | 31 | 103,3% |
| | Pediatric nurse | 30 | 23 | 76,7% |

During the follow-up study, 30 postsurgical patient handovers from the operating room to the pediatric intensive care unit were examined. All handovers took place between 2pm and 6pm. Patients in both groups were not significantly different in terms of age, gender, and severity of illness. Ideally, one member of one of the five above mentioned professional groups should be present during a postsurgical handover and fill out a questionnaire post-handover. If one representative of each professional group filled a questionnaire out, this would result in a total of 150 questionnaires. In the follow-up study, 110 completed questionnaires were eventually returned. At least one pediatric intensive care specialist completed a questionnaire during every observed handover. The response rate of 103,3% means, that this professional group was occasionally represented by more than one member. Anesthetists (110%) were present in 29 of the 30 patient handovers and also occasionally represented by more than one member. We received 12 questionnaires from the surgeons and 11 from nurse anesthetists. Their participation rates during postsurgical handovers were significantly lower (surgeons 40%, nurse anesthetist 36,7%).

## 4.2 Question 1: Equipment preparation and team set-up before handover

With the first question of our study, we examined the quality of equipment preparation and team set-up prior to the patient handover and compared the results to the data of the baseline study. Prior to the start of information exchange as part of the patient handover, the completeness of the equipment tasks was assessed. This included the setting of monitors and alarms, the appropriate placement of surgical drains, cables, urine bags and syringe pumps. Furthermore, the final completeness of the equipment was assessed immediately before starting the information transfer of the patient handover. The equipment tasks were marked as “yes” when properly executed, or as “no” or “non applicable”. All items were aggregated into an overall value (i.e., percentage of applicable items observed). Table 3 shows the mean sum score

of the six items representing completeness of equipment preparation as rated by the present observer, prior to the patient handover:

Table 3: Comparison of equipment preparation between baseline (n = 31) and follow-up (n = 30) study

| Feature | Baseline M (SD) | Follow up M (SD) | Test of significance F (df) | p |
|---|---|---|---|---|
| **Equipment preparation (%)** | 79,34 (22,80) | 98,57 (5,76) | 20,10 (60) | < 0,001 |

Annotation: Scale range: “yes”, “no”, “non applicable (N/A)”; SD: Standard deviation; df: Degrees of freedom; p: Level of significance

Our evaluation shows statistically significant improvement ($p < 0,001$) in the execution and completeness of equipment tasks between the baseline and the follow-up.

Additionally, team set-up was checked for completeness before the immediate start of the patient handover. It was noted whether a member of each professional group was present. Attendance was documented with “yes” if present, “no” or “non-applicable”. Moreover, the attention of all participating team members and their simultaneous presence was documented. A prematurely withdrawing team member resulted in a “no” rating for “whole staff present at the same time”. Table 4 displays the overall mean percentage of the team set-up prior to the patient handover.

Table 4: Comparison of team set-up between baseline (n = 31) and follow-up (n = 30) study

| Feature | Count baseline | Baseline presence (%) | Count follow-up | Follow up presence (%) |
|---|---|---|---|---|
| **Pediatric nurse** | 31 | 100 | 30 | 100 |
| **Anesthetist** | 31 | 100 | 29 | 96,7 |
| **Intensive care specialist** | 31 | 100 | 30 | 100 |
| **Pediatric surgeon** | 12 | 38,7 | 13 | 43,3 |
| **Nurse anesthetist** | 18 | 58,1 | 16 | 53,3 |
| **Whole staff attentive** | 23 | 88,5 | 28 | 93,5 |
| **Whole staff present at the same time** | 8 | 32 | 21 | 70 |

Annotation: Scale range: “yes”, “no”, “non applicable (N/A)”

The attendance of intensive care specialists and pediatric nurses was 100% at both time points. There was a minimal decrease in the attendance of anesthetists (96,7%), since a representative was present at all handovers in the baseline study, however, one handover was executed without an anesthetist in the follow-up study. Regarding the presence of a nurse anesthetist, a moderate decrease in attendance was measured from 58.1% to 53.3% in the follow-up. In contrast, the attendance of surgeons increased from 38.7% to 43.4%, with participation rates still below 50%. Improvement could be noted in the simultaneous attention of the team members during the patient handover. The percentage increased from 88.5% to 93.4%. An increase of attendance of all team members was observed, with attendance doubling from 32% to 70% in the follow-up study.

### 4.3 Question 2: Volume and quality of information and contents conveyed

In the second question of our study, the volume and quality of patient information conveyed during the handover process was divided into three sections and assessed according to the professional group currently handing over the information. The observer distinguished between general, anesthesiological and surgical patient information, as seen in table 5.

The information exchange of the patient handover was initiated by exchanging general patient information. The corresponding section in the evaluation sheet (see attachment 1) consisted of seven items such as name, age, medical history, allergy status, diagnoses, name of surgical procedure and current condition of the patient. The transmission of the general patient information was ideally provided by the responsible surgeon, but often taken over by the anesthetist, stemming from the frequent absence of the surgeons.

The anesthesiological information included the anesthesiological intraoperative course and complications, blood transfusions given, long-term medication/premedication, medication administered intraoperatively (e.g., catecholamines, antibiotics), pain and fluid management, accesses (e.g., intravenous, arterial) and multi-resistant pathogens. The corresponding section on the evaluation sheet thus consisted of eight items.

The surgical patient information was documented through eight items, consisting of intraoperative surgical course and complications, estimated blood loss, amount and placement of surgical drains (including further necessary procedures), anticoagulation, further antibiotic treatment, dietary requirements/fasting, existence of drawings of surgical areas as well as required postoperative examinations (e.g., ultrasound, X-ray).

Mentioned patient information of the three groups was marked with “yes” if given, “no” if missing and “non applicable” if not relatable to the patient case. If a surgeon or anesthetist were absent during the patient handover, the entire respective information group was marked as “no” for missing and not given.

