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Handoffs From the Operating Room to the Intensive Care Unit After Cardiothoracic Surgery: From The Society of Thoracic Surgeons Workforce on Critical Care

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Executive Summary

Several studies have focused on the role of provider handoffs as an important consideration in patient safety. However, the number of studies focused on the handoff transition of patients from the cardiothoracic operating room (OR) to the intensive care unit (ICU) has been limited. As clinicians with a dedicated interest in the perioperative care of cardiothoracic surgery patients, we performed a systematic review of the literature to analyze whether a structured handoff process from the OR to the ICU is beneficial for cardiothoracic surgery patients.

A systematic search of Medline, Embase, and Cochrane Review databases identified 3,596 articles for review. Data including patient demographics, methodology, interventions, and outcomes were analyzed, with a focus on PICO (population studies, intervention studies, control population, outcomes measures) analysis. After we applied our inclusion and exclusion criteria, 21 studies (4,568 patients) remained and were included in our systematic review.

The outcome measures, the percentage of studies that observed improvement in that outcome measure, and the number of studies reporting on that measure were as follows: handoff completeness (86%, 18/21 studies), prevention of adverse events (33%, 7/21), process measure compliance (24%, 5/21), and provider satisfaction (62%, 13/21).

The evidence presented here supports the use of a structured, interdisciplinary OR-to-ICU handoff. The results of this review demonstrate that using a dedicated handover process was associated with improved handoff completeness, fewer early postoperative adverse events, improved compliance with process measures (eg, efficiency in equipment and monitoring line transfer, handover of information), and provider satisfaction.

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This document has been approved by The Society of Thoracic Surgeons Executive Committee.

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Introduction

Increasing recognition of preventable hospital deaths has made patient safety a central focus in healthcare. The 2007 Joint Commission mandated a requirement to "implement a standardized approach to 'handoff' communication" [1]. Checklists used in the operating room (OR) [2, 3] and before central line insertions [4] have improved patient safety. The transfer of a patient from the OR to the intensive care unit (ICU) is recognized as a high-risk period for clinical instability and events resulting in patient harm. The definition of a "handoff" or "handover" includes the transfer of patient information, equipment, responsibility, and accountability from the OR team to the ICU team. During this transition the communication of surgical and anesthetic considerations from the OR team to the multidisciplinary ICU and nursing teams is vital to enhancing patient safety. Informal and unstructured sign-out processes, often characterized by parallel conversations and a lack of team focus, may result in the loss of critical information being transferred. One report showed important postoperative information loss occurred after 52% of handoffs, with only 30% of the essential surgical information transferred [5]. Indeed, up to 85% of sentinel events are attributable to communication errors, with up to 43% of those occurring during handoffs [6].

Improving communication during the handoff process has been observed to be a key element of reducing medical errors. A review of 444 surgical malpractice cases revealed that 60 (13.5%) involved communication breakdown, which occurred in an evenly distributed manner in all phases of surgical care, including the preoperative (38%), intraoperative (30%), and postoperative (32%) periods [7]. In addition, root-cause analysis reviews have consistently shown the critical role of inadequate ICU handoffs in near-miss scenarios [8].

The Society of Thoracic Surgeons (STS) recognizes the critical role of communication in the handoff process and that "OR-to-ICU handoffs are a particularly vulnerable area for communication breakdown, with a clear risk for direct patient harm (p. 1052)" [9]. As clinicians with a dedicated interest in the care of cardiothoracic surgery patients, the members of the STS Work Force on Critical Care performed a systematic review of the literature on OR-to-ICU handovers, with the goals of examining the benefits of a structured, formal OR-to-ICU handoff compared with no formal handoff process, while also providing practical plans for its implementation.

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Material and Methods

Methods

We performed a comprehensive, structured systematic review of published articles in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement [10] (Supplemental Table 1). The study protocol was registered with PROSPERO (CRD42018100486).

Literature Search and Data Sources

The heterogeneous nature of the subject matter required a broad three-dimensional search strategy. The electronic databases Ovid Medline (PubMed), Embase, and Cochrane Review were thoroughly searched (March 2, 2018). Rayyan (https://rayyan.qcri.org/) was used to evaluate articles for inclusion in this systematic review [11]. The search strategy was devised by initially compiling key words from major articles and broad literature searches performed by using the electronic databases listed. Detailed search terms are provided in Supplemental Figures 1A–1C.

Search terms were refined through an iterative process by reviewing outcomes of preliminary keywords searched in the databases. The medical subject headings, or MeSH terms, from key articles were also identified to make the search more comprehensive. Using the term "and," we combined terms under three broad categories as follows: (1) cardiothoracic patient search: cardiac surgical procedure, heart surgery, cardiac surgery, thoracic surgery, thorax surgery, cardiothoracic/cardio-thoracic surgery, OR, ICU, surgery, surgeries, surgical; (2) handoff search: patient transfer, patient handoff/hand-off, handover/hand-over, checklist, clinical handover, continuity of patient care, communication, interdisciplinary communication; and (3) outcome search: medical error, medication error, near miss, patient safety, postoperative communication, treatment outcome, outcome assessment, patient outcomes, postoperative complication.

