THE IMPACT OF CHECKLIST USE ON POST-ANESTHESIA TRANSFER OF CARE EVENTS: A MIXED-STUDIES REVIEW

A Major Paper Presented

by

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Abstract

The purpose of this paper is to complete a mixed-studies review, in order to answer the question, “How does the use of a checklist by anesthesia providers for post-anesthesia transfer of care (TOC) impact the objective quality of the handoff?” Checklists are tools used to improve the quality and reliability of high-risk processes both within and outside of the healthcare setting. A specific interest in intraoperative checklist use was the impetus for the clinical question. Due to a lack of available research, post-operative checklist use was reviewed. A link to intraoperative checklist use is made from the findings. Lewin’s Planned Change Theory was used for examining how implementation of a checklist may be successfully completed in the anesthesia arena. The PRISMA checklist was utilized. Current literature was systematically searched to select a sample of studies pertinent to the clinical question. Data from these studies was extracted, analyzed, evaluated, and reported in a manner consistent with the PRISMA guidelines. The following terms were used to complete the search: “post-anesthesia,” “transfer of care,” “handoff,” “checklist,” “standardized checklist,” “anesthesia,” and “patient safety.” Three randomized controlled studies met the inclusion and exclusion criteria, and a fourth study pertinent to the clinical question was included in the review to increase the sample size. Findings were that the use of a checklist by anesthesia providers for post-anesthesia TOC was effective in increasing the percentage of overall items included in the handoff, while the effect of checklist use on handoff duration was inconclusive.

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The Impact of Checklist Use on Post-anesthesia Transfer of Care Events: A Systematic Review

Background/Statement of the Problem

In the perioperative setting, it is common for the care of a patient to be transferred from one healthcare provider to another. The transfer of care (TOC), or "handoff" is considered a high-risk event. Wilbanks et. al. (2018) cite the inadequate relay of information as an antecedent of approximately 80 percent of medical errors, and according to Canale (2018), breakdown in communication during TOC is a leading cause of patient morbidity and mortality. The safety risk associated with handoffs is pertinent to anesthesia practice, where intraoperative TOC is common (Boet et. al., 2020). Jayaswal et. al. (2011) report about five anesthesia TOC events per operating room (OR) per day at their study site. Additionally, there is evidence in the literature that intraoperative anesthesia TOC is associated with increased incidence of adverse outcomes (Boet et. al., 2020).

One way to mitigate the risk posed by frequent intraoperative anesthesia TOC is the use of a standardized checklist during these events. Checklists have been created and used during performance of high-risk processes both within and outside of the healthcare industry. Robins and Dai (2015) cite the use of checklists to decrease error and improve safety in the aviation industry, and also promote checklist use in healthcare. Findings by Bergs et. al. (2014) suggest that the use of the World Health Organization's Surgical Safety Checklist correlates with a decrease in complication rates, mortality, and surgical site infection. Despite evidence that standardized checklists can improve quality and safety, TOC events between anesthesia providers remain informal and inconsistent (Canale, 2018). The lack of uniformity in intraoperative anesthesia handoffs may result in inadequate relay of key information to the oncoming provider, and lead to a poor outcome.

A method to appreciate the impact of these tools on intraoperative anesthesia handover practice is to examine how their use affects objective handover of information during the TOC. Currently, no quantitative studies relating these two variables have been identified in the literature. However, there are published studies that examine the above relationship during post-anesthesia, rather than intraoperative, TOC events. For that reason, the purpose of the major paper is to complete a systematic review of current literature, in order to answer the question, "How does the use of a checklist by anesthesia providers for post-anesthesia TOC impact the objective quality of the handoff? A secondary aim of the project is to discuss the findings of the systematic review as they relate to intraoperative anesthesia TOC, and present implications for nurse anesthesia practice.

Literature Review

Cochrane, The Cumulative Index of Nursing and Allied Health Literature (CINAHL), CINAHL Plus with Full Text, Google Scholar, and PubMed databases were searched. Search terms included standardized checklist, checklist, transfer of care, handoff, quality, quality of care, safety, patient safety, intraoperative, anesthesia, and post-anesthesia. Studies published between 2011 and 2020 were included in the search. The following literature review summarizes the use and effectiveness of checklists for handoff practices in healthcare, as well as use of TOC checklists by anesthesia personnel.