Table 5: Volume and quality of information and contents conveyed (in %)

| Feature | Baseline M (SD) | Follow-up M (SD) | Test of significance F (df) | p |
|---|---|---|---|---|
| **General patient information** | 66,71 (26,66) | 79,31 (23,10) | 3,81 (59) | 0,056 |
| **Anesthesiological information** | 78,57 (14,90) | 87,27 (9,66) | 7,26 (60) | 0,009 |
| **Surgical information** | 36,02 (25,92) | 31,67 (37,53) | 0,28 (60) | 0,599 |

Annotation: Scale range: “yes”, “no”, “non applicable (N/A)”; SD: Standard deviation; df: Degrees of freedom; p: Level of significance

Regarding the general patient information, an increase (p = 0.056) in the completeness of exchanged information could be determined after the implementation of the checklist and intervention, with the difference remaining insignificant. The same effect was found in relation to the anesthesiological information, with a significant increase in shared information (p = 0.009). In contrast, slightly less surgical information was shared than in the baseline study, with the difference over time being insignificant (p = 0,599).

### 4.4 Question 3: Team performance characteristics expert and provider rated

Next, we examined whether the establishment of our checklist and intervention had an impact on team performance characteristics. Team performance characteristics evaluated in our study consisted of leadership, teamwork, cooperation, communication, workspace and environment as well as situational awareness. Handover team performance characteristics were judged according to the above-mentioned categories on a scale of one to five rated by the experts. To examine the effectiveness of the checklist, the comparison between baseline and follow-up study was as following (table 6):

Table 6: Team performance characteristics, expert rated

| Feature | Baseline M (SD) | Follow-up M (SD) | Test of significance F (df) | p |
|---|---|---|---|---|
| **Leadership** | 3,16 (0,78) | 4,50 (0,73) | 47,84 (60) | < 0,001 |
| **Teamwork** | 3,69 (0,64) | 4,57 (0,73) | 24,75 (60) | < 0,001 |
| **Cooperation and resource management** | 3,29 (0,74) | 4,60 (0,72) | 48,85 (60) | < 0,001 |
| **Communication** | 3,40 (0,76) | 4,40 (0,86) | 25,66 (60) | < 0,001 |
| **Workspace and equipment** | 3,20 (0,87) | 4,60 (0,68) | 46,84 (60) | < 0,001 |
| **Situational awareness** | 3,35 (0,71) | 4,80 (0,48) | 85,80 (60) | < 0,001 |

Annotation: Scale range: 1 “very poor” to 5 “very good”; SD: Standard deviation; df: Degrees of freedom; p: Level of significance

Our evaluation shows that all six-expert rated team performance characteristics improved significantly after the checklist was established (p = < 0,001).

When assessing the team performance characteristics by the participating professional groups, the identical rating scale and characteristics were used. The evaluation took place immediately following the patient handover by means of questionnaires. Again, a comparison was made with the results of the baseline study. The results can be seen in table 7:

Table 7: Team performance characteristics, provider rated

| Feature | Baseline M (SD) | Follow-up M (SD) | Test of significance F (df) | p |
|---|---|---|---|---|
| **Leadership** | 3,84 (0,42) | 3,75 (0,57) | 0,55 (60) | 0,46 |
| **Teamwork** | 4,12 (0,40) | 4,11 (0,50) | 0,002 (59) | 0,97 |
| **Cooperation and resource management** | 3,68 (0,56) | 3,82 (0,48) | 1,22 (60) | 0,28 |
| **Communication** | 3,96 (0,42) | 3,88 (0,65) | 0,30 (60) | 0,60 |
| **Workspace and equipment** | 3,89 (0,50) | 3,96 (0,48) | 0,35 (60) | 0,56 |
| **Situational awareness** | 3,93 (0,45) | 4,01 (0,52) | 0,40 (60) | 0,54 |

Annotation: Scale range: 1 “very poor” to 5 “very good”; SD: Standard deviation; df: Degrees of freedom; p: Level of significance

Leadership was rated slightly lower in the follow-up study than at baseline (M = 3.75 instead of M = 3.84), as were teamwork (M = 4.11 instead of M = 4.12) and communication (M = 3.88 instead of M = 3.96). However, the differences between the three team performance characteristics were insignificant (leadership: p = 0.46; teamwork: p = 0.97; communication: p = 0.60). On the other hand, the characteristics workspace and equipment (M = 3.96 instead of M = 3.89) and situational awareness (M = 4.01 instead of M = 3.93) were rated more positively in the follow-up study. Similarly, this difference was insignificant.

## 4.5 Question 4: Completeness of medical patient information for PICU care

The fourth question dealt with the topic of whether the intervention lead to an improvement in the completeness and correctness of the medical patient information received by the intensive care specialist in charge of further treatments on the PICU. For this purpose, the intensive care specialist present during the patient handover received an additional questionnaire. This

questionnaire consisted of nine questions analyzing whether the following patient information was provided: medical accesses, long term medication, intraoperative blood loss, dosage of catecholamines, location of surgical drains, antibiotic therapy, duration of fasting, further treatments, structured handover by a surgeon on the ward two hours postoperatively received. The questions were rated with “yes” when the information was received, “no” if unknown and “non applicable” if not applicable to this patient’s case. The final question regarding the surgeon’s handover within a two-hour window was only rated with “yes” or “no” since it was considered applicable for any patient case. The comparison of the percentages of completeness of medical information can be seen in table 8:

Table 8: Completeness of medical patient information for further treatments on the PICU

(in %)

| **Feature** | **Baseline M (SD)** | **Follow-up M (SD)** | **Test of significance F (df)** | **p** |
|---|---|---|---|---|
| **Completeness of medical patient information** | 65,91 (22,60) | 76,15 (19,40) | 3,60 (60) | 0,063 |

Annotation: Scale range: “yes”, “no”, “non applicable (N/A)”; SD: Standard deviation; df: Degrees of freedom; p: Level of significance

The result of the follow-up study (76,15%) showed an improvement in the completeness of the received patient information compared to the baseline study (65,91%), yet the difference was insignificant (p = 0,063).