Study Selection

Electronic citations, including those of available abstracts, were screened by at least three authors to select reports for consideration of full-text review. Thirteen of the listed authors (each with backgrounds in cardiothoracic surgery, critical care, and/or anesthesiology) reviewed at least 500 abstracts. After discussion, consensus was reached regarding appropriate abstracts to include in the review. Finally, using prespecified eligibility criteria, two authors (SC, JGS) independently assessed these abstracts for inclusion by performing a full-text review. Selection criteria are listed in detail in Supplemental Table 2.

Inclusion Criteria

All studies included in the review were written in English and were represented by complete articles of human studies that focused on interprofessional communication that occurred during the handoff from the OR to the ICU. Studies in adult cardiothoracic surgery, congenital cardiothoracic surgery, or surgical critical care were included. All references for the included articles were also hand-searched for additional citations.

Exclusion Criteria

Studies were excluded from the review if the OR-to-ICU handoff was not the focus of the article, such that intraoperative handoffs within the OR among anesthesiologists, inter-ICU handoffs from a day team to a night team, or ICU-to-ward handoffs were excluded. Other systematic reviews were not included in this analysis.

Review Methods

Data extracted from studies included country of origin, sample size, study design, study aim, key findings, and implications. The focus was on a PICO (population studies, intervention studies, control population, and outcomes measures) analysis. Specifically, the outcome measures included handoff completeness, prevention of adverse events, process measure compliance, and provider satisfaction.

Risk of Bias Assessment in Individual Studies

The risk of bias was assessed by using the Newcastle-Ottawa Scale [12]. The Newcastle-Ottawa Scale is used to assess study selection, study groups' comparability, and study exposure. A study was awarded a maximum of one star for each numbered item within the selection and exposure categories. A maximum of two stars was given for comparability. Two reviewers (RS and SC) independently reviewed each study to evaluate the risk of bias. Each study was given an overall score ranging from 0 to 9. A score of 0 reflects greatest risk of bias, and higher scores reflect lower risks.

Results

From the initial database searches, we identified 4,155 articles: 1,019 from Medline (Ovid), 2,794 from Embase, and 342 from the Cochrane Review (Fig 1). After removing 559 duplicate articles we screened 3,596 articles for titles and abstracts, which reduced the number to 98 remaining studies for further analysis. After the inclusion and exclusion criteria were applied and a full-text review was conducted by two referees (SC, JGS), 21 articles remained (Fig 1, Table 1) to be included in our study. The agreement kappa statistic for study inclusion was good ($\kappa = 0.947$; standard error = 0.037; 95% confidence interval [CI], 0.873 to 1.00).

Of the 21 included studies, 14 were reported from centers in North America (10 from the United States, 3 from Canada, and 1 multicenter study from the United States and Canada) and 7 from centers in Europe or South Africa. The mean number of patients included in the studies was 304 patients (range, 25 to 1,507), with four studies having more than 1,000 patients.

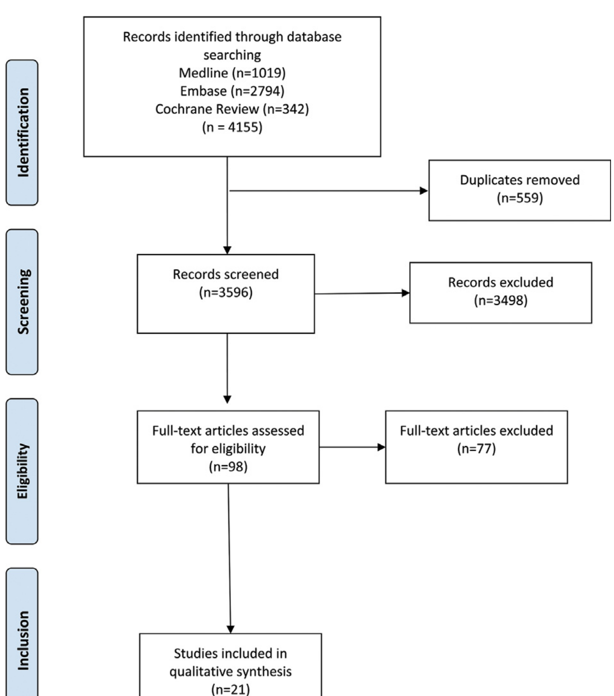

Fig 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram of the systematic review search.

Handoff Completeness

Overall, 18 of the 21 studies examined handoff completeness to analyze improvement in the handoff process during the study period (Table 2). Independent observers who were knowledgeable of the agreed on standardized protocol recorded the number of missed protocol elements for the witnessed handoffs before and after the implementation of the structured protocol for an OR-to-ICU handoff, which was most commonly a structured handoff checklist. Deviations from the structured handoff protocol were most commonly referred to as technical errors. The failure to mention knowledge or elements of patient information mandated by the structured handoff was most often referred to as information omission. The comparison of results from the phase before intervention with those after the implementation of a standardized postoperative handoff consistently showed improvements. In several studies, both technical errors and information omission were significantly decreased.

Dixon and colleagues [13] analyzed 52 unique parameters of an OR-to-ICU transfer within a cardiothoracic ICU. The transfer elements included the handoff procedure, adherence to a verbal script, and attention to the completion of line items contained within a handoff checklist. Five parameters studied were time to completion of a specified element, whereas the other 47 were not timed. After the institution of a structured process, the authors found that 37 of those 47 parameters improved significantly, including the successful completion of items deemed crucial, which had previously not even been performed. Using a similar handoff protocol and measurement tool, Mukhopadhyay and colleagues [14] showed improvements in provider presence, technical errors, and information omission. Most importantly, critical details were communicated significantly more often, including those regarding the presence of a difficult airway, vasopressor requirements, any operative complication, and a thorough description of the procedure performed. Furthermore, in a study of 117 patient handovers, Manser and colleagues [15] found that when deficits in the handover were identified by the receiving

Table 1. Studies Included in This Systematic Review

First Author [Reference]	Location	Number of Patients	Population	Intervention/ Exposure	Control/ Comparison	Outcomes	Study Design
Agarwal [19]	USA Nashville, TN	1,078	PCICU pediatric	Structured handoff (n = 378)	Unstructured verbal handoff (n = 700)	Patient information transfer, quality of communication	Prospective observational study
Breuer [22]	USA Durham, NC	142	PICU (medical and noncardiac surgery) pediatric	Structured handoff (n = 44)	Unstructured handoff (n = 65)	Postoperative communication, patient outcomes	Prospective cohort study
Catchpole [24]	UK London	50	PCICU pediatric	Structured handoff (n = 27)	Unstructured handoff (n = 23)	Technical errors, information omissions, handoff duration	Prospective cohort study
Chenault [25]	USA and Canada (5 centers)	117	PCICU pediatric	Structured handoff (n = 38)	Unstructured verbal handoff (n = 41)	Technical errors, verbal information omissions	Prospective cohort study
Craig [26]	UK Glasgow	43	PCICU pediatric	Structured handoff (n = 22)	Unstructured handoff (n = 21)	Prepatient and prehandover readiness, information handover	Prospective cohort study
Dixon [13]	USA Temple, TX	60	CVICU adult	Structured handoff (n = 30)	Unstructured handoff (n = 30)	Provider satisfaction and handoff observation outcomes	Prospective cohort study
Gleicher [18]	Canada Toronto	37	CVICU adult	Structured handoff (n = 31)	Unstructured handoff (n = 7)	Quality of handover, handover duration, protocol adherence, team satisfaction	Interventional time-series study
Hall [20]	USA Seattle, WA	1,127	CVICU adult	Structured handoff (n = 557)	Unstructured handoff (n = 550)	Reduction in preventable complications	Retrospective cohort
Joy [29]	USA Chicago, IL	79	CVICU, pediatric	Structured handoff (n = 38)	Unstructured handoff (n = 41)	Reduced technical errors and information omission	Prospective, interventional study
Karakaya [28]	Belgium Ghent	58	CVICU pediatric	Structured handoff (n = 23)	Unstructured handoff (n = 33)	Significantly improved data transfer	Prospective cohort study
Kaufmnan [21]	USA Denver, CO	1,507	CVICU pediatric, adult	Structured handoff (n = 886)	Unstructured handoff (n = 621)	Decreased unplanned extubation and median ventilator times	Prospective cohort study
Krimminger [23]	USA St Louis, MO	76	CVICU adult	Structured handoff (n = 38)	Unstructured handoff (n = 38)	Fewer interruptions, handoff process errors, and information-sharing errors	Prospective cohort study
Manser [15]	Switzerland and UK Fribourg Aberdeen	117 (25 CVICU)	CVICU adult	Structured handoff (n = unknown[a])	Unstructured handoff (n = unknown[a])	Higher ratings of handover quality	Prospective, cross-sectional observational study
Moon [37]	USA Dallas, TX	35	SICU adult	Structured handoff (n = unknown[a])	Unstructured handoff (n = unknown[a])	Provider satisfaction, perceived effectiveness of handoff process	Prospective, interventional study
Mukhopadhyay [14]	USA Temple, TX	62	SICU adult	Structured handoff (n = 21)	Unstructured handoff (n = 31)	Physician presence, improved information transfer, communication completeness	Prospective cohort study
Northway [27]	Canada Vancouver	47	PICU, cardiac pediatric	Structured handoff (n = unknown[a])	Unstructured handoff (n = unknown[a])	Handover process defects, time for handoffs	Prospective cohort study

(*Continued*)

Table 1. Continued

First Author [Reference]	Location	Number of Patients	Population	Intervention/ Exposure	Control/ Comparison	Outcomes	Study Design
Petrovic [16]	USA Baltimore, MD	60 patients, 308 satisfaction surveys	CVICU adult	Structured handoff (n = 169[a])	Unstructured handoff (n = 137[a])	Presence of all handoff team members, missed information, provider satisfaction	Prospective cohort study
Ramasubbu [30]	UK London	100	CVICU adult	Structured handoff (n = 50)	Unstructured handoff (n = 50)	Improved median handover score	Prospective cohort study
Salzwedel [38]	Germany Hamburg	121	SICU adult	Structured handoff (n = 63)	Unstructured handoff (n = 69)	Critical information transfer completed	Prospective randomized trial
Van der Walt [17]	South Africa Cape Town	60	CVICU adult	Structured handoff (n = 30)	Unstructured handoff (n = 30)	Provider attendance, fewer distractions, improved information sharing	Prospective cohort study
Zavalkoff [39]	Canada Montreal	31	PCICU pediatric	Structured handoff (n = 16)	Unstructured handoff (n = 15)	Total handover scores, free of high-risk events	Prospective cohort study

[a] Incomplete data or unknown from article.

CVICU = cardiovascular intensive care unit; ICU = intensive care unit; PICU = pediatric intensive care unit; PCICU = pediatric cardiac intensive care unit; SICU = surgical intensive care unit.

team, the seeking of information by the receiving team increased.