## 4.6 Results of post intervention interviews on intervention processes and implementation

The initial question of the interview attempted to analyze whether the different professional groups involved had obtained knowledge regarding the conducted study and its current status. All interviewed representatives were aware of the attempt to standardize postoperative patient handovers and to establish checklists in the operating room.

The second question of the interview attempted to identify success and obstacle factors for the standardization of patient handovers in the clinic. With the anesthesia department of the surveyed hospital already having a standardized anesthesiological handover checklist prior to the intervention, anesthetists were accustomed to executing structured patient handovers among their professional group, which was mentioned to be a success factor for the implementation.

The obstacle factors mentioned included frequent interruptions during patient handovers, long duration of patient handovers and time pressure. The frequent absence of pediatric surgeons was also deemed to negatively impact the handover process. When the pediatric surgeons were interviewed regarding obstacle factors it turned out that extended waiting times leading to the execution of the patient handover following the operation resulted in a temporal overlap with the subsequent operation. This, in combination with the obligation to create a surgical report immediately after the operation often made it impossible for pediatric surgeons to attend the patient handovers under study. In our study surgical handovers were largely carried out individually on the pediatric intensive care unit.

The third question of the interview dealt with specific framework conditions in the clinic with regard to patient handovers, such as patient safety, teamwork, and cooperation, involvement, and support from superiors. The question was divided into seven sub questions.

First, participants were asked to rate patient safety in the clinic prior to the intervention and post intervention. Patient safety prior to the intervention was generally assessed as being very high. However, it was noted that the frequent loss of crucial information during patient handovers negatively impacted patient safety.

When participants were asked to evaluate patient safety post intervention, improvement was noted mainly due to a reduction in loss of patient information due to standardized postsurgical handover processes.

Secondly, participants were questioned regarding possible changes in teamwork and interprofessional cooperation due to the handover intervention.

No change was noticed as both aspects were rated high prior to the intervention. Pediatric nurses mentioned that they had more time to actively listen during patient handovers since the patient's wellbeing had been established prior to the exchange of information. Furthermore, communication among team members was reported to be improved.

Thirdly, participants rated the involvement and support from superiors in terms of feedback and active co-development. Answers varied greatly ranging from some interviewees having been present during discussions concerning the handover intervention in team meetings to some having received no feedback or support.

Fourthly, professional groups were asked to identify framework conditions in the clinic which made the handover intervention easier or more difficult. Conditions deemed to make the handover intervention easier referred to small professional teams that were used to working together and a high level of interest of participating professional groups in the study. Conditions which were mentioned to make the intervention more difficult were the lack of implementation of the handover intervention by the surgical side due to their frequent absence, the team in the operating room frequently being unable to set a precise time frame for when the patient handover would occur, increasing the difficulty of documenting patient handovers as well as the providing team being uncertain of the level of medical experience and knowledge of terminology by the receiving team members when exchanging complex patient information.

Fifthly, participants commented on other external conditions potentially affecting the handover intervention. Mentioned conditions were staff shortages and frequent changes in medical personnel. In terms of the COVID-19 pandemic, wearing masks was mentioned to have led to a loss of patient information due to misunderstandings and a reduced amount of total operations with fewer patient handovers taking place to actually implement and perform the new tasks and checklists introduced by the intervention.

Sixthly, participants were asked if they had received staff trainings or other support offers during the introduction of the handover intervention. Some

participants were informed via email or team meetings, whereas employees who had recently joined the clinic had not received any training or information.

# 5 Discussion

## 5.1 Overall research aim

The research aim of our study of postoperative patient handovers was to investigate the impact of a participative, systemic change through the establishment of a handover checklist on the quality of equipment preparation, shared patient information, team performance characteristics as well as completeness of patient information for further treatments on the PICU, comparing results of the baseline to the follow-up assessment. The baseline results are listed in the study of Heinrich et al. (2021, pp. 34-46) and were used for the prospective evaluation of effects of the handover intervention in the follow-up study.

Through our study we were able to validate the positive impact on the efficiency and completeness of patient handovers and teamwork through the standardization of the handover process. In the following sections, the results of the individual research questions will be evaluated and discussed.

## 5.2 Question 1: Which impact did the implementation of a handover checklist have on equipment preparation and team set-up before patient handovers, compared to the baseline study?

In the baseline study, the completeness of equipment preparation prior to information exchange was rated at 79,34%. According to Heinrich (2021, p. 46) , patient monitors are frequently not visible to all participating team members during information transfer (as one individual behavioral item), making it more challenging to observe the patient.

We detected a significant improvement in equipment preparation during our study, rated at 98,57%. A reason for the improvement was noted in the active use of the checklist by participating team members. Following the checklist, the patient is to be transferred prior to information exchange. Handover information exchange is not to be initiated unless the patient is transferred onto the intensive care's patient bed and all equipment is adequately placed and alarms are set. The resulting window for staff being able to solely focus on equipment tasks, without having to simultaneously pay attention to the

information transfer, can be linked to the improvement in completeness and quality of equipment preparation (Craig et al., 2012). Catchpole et al. (2007) document similar results with the establishment of a checklist leading to a decrease in technical errors. During the time frame of our study, physical patient transfers were mostly announced and initiated by the anesthetist. Both the providing and receiving team worked together to transfer the patient onto the patient bed, including all cables and monitors. Once the technical equipment was adequately placed and ventilation set to the intensive care's ventilation system, information exchange was initiated by the pediatric surgeon, if present, otherwise through the anesthetist.