In a prospective study with a pre-/poststudy design, Petrovic and colleagues [16] evaluated various elements of the handoff process, including the handoff procedure and environment, duration of the handoff, type of providers present, and percent of required information shared (the information sharing score). The presence of all handoff core team members increased from 0% at baseline to 68% after intervention. The percentage of information omission decreased significantly from 26% to 16% ($p = 0.03$) in the surgery report, although no change was noted in the anesthesiology report (19% to 17%, $p > 0.05$).

Using a similar study design, Van Der Walt and colleagues [17] showed significant improvements after the implementation of a postoperative handoff protocol. Personnel attendance increased from 20% to 87% ($p < 0.001$), parallel conversations decreased from 100% to 60% ($p < 0.0001$), the mean number of interruptions decreased from 3.37 to 0.77 during the anesthesiologist handoff and from 1.84 to 0.27 during the surgeon handoff ($p < 0.0001$ for each), and the information sharing score increased from 51% to a robust 88% ($p < 0.00001$).

Gleicher and colleagues [18] introduced a standardized handoff protocol and developed a unique handover score to evaluate its effectiveness. Specifically, the handover score was based on three dimensions: content, teamwork, and patient care planning. The mean handover score increased from 6.5 to 14.0 (maximum, 18 points). Notably, the structured approach led to fewer handoff interruptions and more frequent discussions of patient care planning.

In summary, in many of the studies reviewed, the authors attempted to measure handoff improvement by assessing the completion of various prespecified handoff elements. Although different metrics were assessed, handoff completeness was most commonly assessed by examining process measures (often referred to as technical elements) and completeness of information transfer. In every instance, the implementation of a structured handoff led to an improved handover process.

Prevention of Adverse Events

In 6 of the 21 studies reviewed, the effect of OR-to-ICU handoffs on the incidence of adverse events after cardiothoracic surgery was analyzed (Table 2). In a group of 1,078 pediatric cardiothoracic surgery patients, Agarwal and colleagues [19] found that a standardized postoperative handover was associated with a decreased incidence of cardiopulmonary resuscitation (5.4% vs 2.6%), mediastinal reexploration (9.0% vs 5.5%), and metabolic acidosis (6.7% vs 2.6%, $p < 0.05$ for each). In addition, a demonstrable increase in early extubation (<24 hours) was observed (43.2% vs 50.0%, $p = 0.04$).

In a landmark study, Hall and colleagues [20] evaluated 1,127 patients in an adult cardiovascular ICU and showed that preventable complications were reduced after the introduction of a collaborative, comprehensive

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Table 2. Breakdown of Study Outcomes Measured

First Author [Reference]	Completeness of Handoff (Y/N)	Prevention of Adverse Events (Y/N)	Provider Satisfaction (Y/N)	Process Measure Compliance (Y/N)
Agarwal [19]	Y	Y	Y	N
Breuer [22]	Y	Y	Y	N
Catchpole [24]	Y	Y	Y	N
Chenault [25]	Y	Y	Y	N
Craig [26]	Y	N	Y	Y (attentiveness)
Dixon [13]	Y	N	Y	N
Gleicher [18]	Y	N	Y	N
Hall [20]	Y	Y	N	N
Joy [29]	Y	N	Y	N
Karakaya [28]	Y	N	Y	N
Kaufmnan [21]	N	Y	N	N
Krimminger [23]	Y	N	Y	Y
Manser [15]	N	N	Y	N
Moon [37]	N	N	Y	N
Mukhopadhyay [14]	Y	N	N	Y
Northway [27]	Y	N	N	Y
Petrovic [16]	Y	N	Y	N
Ramasubbu [30]	Y	N	N	N
Salzwedel [38]	Y	N	N	N
Van der Walt [17]	Y	N	N	Y
Zavalkoff [39]	Y	Y	N	N
Percentage of studies reporting on measure	86	33	62	24

N = no; Y = yes.

handover process. A group of cardiac surgical intensivists determined the serious complications they believed were preventable through the implementation of a structured handover process (eg, cardiac arrest, prolonged hypotension, line complications, anaphylaxis/allergic reactions, drug dosage error, and pneumothorax) and the serious complications that would most likely not be affected by an improved handoff process (ie, cardiac arrest, death, myocardial infarction, sustained metabolic acidosis, new neurologic injury, unplanned return to the OR, ventilator-associated pneumonia, and acute renal failure). After implementing the improved handoff process, a significant reduction in preventable complications (5.3% vs 1.9%, $p = 0.002$) was observed, whereas the incidence of serious complications not believed to be preventable (9.6% vs 8.7%, $p = 0.6$) did not change.

Kaufmnan and colleagues [21] evaluated 1,507 patients in a pediatric cardiovascular ICU and showed that after implementing a handoff checklist, the number unplanned extubations was significantly reduced (0.62 vs 0.24 per 100 ventilator-days, $p = 0.03$), as was the median time to extubation (17 hours to 13 hours, $p = 0.02$).

Last, Breuer and colleagues [22] analyzed how a structured handoff affected complications in 142 patients in pediatric intensive care in medical and noncardiac surgical ICUs. The analysis showed improvements in the number of hemodynamic and respiratory interventions and in patient pain scores within 6 hours of arrival in the ICU. Notably, all studies reviewed consistently showed improved outcomes with fewer adverse events after the implementation of a handoff checklist.

Process Measure Compliance

In 5 of the 21 studies reviewed improvement of at least one process measure was documented, an outcome distinct from errors or omissions in the transfer of information, patient adverse events, or overall provider satisfaction (Table 2). In one of the more comprehensive analyses by Krimminger and colleagues [23], five process measures were evaluated for 76 handovers in a pediatric cardiac ICU before or after the implementation of a structured handover. The process measures included a printed, well-organized handover report, the presence and attention of all ICU team members, and the availability of all equipment on patient arrival to the ICU. After the new handover structure was implemented, reductions were observed in the number of process errors (6.1 to 1.7), information-sharing errors (5.2 to 2.3), and report interruptions (1.7 to 0.1, $p < 0.0001$ for each) per handover.

Catchpole and colleagues [24] evaluated a total of 50 pediatric OR-to-ICU handovers, 23 before and 27 after the implementation of a handover protocol. The handover protocol was designed with the help of a Formula 1 racecar team who came and observed the process and helped with the redesign. Process measures that were

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evaluated spanned four dimensions: equipment and technology handover (16 measures), information transfer, duration of the handover, and teamwork. After handover education and implementation the mean number of technical/process errors decreased from 5.4 to 3.2 ($p < 0.05$) per handover.

Chenault and colleagues [25] evaluated a total of 119 pediatric OR-to-ICU handovers that occurred before handover implementation, immediately after handover implementation, or at 5 years after handover implementation (groups were relatively even in number). Remarkably the median interquartile range for process errors (13 technical process errors involving personnel, equipment, or the verbal handover process) was significantly reduced, even in the sustainability phase 5 years later.

Craig and colleagues [26] evaluated 43 cardiac surgical handovers in a pediatric ICU, of which 21 occurred before and 21 occurred after handover intervention. This study evaluated not only information transfer but also analyzed process metrics in the following two spheres: the prearrival availability of crucial patient information (eg, cardiac echocardiograms, conference reports, admission orders) and the efficiency and quality of equipment transfer on patient arrival before the verbal handover. Consistent with previous studies, the improvement in process compliance after intervention was dramatic, with almost 100% compliance for these relatively straightforward technical tasks.

In noncardiac surgery patients, Mukhopadhyay and colleagues [14] observed a similar effect of an improved OR-to-ICU handoff on time elements and the presence of all team members during the handover. Northway and colleagues [27] evaluated not only the immediate effect of a formalized OR-to-ICU protocol–driven handover, but the durability of the initiative 2 years later by using video recordings of the handoffs for analysis. The process measures involved tangled lines, availability of essential supplies, unnecessary staff, waiting for team members, and inattentiveness of the team during the verbal handover. In all respects the initiative was successful, decreasing handoff defects from approximately 13 per handover to less than 1 per handover, at both early and late time points.

Finally, as alluded to above in Handoff Completeness, Van der Walt and colleagues [17] studied 60 adult cardiac ICU handovers before (n = 30) or after (n = 30) the implementation of a structured handover process. Process improvement was not as dramatic as that seen in other studies, largely because of a well-functioning unit before intervention. However, the number of interruptions during the report decreased, audibility increased, and staff presence increased. In summary, standardizing protocols for the OR-to-ICU handoff in both the pediatric and adult cardiac ICU significantly improved all process measurements including room readiness, time to accomplish critical tasks, presence of key personnel, and completeness of the verbal transfer.

Provider Satisfaction

The structured handoff process requires a collaborative effort involving key stakeholders to be sustainable, provide meaningful benefits, and ensure that it is designed to address clinical needs. In 13 of the 21 studies (62%) that were reviewed, some measure of provider satisfaction was analyzed (Table 2).

Gleicher and colleagues [18] distributed a formal survey to interdisciplinary team members to determine their impression of quality improvement in the handover process and whether it enhanced patient care. More than 90% of the surveyed team members recognized an improvement in teamwork and the quality of the handover. Similar findings were described in the aforementioned study by Petrovic and colleagues [16] in which nursing team satisfaction scores were found to increase from 61% to 81%. Karakaya and colleagues [28] actually observed a reduction in the handoff time from 6 to 4 minutes after implementing a structured process.

Important observations that almost certainly have led to team satisfaction include improvements in patient readiness, team focus, knowledge of the patient's surgical course in the OR, and the consistency of the handover process [26]. Improved team satisfaction was reported in 12 of 13 studies regarding provider satisfaction [25] in either a pediatric [19, 22, 24, 28, 29] or adult [13–15, 23] postoperative cardiac surgery ICU. For studies that did not analyze or demonstrate an improvement in team satisfaction, the authors acknowledged limitations related to the timing of survey delivery or the lack of directly visualizing team dynamics. The evaluation of team cohesiveness and interpersonal interaction may not have been evaluated in their survey.

Several studies enumerated processes of particular importance to the OR and ICU team satisfaction, including an inability to adequately hear the handover report (because of noise or distractions); a lack of appropriate content provided in the handover to clearly guide the ICU team and follow-up with the postoperative care plan [30]; and a lack of formal review, evaluation, and revision of the implemented process [18, 25].

Risk of Bias

Overall, the risk of bias was low (Supplemental Table 2), with most studies receiving 9 of 9 points on the Newcastle-Ottawa Scale.