Another factor having potentially contributed to the improvement in equipment preparation was the concurrent establishment of a docking cart for the intensive care unit (as a concurrent improvement measure during time of observation). At the time of the baseline study, required equipment for patient transfers had to either be carried or transported on the patient bed by the providing team, which frequently lead to medical equipment being left behind on the intensive care unit. Following completion of the baseline study, a docking cart designated for patient handovers was purchased, equipped with monitors, syringe pumps, a ventilator and further necessary items to safely transport the patient from the operating room to the intensive care unit. The cart could easily be attached to the patient's bed and significantly decreased the probability of forgetting important medical equipment. Heinrich (2021, p. 46) determine inadequate medical equipment preparation and stabilization of the patient before the start of information exchange as a factor leading to more stress for medical professionals due to an increased workload. Insufficient equipment preparation is associated with higher numbers of distractions (Craig et al., 2012). Ultimately resulting in a negative impact on teamwork and the quality of patient handovers. Furthermore, poor technical preparation shows to be associated to information loss during postsurgical handovers (Catchpole et al., 2007).

The analysis of team set-up during postsurgical patient handovers resulted in the following values for the participating professional groups: The presence of

the pediatric nurse and intensive care specialists was 100% in both studies. Since patients are frequently in critical condition and are monitored by a pediatric nurse as well as an intensive care specialist post-handover, at least one member of both professional groups should be present for the handover and patient transportation to the intensive care unit. Concerning the participation rate of pediatric surgeons, we were able to observe a small increase from 38,7% to 43,3%. More than half of the observed postsurgical patient handovers were executed without a pediatric surgeon. Through interviewing anesthetists and pediatric surgeons with regard to possible causes for the high absence rate, several indications arose. Anesthetists mentioned it being difficult to coordinate handover timing with pediatric surgeons. Once the patient was sufficiently stabilized post-surgery by the anesthesia team for discharge to the intensive care unit, the pediatric surgeon in charge was no longer present or already participating in the subsequent surgery. The interviewed pediatric surgeons noted being obligated to create the operative report immediately post-surgery as well as strictly timed operating room schedules leaving little to no time for participation in patient handovers. Both reasons mentioned potentially lead to pediatric surgeons' preference of handing over their surgical information separately to the intensive care specialist on the intensive care unit. According to the intensive care specialist, receiving a separate surgical handover was associated with an increased workload, as this information needed to be handed over to the responsible pediatric nurse. The absence of the pediatric surgeon subsequently resulted in two additional handovers.

Regarding the attentiveness of the whole staff, we were able to document an increase from 88,5% to 93,5%. Staff attentiveness was documented directly at the start of information exchange of the pediatric surgeon or anesthetist. A positive rating included no side conversations or other tasks being performed. Staff attention can be increased by completing technical tasks prior to information exchange as this leads to fewer distractions and interruptions (Craig et al., 2012). Following a checklist a clear "Time Out" is created before initiation of information exchange, leading to a quieter handover setting and

enhanced participation rates and attention of the whole team (Segall et al., 2012). Prior to the intervention technical equipment preparation was mainly carried out by pediatric nurses and nurse anesthetists while information exchange was already taking place between the intensive care specialist, anesthetist and pediatric surgeon. Interviewed pediatric nurses mentioned to frequently have been missing important information for further treatment on the PICU. The introduction of the checklist may have led to a more active participation in information transfer for pediatric nurses. Similar observations are evident in the study of Riley et al. (2017): Before standardizing handovers through a checklist, technical equipment transfers are mainly carried out by nurses, while handover information exchange is already taking place, resulting in staff dissatisfaction and multiple simultaneous handovers between the various professional groups.

In terms of “whole staff present” we observed the strongest change from 32% to 70%. Breuer et al. (2015) record similarly strong improvements from 39,3% to 68,2% in provider attendance after standardizing the handover process.

## 5.3 Question 2: Which impact did the implementation of a handover checklist have on the volume and quality of information and contents conveyed compared to the baseline study?

Based on the results of our study, we were able to determine an increase in shared patient information transmitted during postsurgical handovers in comparison to the baseline study. Including general patient information provided by the surgeons and/or anesthetists as well as anesthesiological patient information shared solely by the anesthetists. The high rating for completeness of anesthesiological information in the baseline study (78,57%), followed by a significant improvement in the follow-up study (87,27%) can be explained by their high participation rate ranging from 96,7-100% during postsurgical handovers. Furthermore, anesthetists in the clinic of our study are accustomed to executing standardized handovers as they are common practice in their professional field during shift changes. This aspect was mentioned to be a key success factor for the implementation of the study by

interviewed anesthetists. Before the start of information exchange the participating anesthetist frequently drew attention to the checklist placed on the wall. Consequently, the exchange of information took place working through the points listed.

The low attendance rate of pediatric surgeons after the intervention correlates with the lack of completeness of surgical information transferred. Pediatric surgeons mostly carried out a separate handover to the intensive care specialist on the intensive care unit. In terms of the completeness of shared surgical information, we noticed a slight decrease from 36,02% to 31,67% in the follow-up study, with the difference remaining insignificant.

Our results largely confirm findings of existing handover research. Standardization of the handover process shows to significantly decrease information losses during postsurgical patient handovers resulting from medical staff not having to exchange information freehand, but instead being guided by a checklist highlighting the most crucial information (Agarwal et al., 2012). Poor information exchange may stem from providers considering different points of information to be relevant in contrast to the receivers' expectations. Besides that, providers tend to overestimate communication skills, leading to the assumption of all questions being answered (Chang et al., 2010). With standardized checklists, points of information are established in advance, minimizing provider-receiver disagreements. Thus, communication between providing and receiving teams can be improved (Craig et al., 2012). Despite specifying important subitems through checklists, some points may not be mentioned, due to the receivers deeming them insignificant for their own profession (Rehm et al., 2021). Through creating a specific window for remaining questions it might be possible to narrow down this issue. Encouraging questions shows to flatten hierarchical structures and reduce cultural differences, resulting in improved communication with a more extensive exchange of information (Agarwal et al., 2012). Consistent with our results, Karakaya et al. (2013) notice no increase of shared surgical information after the establishment of a checklist-based intervention, which emphasizes the importance of surgeons participating in postsurgical

handovers to ensure completeness and accuracy of transmitted patient information.