Comment

There is no agreed on, universal, standardized OR-to-ICU handoff protocol ensuring a perfect handoff. However, the necessity of a checklist recognizes that under stressful conditions errors of omission occur. Checklists diminish these errors of omission and help ensure the use of best practices [19]. The results of this systematic review demonstrate that a routine handoff checklist can lead to more complete information transfer during the handoff, process compliance, provider satisfaction, and a reduction in adverse events in a cardiothoracic surgery ICU.

Others have found that communication errors can often be attributed to hierarchical situations in which one member does not wish to appear incompetent or offend a more senior member. For example, when a junior resident or inexperienced midlevel provider in the ICU meets with a senior anesthesiologist during a patient handoff because the attending intensivist was occupied in an urgent patient care situation, the information presented by the senior anesthesiologist may not be sufficient, and the junior ICU member may not feel comfortable asking for additional information. The standard handoff checklist ensures that adequate information is transferred as a matter of routine and reduces the likelihood of information being withheld [22]. Moreover, in contrast to the exchange of multiple simultaneous conversations in a noisy environment, systematic handoffs provide an orderly exchange of information for the multidisciplinary team. By directing all providers to first undertake the transfer of equipment and monitoring lines before the verbal report is given, parallel conversations are reduced, thereby improving caregiver and provider satisfaction. This has also been shown to improve teamwork and unit cohesion in the ICU [24].

To judge the success of a new handoff protocol or tool interdisciplinary quality improvement, groups at several institutions have attempted to identify the most important technical requirements of a successful handoff. Some have hypothesized that completeness of the handoff, including the discussion of each identified metric believed to be valuable, would result in a "better" handoff. Others have considered the avoidance of adverse events or provider satisfaction as the litmus test for an improved handoff. Finally, some have used a combination of the above-listed metrics (completeness of information transfer, avoidance of adverse events, provider satisfaction) to determine efficacy.

Handoff Checklist Examples

For the consideration of the cardiothoracic surgery community, the STS Task Force on Critical Care obtained several distinct handoff checklists from respective member institutions and synthesized those into sample checklists. Sample cardiac (Fig 2) and thoracic (Fig 3) surgery OR-to-ICU handoff checklists are the results of compiling checklists from a broad array of existing programs. Most information listed is routine and familiar to providers caring for cardiothoracic surgery patients. Discussing any anticipated adverse events (eg, bleeding, low cardiac output, blood pressure management, arrhythmias, hypoxemia) is important and can focus the caregivers, leading to targeted, proactive behavior. Discussing intraoperative events or surgical concerns may affect the expected postoperative course of a patient. Because up to one-third of critical events are reportedly not communicated with attending physicians, it has been suggested

A

Cardiac Surgery to ICU Handoff Checklist

Patient Name ______________ **Age** ___________ **Surgeon** ____________

- ☐ Is the receiving nurse, ICU team, and Anesthesia ready for handoff?
- ☐ Surgical Procedure
- ☐ Indication for surgery
- ☐ Pertinent past medical history
- ☐ Surgical Issues (Completeness of revascularization, Quality of targets, Aortic fragility, Neuromonitoring concerns or NONE)
- ☐ Issues with separation from bypass? Defibrillation/Cardioversion? _____
- ☐ Times: CPB ________Cross-clamp _______ Circ. Arrest ________
- ☐ Bleeding/coagulation Issues
- ☐ Systolic/MAP blood pressure goals/limits
- ☐ Chest tube placement/location?
- ☐ How much Chest Tube drainage when leaving OR ?
- ☐ Pacing wires. Atrial ____ Ventricular ___ Underlying rate & rhythm ________
  OK to pull for later removal or need to be cut _______
- ☐ Aspirin/Clopidogrel tonight? ______
- ☐ Family discussion completed (y/n) ______
- ☐ Other issues relevant to ICU care ?
- ☐ Is this patient a Fast Track Extubation candidate?
- ☐ What concerns me most about this patient is ____________________

B

Cardiac Anesthesia to ICU Time-out Checklist – Out of OR Time ___________

Patient Name _______________ **Age** __________ **Surgeon** ___________

- ☐ Pertinent past medical history, physical exam and co-morbidities, medications (anticoagulants), allergies
- ☐ Baseline LVEF, Hemoglobin, Creatinine, BP and HR
- ☐ Airway Issues (Difficulty, ETT at __cm)
- ☐ Issues with Induction?
- ☐ Oxygenation/ventilation issues (Last settings)
- ☐ Lines & Location. PA Catheter __ Central Line __ Art Line ___ Peripheral IV __
- ☐ Pre/Post TEE findings _________________
- ☐ Technical Considerations/Issues with separation from bypass___
- ☐ Drugs: Inotropes/vasopressors (dosages), last antibiotic, analgesics, last paralytic/sedation.
  Epinephrine ____ Norepinephrine ____ Nicardipine _____
  Milrinone ____ Vasopressin______ Nitroglycerine _____
  Dobutamine ____ Dopamine _______ Nitroprusside _____
  Isoproterenol____ Flolan/NO_______ Other _________
- ☐ Fluids/blood products administered:
  Crystalloid ______ Colloid _____EBL ______ Cell Saver ____
  PRBC ____ FFP ____ Platelets ____ Cryoprecipitate ____
  PCC/rFactor VIIa _____
  Diuretic given? _______Urine Output _______
- ☐ Desired hemodynamic goals/filling pressures
- ☐ Last Hgb, ABG, Relevant labs, Temperature on arrival to ICU.
- ☐ Other issues relevant to ICU care.
- ☐ Is this patient a Fast Track Extubation candidate?
- ☐ What concerns me most about this patient is ___________________

Fig 2. Sample operating room (OR)-to-intensive care unit (ICU) handoff checklist after cardiac surgery with cardiac surgery (A) and anesthesia (B) handoffs. (BP = blood pressure; CPB = cardiopulmonary bypass; EBL = excessive blood loss; ETT = endotracheal tube; FFP = fresh frozen plasma; HR = heart rate; IV = intravenous; LVEF = left ventricular ejection fraction; PA = pulmonary artery; PCC = prothrombin complex concentrate; PRBC = packed red blood cells; TEE = transesophageal echocardiography.)

A **Thoracic Surgery team to ICU Handoff Checklist**

Patient Name ______________ **Age** ________**M/F**____ **Surgeon** ____________

- ☐ Is the receiving nurse, ICU team, and Anesthesia ready for handoff?
- ☐ Resident/Fellow in Case ____________
- ☐ Surgical Procedure
- ☐ Indication for surgery
- ☐ Pertinent past medical history (FEV1/DLCO, Cardiac)
- ☐ Surgical Issues/Intraoperative Concerns
- ☐ Bleeding/Airleak Concerns
- ☐ Chest tube(s) & Drains – Location/Management (Suction vs. Water Seal) __________________ ____________________
- ☐ If Esophagectomy, specific plan for NGT/ Swallow study ________________
- ☐ Family discussion occurred (y/n)
- ☐ Extubation concerns (Y/N)
- ☐ Other issues relevant to ICU care.
- ☐ ABG/Lab frequency?
- ☐ I am most concerned about ______________________________

B **Thoracic Anesthesia to ICU Time-out Checklist**

Patient Name ______________ **Age** ________**M/F**____ **Surgeon** ____________

- ☐ Pertinent past medical history, physical exam and co-morbidities, medications
- ☐ Baseline Hgb, Cr, BP and HR, PA/CVP pressures at start of the case
- ☐ Airway Issues
- ☐ Issues with Induction
- ☐ Oxygenation/ventilation issues
- ☐ IV and arterial-line placement
- ☐ Drugs: allergies, inotropes/vasopressors, last antibiotic, analgesics, last paralytic, Y/N epidural
- ☐ Fluids/blood products administered
- ☐ Desired hemodynamic goals/filling pressures. Last ABG, Hgb
- ☐ Desired period of sedation (if required)
- ☐ Other issues relevant to ICU care
- ☐ I am most concerned about _________________ ________________

Fig 3. Sample operating room (OR)-to-intensive care unit (ICU) handoff checklist after thoracic surgery with thoracic surgery (A) and anesthesia (B) handoffs. (ABG = arterial blood gas; BP = blood pressure; Cr = creatinine; CVP = central venous pressure; DLCO = diffusing capacity for carbon monoxide; FEV_1 = forced expiratory volume in the first second; Hgb = hemoglobin; HR = heart rate; N = no; NGT = nasogastric tube; PA = pulmonary artery; Y = yes.)

that the handoff outline specifically include trigger events that mandate the notification of a surgical attending [25].

How to Implement ICU Handoffs

In 2013, the American Heart Association made a Class I recommendation that formal handoff protocols should be implemented during the transfer of care of cardiac surgery patients to new medical personnel [31]. Important elements and universal strategies include the following (Fig 4):

1. Standardization (same order or template)
2. Structured format beginning with a high-level overview and introduction of providers
3. Limited interruptions
4. Face-to-face verbal update with interactive questioning

In diverse settings with high consequences of failure (ie, the NASA Space Center, nuclear power plants, railway and ambulance dispatch centers), many constructive lessons can be learned regarding handoff effectiveness and efficiency [32]. Additional strategies that are common in the cardiac surgery OR-to-ICU handoff protocols are as follows [33]:

1. The ICU staff wait for the patient's arrival with a face-to-face handoff (often requires one or two phone calls from the OR nurses to relay the time of arrival).
2. An individual is assigned to manage the patient's care throughout the handoff process to allow the receiving nurse and the ICU staff to listen to the presentation (usually done by a senior anesthesiology provider from the OR with the assistance of a temporary additional ICU nurse or charge registered nurse).
3. All members of the handoff team remain until the end of the handoff process. In addition, urgent clinical tasks are completed before the handoff.
4. The room is quiet; there are no interruptions, and side conversations are avoided. The handoff is taken seriously with only patient-specific discussions allowed.
5. A protocol determines who speaks and in what order.
6. A checklist provides a structured format for the expected sequential contents of verbal handoff (usually a separate checklist for the surgeon and anesthesiologist).
7. There is a question and answer period, if required by the receiving team.
8. An ICU summary contains a systems-based discussion of key postoperative concerns, expected course, and a formal assumption of ICU care responsibility by the critical care team.