## 5.4 Question 3: Which impact did the implementation of a handover checklist have on team performance characteristics both expert and provider rated, compared to the baseline study?

With regard to the assessment of team performance characteristics through the expert in the baseline study, scores generally ranged from medium to good. Teamwork ratings showed highest scores, whereas leadership, workspace and equipment were rated lowest. According to Heinrich's assessment (2021, p. 46), nontechnical skills exist, yet are not sufficiently used due to the lack of structure in the handover process.

During the follow-up study, significant improvement in all six subitems of team performance characteristics evaluated by the expert was documented, with scores ranging from good to very good. Situational awareness, workspace and equipment as well as cooperation and resource management received the highest scores. The significant improvement of team performance characteristics can be linked to the positive change in the quality and completeness of equipment preparation prior to exchanging information, which forms the base for the subsequent handover. Previous studies show insufficient equipment preparation and poor workspace conditions negatively impact communication and cooperation between the involved medical staff and increase the risk of errors during the patient handover (Agarwal et al., 2012; Catchpole et al., 2007; Manser & Foster, 2011; Morey et al., 2002). An inefficiently prepared workspace due to faulty medical equipment preparation can lead to elevated stress on team members due to additional tasks having to be performed during the actual information exchange. Handovers being accompanied by frequent distractions are associated with poorer team performance (Weigl et al., 2020). The doubling burden of complex information exchange, equipment setup and distractions culminates in information omission and a negative influence on patient outcomes (Sharit et al., 2008).

Strong situational awareness can be achieved through adequately placed medical equipment and monitors visible to all participants during the patient handover, allowing for assessment of the patient's current condition while engaging in information exchange. Prior to the checklist establishment in the clinic of our study this was frequently not the case for the medical staff involved, due to the monitors being not visible for all team members and frequently unmentioned current condition of the patient (Heinrich, 2021, p. 47). Teamwork is rated positively when everyone involved fulfills a clear function, accompanied by a smooth and respectful cooperation where team members support each other (Catchpole et al., 2007). Team members in everyday clinical settings usually have larger time frames to adjust to one another and to establish optimal teamwork. In postsurgical handovers, different medical professionals, with various backgrounds come ad hoc together to perform a highly complex task in a limited time frame. Medical professionals involved have different foci and expectations regarding which patient information should be shared and reported (Siddiqui et al., 2012). The providing team is primarily interested in transmitting surgical and anesthesiological information regarding the course of the surgery, possibly with reference to further procedures, not knowing whether all details mentioned are relevant for the providing team to further treat the patient. If every person involved in the patient handover solely focuses on their tasks and goals instead of working together in a team, tension and misunderstandings can quickly arise, which negatively impact cooperation and teamwork (Randmaa et al., 2017). Through the development of the standardized handover checklist in cooperation with representatives of surgery, pediatrics, nursing and anesthesia the different points of interest of the providing and receiving team are represented during the patient handover. Instead of having to freely exchange information and to guess what is deemed relevant to the participating medical professionals, a guideline can be used which will positively impact teamwork and information flow. Studies already show the link of clearly distributed tasks leading to faster workflows and more successful handovers (DeVita et al., 2005; Marsch et al., 2004).

Leadership can be seen in narrow context with the positive evaluation of teamwork. Teamwork is usually rated positively with a clearly defined team leader who ensures a smooth and structured sequence of tasks to be completed without acting in a hierarchical manner (Catchpole et al., 2007). In our study this position was mainly fulfilled by the anesthetist, who structured the handover process with the help of the checklist. The anesthetist determines when the patient transfer is completed and information exchange could be initiated, paying attention to and ensuring all team members are present. If surrounding distractions and background noise are too prominent the anesthetist politely informs the surrounding medical staff about the ongoing patient handover before continuing information exchange. The influence of a clearly defined leadership role on the effectiveness of patient handovers is documented in previous studies (DeVita et al., 2005; Hjortdahl et al., 2009).

In the follow-up study, team performance characteristics are rated more critically by the providing medical professionals than by the expert. The opposite is documented in the baseline study, where expert ratings are more critical than ratings by the professional groups. Comparing the ratings in the two studies shows that the provider ratings remain relatively stable. Leadership, teamwork and communication are rated slightly more negative in the follow-up study, with the difference being insignificant. In contrast, cooperation, workspace and equipment as well as situational awareness show minor improvements, which are also deemed insignificant.

The more positive rating in the follow-up study through the expert could be due to the expectation of a certain level of improvement as a result of the established intervention as well as different expectations to what an ideal patient handover should look like compared to the observing expert in the baseline study. In order to limit this effect, the objective assessment of team performance characteristics was calibrated by jointly assessing the first five postsurgical handovers with the expert, who also carried out the training of the observer in the baseline study, without including these results in this dissertation.

Another reason for the differing ratings could be seen in medical professionals not only assessing the patient handover but also actively participating in it. Certain dynamics among medical professionals might not be apparent to the expert who is observing from a distance. Furthermore, it can be assumed that the rating is based on experiences in previous handovers and individual expectations of what good teamwork characteristics should be. It is possible that the high baseline ratings by the providers might stem from a certain level of unawareness towards inefficient handover processes prior to the intervention (Bigham et al., 2014). Additionally, the ratings in the baseline study are already set in a positive range preceding the intervention.