Although numerous versions of checklists are used at various institutions, the basic tenets remain the same. The sample checklists shown in Figures 2A and 2B and Figures 3A and 3B represent reasonable best practices and should be modified according to the setting or local practice. It is advisable that the nursing staff who will be implementing the handoff checklists actively provide input and close the loop of the intended care plan with the team. In an illustrative example, Petrovic

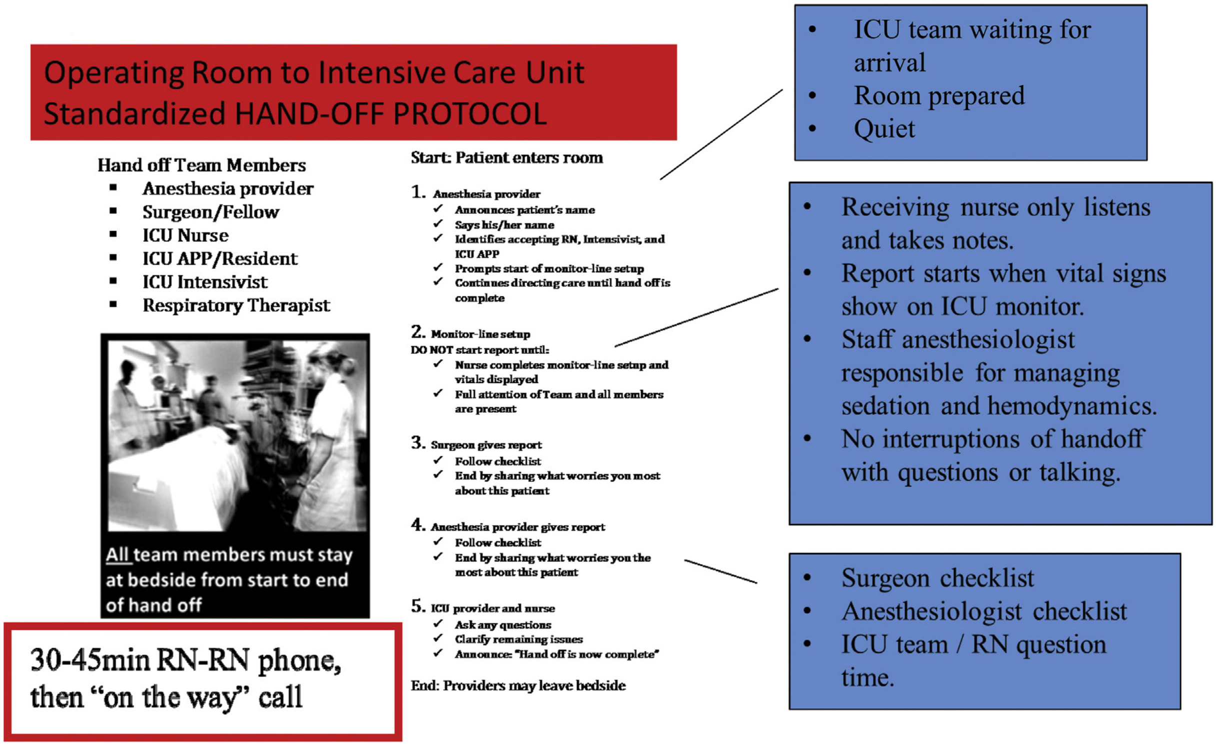

Fig 4. Standardized operating room (OR)-to-intensive care unit (ICU) handoff protocol highlighting key strategies in the implementation of the checklist. (APP = advanced practice provider; min = minute; RN = registered nurse.) (Adapted from Petrovic and colleagues [34] with permission.)

and colleagues [34] have outlined the process of implementing a handoff checklist at Johns Hopkins Hospital. They identified the following administrative tasks necessary for successful implementation: garnering leadership support at multiple administrative levels, building an implementation team of local champions, training healthcare providers on the new perioperative protocol, implementing the changes, and periodically reviewing the protocol to ensure sustainability and success.

Nevertheless, the mere presence of a checklist is not sufficient for success. Overcoming barriers to using the checklist, encouraging a supportive team culture, and providing feedback to staff are all vital [35]. It is not uncommon to experience resistance from senior staff, citing tradition or skepticism. A cumbersome process will be quickly abandoned. However, surgery those in doubt can be convinced by the numerous examples of how implementing a structured handoff process preserves process efficiency while minimally increasing the time spent during a handoff. Moreover, although studies analyzing the financial impact of implementing routine handoff checklists are lacking, it seems probable that improving handoff communication and reducing errors directly related to handoffs, which require minimal time and expense, would have financial benefits [36].

In summary, the OR-to-ICU handoff represents a vital opportunity to ensure the orderly exchange of information while maintaining patient safety as the primary focus. A structured handoff with a checklist incorporates elements of standardization, teamwork, and accountability into the process and ensures that important information is unlikely to be missed. Furthermore, it promotes a culture of safety with improved communication among cardiothoracic surgeons, anesthesiologists, and the critical care team.

Limitations

This review has several limitations. First, the classification and nomenclature of patient safety research is heterogeneous; thus, despite our use of a comprehensive search strategy, the possibility remains that some studies were overlooked. In addition, it was not possible to perform a meta-analysis of the studies included in our review because of the variability in subject matter, methodology, and outcome measures. We combined both adult and pediatric studies because much of the initial work in the study of handoffs began in the field of pediatric cardiac surgery. Nonetheless, restricting our analysis to adults would have substantially limited the scope of the review. Finally, the choice to limit our review to articles written in the English language may have excluded important studies published in other languages.

REPORT

Conclusion

This systematic review focused on studies of handoffs from the OR to the ICU, with a special emphasis on cardiothoracic surgery patients. The results of our review indicated that the implementation of a structured handoff improved the handoff process, specifically with respect to process compliance, patient outcomes (ie, fewer adverse events), and provider satisfaction. The STS Workforce for Critical Care strongly recommends the implementation of a routine, structured OR-to-ICU handoff as a quality measure that benefits the entire cardiothoracic caregiving team.

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