Our results differ slightly from previous results in handover research which are linked to a significant improvement in provider ratings after the standardization of the handover process (Breuer et al., 2015).

## 5.5 Question 4: Which impact did the implementation of a handover checklist have on the completeness of medical patient information for further treatments on the PICU, compared to the baseline study?

With transferred information to the receiving team being the most important aspect of postsurgical patient handovers (Craig et al., 2012), the impact of the handover checklist on the completeness of information required for further patient care on the intensive care unit was assessed. We evaluated an average improvement from 65,91% in the baseline study to 76,15% in the follow-up study. Our results show a positive development compared to the baseline results, yet this increase was deemed insignificant.

Our result coincides with the findings of previous handover research. Karakaya et al. (2013) observe an improvement in shared patient information to the intensive care unit from 48% to 73% following cardiac surgery after the implementation of a handover checklist. Malenka et al. (2018) note similar improvements in completeness of shared information from 56% to 81%. Postsurgical patient handovers using a standardized checklist or protocols are linked to reduced information omission, which can directly be connected to a decrease in postoperative complications, decrease in need for hemodynamic

or respiratory interventions, less delays in antibiotic treatments and drastically shortened time frames until the first analgesia dosing following the admission to the PICU (Breuer et al., 2015). Agarwal et al. (2012) observe shorter intubation time frames post-surgery and improved 24h patient outcomes. If important information is fully shared during the postsurgical patient handover, the receiving intensive care personnel can quickly act in case complications arise. However, if important information has to be researched in case of an emergency in operative reports or charts, valuable time is lost (Kluger & Bullock, 2002; Møller et al., 2013). Postoperative complications pose a greater risk on patient outcomes than perioperative risks (Khuri et al., 2005). An important aspect to be considered since missing information can lead to avoidable incidents (Botti et al., 2009). With working atmosphere on pediatric intensive care units being frequently characterized by staff shortages, time pressure and interruptions, all while patients are in a vulnerable state, standardization of postsurgical patient handovers should be considered.

The high absence rate of pediatric surgeons during postsurgical handovers can be connected to the lack of important information for further patient care on the intensive care unit (Karakaya et al., 2013). Patient handovers with an absent pediatric surgeon leads to the anesthetists partially taking over the surgical information, which only creates a limited picture of the surgical intraoperative course.

# 6 Limitations

Our prospective observational study has some limitations. Several results turned out to be insignificant, which may be due to limited statistical power. Despite the efforts to collect a larger number of postsurgical patient handovers through extending the observation time frame, we were repeatedly challenged by spontaneously changing operating room schedules. Numerous operations had to be cancelled or postponed due to the patients being unfit for surgery and staff shortages. Particularly staff shortages on the pediatric intensive care unit and the associated lack of available patient beds portrayed a major obstacle. Additionally, the temporal overlap of our observation period with the COVID-19 pandemic intensified the aforementioned problems. The operating room schedules were reduced to emergency operations only and staff was moved to help monitor patients suffering from COVID-19. The small number of observed handovers, both in the baseline as well as the follow-up study, made it difficult to define general statements. In order to achieve more significant results, it is therefore recommended for future studies to evaluate larger numbers of patient handovers to further solidify the impact of standardizing the handover process on patient outcomes and completeness of information.

Since evaluation of patient handovers in the baseline and follow-up study were not assessed by the same expert, it might have influenced the results of our study and observer bias cannot be ruled out.

Additionally, the mere presence of an observer can lead to changes in the behavior of the professional groups involved, also known as the Hawthorne effect (Agarwal et al., 2012; Craig et al., 2012; Yang & Zhang, 2016). It cannot be ruled out that the checklist was mainly used during postsurgical handovers due to the presence of the observer.

Another factor potentially having impacted the results of our study were the varying time frames and conditions for involved medical staff filling in the questionnaires post-handover. Patient care was always the main priority and we endeavored to avoid interrupting work processes through our observations. Thus, free windows for medical professionals to fill in the questionnaires post-handover were anticipated. The assessment of the patient handover by the

providing team was mostly carried out directly after departure of the patient to the intensive care unit with the receiving team. Consequently, the providing team was able to evaluate the handover in a relatively disturbance free time frame. It was not possible for the receiving team to evaluate the handover directly afterwards. Following the patient handover, the receiving team made their way to the intensive care unit. Immediately upon arrival the patient was cared for through correct positioning in the patient bed, adjusting monitors, syringe pumps and preparing IV fluids as well as medication. During this period, it was difficult to engage the pediatric nurse and intensive care specialist in filling out the questionnaires, as this would have led to the interruption of their highly focused workflow and patient care. Therefore, questionnaires were frequently filled in in a hurry or filled in later on throughout the shift. This resulted in a greater time interval to the patient handover, which could have led to a spurred assessment through recall bias and consequently impacted the results of the intensive care staff.

# 7 Implications

## 7.1 In general

The key role of patient handovers in patient safety culture is repeatedly being scientifically scrutinized. Most studies are conducted in the USA, mainly focusing on specific medical fields such as cardiovascular or cardiothoracic surgeries with adults. The transfer of results to other medical areas is questionable. Strategies mainly focus on improving handovers in healthcare, but not specifically on postsurgical handovers. Evidence of the impact of standardized patient handovers on patient outcomes and reduction of medical errors is still scarce and should be further investigated in future research (Bigham et al., 2014).

## 7.2 To clinical practice

It is important to further study post-surgical handovers to increase patient safety and workflow effectiveness, as well as to encourage the interest in long-term application and enforcement of changes by the medical staff (Møller et al., 2013). The majority of existing handover studies evaluates the handover situation in the respective hospital prior to establishing a handover protocol with attempts of standardization (Agarwal et al., 2012; Breuer et al., 2015; Zavalkoff et al., 2011). Structural conditions, administrative and organizational structures, training protocols, medical equipment as well as patient populations may vary greatly in clinics and different countries. It is therefore advisable to carry out an evaluation of the current handover situation through observational studies, team meetings and/or feedback evaluations from staff, before integrating a handover protocol into everyday clinical practice. For checklist-based interventions it can strongly be recommended to specifically design checklists for the area they will be applied in, since items not listed on the checklist are less likely to be mentioned during the handover (Rehm et al., 2021). Integrating an intervention into the medical field already saturated with working protocols and achieving long term application by the staff can be challenging (Sharit et al., 2008). Catchpole et al. (2010) underline varying levels of acceptance and implementation of interventions to standardize the

handover process among different professional groups. It cannot be assumed that more effective communication during patient handovers can be achieved solely through longer clinical experience (Chang et al., 2010). It is recommended to create awareness for necessary improvements in patient handovers and a shared understanding through team trainings, prior to introducing changes in the handover process (Bigham et al., 2014).

Due to frequent changes in medical personnel in clinical settings, it is recommended to establish handover improvement interventions that can easily be applied to and understood in short periods of time to achieve high levels of compliance (Catchpole et al., 2007). Future research is necessary to increase acceptance rates and understanding among medical professionals regarding the importance and benefits of standardization of patient handovers.

# 8 Conclusion

Standardizing postsurgical patient handovers can be linked to increased levels of attentiveness of participating team members as well as higher simultaneous presence of involved medical professionals for the full duration of the handover process. Standardized handover checklists embody a time and cost-efficient method to increase handover quality as well as teamwork and staff contentment. Furthermore, handover checklists show to overall be sustainable tools for long-term improvements in patient handovers far beyond research periods, even though certain categories may deteriorate over time (Chenault et al., 2016). Yet future research is necessary to increase acceptance rates and understanding among medical professionals. Since staff shortages, time shortages and increasingly complex medical treatments will continue to accompany us in the foreseeable future, it is advisable to further establish standardization of handovers in hospitals.

With postsurgical patient handovers representing a lively process that can vary greatly in the respective hospitals due to structural conditions, time schedules and composition of the involved professional groups, it is important in future attempts of standardization to always consider the challenges and the context in which the handovers take place (Møller et al., 2013).

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# 10 Attachments

## Attachment 1: Interview results per professional group

Question 1: What do you know about the intervention, how it has been implemented in recent years and the current status?

| Professional group | Result |
|---|---|
| **Anesthetist** | - Was present in all meetings regarding the handover study<br>- Was participating in design of anesthesiological part of study |
| **Anesthetist** | - Standardized patient handovers |
| **Pediatric surgeon** | - Importance of standardization of patient handovers |
| **Pediatric surgeon** | - Checklist placed on walls in handover area |
| **Pediatric nurse** | - Implementation of structured patient handovers |
| **Pediatric nurse** | - Study on patient handovers and reduction of sources of error |
| **Intensive care specialist** | - Standardization of patient handovers and implementation of checklist in operating area |
| **Intensive care specialist** | - Study of patient handovers in operating room |

Question 2: What were the key success factors for the intervention?

| Professional group | Result |
|---|---|
| **Anesthetist** | - Anesthetists already had a standardized handover tool prior to the study |
| **Anesthetist** | - None |
| **Pediatric surgeon** | - None |
| **Pediatric surgeon** | - None |
| **Pediatric nurse** | - None |
| **Pediatric nurse** | - Structured patient handovers since the start of the study |
| **Intensive care specialist** | - Structured patient handovers |

| | |
|---|---|
| | - Saving of time |
| **Intensive care specialist** | - Structured patient handovers with reduced loss of patient information |

Question 3: What were the key obstacles for the intervention?

| **Professional group** | **Result** |
|---|---|
| **Anesthetist** | - Long duration of patient handovers<br>- Poorly coordinated handover process (surgeon gone by the time anesthetists can handover the patient) |
| **Anesthetist** | - Lack of discipline<br>- No compliance with checklist<br>- Frequency of interruptions during handovers |
| **Pediatric surgeon** | - Long waiting periods for handover to be executed following operation → surgeons need to already attend following operation |
| **Pediatric surgeon** | - Obligation to write an operative report immediately post-surgery → overlap with window for patient handover<br>- Easier for surgeons to give patient handover on the PICU |
| **Pediatric nurse** | - Lack of time to stay in operating room for too long<br>- Shortage of pediatric nurses |
| **Pediatric nurse** | - None |
| **Intensive care specialist** | - Absent pediatric surgeon during majority of patient handovers |
| **Intensive care specialist** | - Multiple professional groups with varying priorities and expectations |

Question 4: Regarding specific conditions in the clinic related to the handover:

a. How would you assess the culture of patient safety before the intervention?

| Professional group | Result |
|---|---|
| **Anesthetist** | - High level of patient safety in clinic |
| **Anesthetist** | - High level of patient safety prior to handover intervention |
| **Pediatric surgeon** | - High level of patient safety due to anesthetists' checklist ensuring patients only enter operation room when all points are checked |
| **Pediatric surgeon** | - High level of patient safety |
| **Pediatric nurse** | - High level of patient safety |
| **Pediatric nurse** | - Good |
| **Intensive care specialist** | - Loss of large amounts of important patient information prior to study → decrease in patient safety |
| **Intensive care specialist** | - High level |

b. How would you assess the culture of patient safety after the intervention?

| Professional group | Result |
|---|---|
| **Anesthetist** | - Intervention had no impact on patient safety culture |
| **Anesthetist** | - Improvement due to more patient information being shared |
| **Pediatric surgeon** | - No difference |
| **Pediatric surgeon** | - No difference |
| **Pediatric nurse** | - Improvement due to structured patient handovers<br>- Reduction of issues regarding treatments of children on the ward due to lack of information |
| **Pediatric nurse** | - Partial improvement due to more information being shared, important for the following patient treatment |
| **Intensive care specialist** | - Better when intervention is executed correctly, all team members are present and more information can be memorized due to structured nature of information exchange |
| **Intensive care specialist** | - Better due to less information loss |

c. Which aspects of teamwork and interprofessional cooperation have or have not changed as a result to the intervention?

| Professional group | Result |
|---|---|
| **Anesthetist** | - Teamwork and cooperation were stellar prior to intervention, have not changed since |
| **Anesthetist** | - No change |
| **Pediatric surgeon** | - No change |
| **Pediatric surgeon** | - No change |
| **Pediatric nurse** | - Staff members listen more closely when information is being shared |
| **Pediatric Nurse** | - Dependent on present medical personnel<br>- More friendly cooperation between professional groups<br>- Nurses have time to listen to information exchange during patient handover now |
| **Intensive care specialist** | - Anesthetist and the intensive care staff engage better with one another during patient handovers<br>- No change with surgeons noticeable due to their frequent absence |
| **Intensive care specialist** | - Handovers are executed with all members present<br>- Information exchange has improved |

d. How would you rate the involvement and support from superiors? (e.g., feedback, active co-development)

| Professional group | Result |
|---|---|
| **Anesthetist** | - Discussion of handover intervention in team meetings |
| **Anesthetist** | - Great<br>- Regular presence of experienced coworkers |
| **Pediatric surgeon** | - Great |
| **Pediatric surgeon** | - Still good |
| **Pediatric nurse** | - Nonexistent |
| **Pediatric nurse** | - Good |
| **Intensive care specialist** | - No feedback received |
| **Intensive care specialist** | - Support from superiors received |

e. Which framework conditions in the clinic made the measure easier or more difficult? (e.g., size of teams, internal organization)

| Professional group | Result |
|---|---|
| **Anesthetist** | Easier: Small teams<br>More difficult: No implementation of handover intervention by the surgical side |
| **Anesthetist** | Easier: PICU members know each other and work well together<br>More difficult: Unknown level of experience when handing over information to the receiving team |
| **Pediatric surgeon** | None |
| **Pediatric surgeon** | None |
| **Pediatric nurse** | None |
| **Pediatric nurse** | None |
| **Intensive care specialist** | Easier: Nothing<br>More difficult: Often no notification by the operating room when handover could take place |
| **Intensive care specialist** | Easier: All professional groups involved where interested in improving patient handovers |

f. Were there other external conditions that affected the handover intervention? (e.g., frequent staff changes, COVID-19 pandemic)

| Professional group | Result |
|---|---|
| **Anesthetist** | - Shortage of patient beds on intensive care unit due to staff shortages |
| **Anesthetist** | - Frequent staff changes |
| **Pediatric surgeon** | - None |
| **Pediatric surgeon** | - None |
| **Pediatric nurse** | - None |
| **Pediatric nurse** | - Wearing masks during pandemic lead to misunderstandings and loss of information |
| **Intensive care specialist** | - Less operations due to COVID |
| **Intensive care specialist** | - Less surgeries due to COVID → fewer patient handovers to implement the intervention |

g. Was the intervention facilitated by staff trainings or other support offers during the introduction period?

| Professional group | Result |
|---|---|
| **Anesthetist** | - Yes |
| **Anesthetist** | - No |
| **Pediatric surgeon** | - Informed via email prior to the intervention |
| **Pediatric surgeon** | - Informed via email prior to the intervention |
| **Pediatric nurse** | - No |
| **Pediatric nurse** | - No |
| **Intensive care specialist** | - No |
| **Intensive care specialist** | - No |

Question 5: Do you have any further comments regarding the intervention?

| Professional group | Result |
|---|---|
| **Anesthetist** | - No |
| **Anesthetist** | - Important to do handover research<br>- Issue with topic not being interesting for broad audience |
| **Pediatric surgeon** | - Interventions to improve patient handovers are important |
| **Pediatric surgeon** | - No |
| **Pediatric nurse** | - Curious how other professional groups will rate the intervention |
| **Pediatric nurse** | - Would recommend interventions to other hospitals to gain a more structured work environment |
| **Intensive care specialist** | - Improvement in staff satisfaction and patient safety due to intervention<br>- Structured processes make working easier |
| **Intensive care specialist** | - No |

## 11 Acknowledgement

Without the support and guidance of the following people the completion of this dissertation would not have been possible.

First of all, my deepest gratitude goes to Professor Dr. Matthias Weigl and Professor Dr. Florian Hoffmann for their outstanding supervision and unwavering support, contribution and guidance throughout the entirety of this work. Observing the work ethic, you both demonstrate each day has been highly inspirational and the constructive exchange on a professional and personal level has always encouraged me. Thank you for your time, patience and shared knowledge.

I would like to thank the team of the pediatric intensive care unit for their calls before patient handovers and their cooperation throughout the data collection period.

I am grateful to my parents and siblings, Alexandra and Manuel, for always being by my side. Your support gives me the courage to follow my dreams.

Lastly, I would like to thank my husband Brian, whose love and support is with me in whatever I pursue and whose motivation kept me going throughout the writing process.

# 12 Affidavit

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Promotionsbüro
Medizinische Fakultät

MMRS

**Eidesstattliche Versicherung**

Rivas, Julia

_____

Name, Vorname

Ich erkläre hiermit an Eides statt, dass ich die vorliegende Dissertation mit dem Titel:

Evaluation of postsurgical patient handovers at the interface between the operating room and the pediatric intensive care unit

selbständig verfasst, mich außer der angegebenen keiner weiteren Hilfsmittel bedient und alle Erkenntnisse, die aus dem Schrifttum ganz oder annähernd übernommen sind, als solche kenntlich gemacht und nach ihrer Herkunft unter Bezeichnung der Fundstelle einzeln nachgewiesen habe.

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