Nursing TOC

Within the inpatient healthcare arena, patients require 24-hour care. Consequently, the responsibility of care must be transferred from one nurse to another. A TOC is defined as the transfer of pertinent patient information from one caregiver to another (Reinbeck & Fitzsimons, 2013). As with other TOC events, nursing TOC is prone to human error, which may have dire consequences. According to Nagpal et. al. (2013) the information being exchanged during a TOC may be misrepresented, misinterpreted, or omitted.

Historically, nursing TOC involved a discussion of the patient's medical history, the plan of care, and other important information, and excluded the patient from the TOC process (Reinbeck & Fitzsimons, 2013). Common areas to complete handoff included a central nursing station or break room. More recently, however, the practice of a bedside nursing handoff with patient participation has been implemented in the healthcare environment.

According to Reinbeck & Fitzsimons, (2013) bedside TOC has been shown to empower staff, improve patient involvement in their own care, and make the provider transition safer.

Handoff Tools for Nursing TOC. One handoff tool developed specifically for TOC between nurses is the Situation, Background, Assessment, Recommendation (SBAR) framework. SBAR breaks down four important aspects of the TOC. First, the current situation of the patient is identified and stated (Tews & Liu, 2012). Second, a brief background of pertinent medical history, assessment findings, and diagnostic data is presented (Tews & Liu, 2012). Next, the current state of the patient is disseminated (Tews & Liu, 2012). Finally, a recommendation or suggestion is made regarding how to proceed (Tews & Liu, 2012). The SBAR tool has been validated in the literature as a tool to reliably reduce medical error and enhance communication between providers (Tews & Liu, 2012).

Abbaszade et. al. (2021) conducted a quasi-experimental study investigating impact of the SBAR tool on the quality of nursing care. Their research took place in the coronary care units of two public hosptials in Bojnurd, Iran between September 2018 and February 2019. The researchers assessed care quality from the patient's perspective using a Persian version of the Quality Patient Care Scale (QUALPACS). Abbaszade et. al. (2021) found that there was a significant increase in the mean QUALPACS scores across all three of the tool's dimensions (psychosocial, physical, and communication) following implementation of the SBAR tool during TOC. The study did not examine the impact of SBAR tool use on objective quality of the TOC or patient outcomes.

Campbell and Dontje (2019) published a project incorporating the SBAR tool with the bedside handoff of patients in the emergency department. The authors measured data using pre- and post-implementation scores on a handoff questionnaire completed by nurses, select items from a hospital patient safety culture survey, and observations of TOC by nurse leaders. The authors found that the SBAR tool was easy to use and prevented information loss (Campbell & Dontje, 2019). However, the authors note that permanent integration of the tool may not be feasible due to resistance by nurses.

Anesthesia TOC

Nature of Anesthesia TOC Events. Although patient TOC between anesthesia providers is common, research investigating the nature of these events is lacking (Lowe & George-Gay, 2017). It is important to have an understanding of the mechanics behind the handoff process, since any handoff may be a cause of an adverse outcome (Jayaswal et. al., 2011). Currently, there is not a universal, standardized method for anesthesia TOC.

In a descriptive qualitative study by Wilbanks et. al. (2018), the authors retrospectively investigated perioperative anesthesia TOC events that were linked with subsequent professional malpractice claims. Their aim was to uncover themes, antecedents, and consequences stemming from these events in order to improve future practice. The authors conducted a qualitative content analysis of 19 closed malpractice claims. Inclusionary criteria for each claim required that the case make a mention of the TOC event, and that the TOC be associated with the initiation of a lawsuit. Wilbanks et. al. (2018) identified six broad themes, naming specific handoff phenomena that preceded the claims. These themes were: 1.)

appropriateness of the level of care and location of the transfer, 2.) the role of production pressure in normalizing shoddy handoff, 3.) the need of the anesthesia provider to conduct their own assessment, 4.) failure of the interdisciplinary team to communicate, 5.) inadequate patient monitoring, and 6.) TOC during high-risk events or patient instability. The researchers point out that even when a single provider cares for a given patient throughout the entire anesthetic, there may still be team communication failure, leading to an adverse outcome. For instance, the anesthesia provider may not communicate recent changes in a patient's condition to other members of the surgical team. Wilbanks et. al. (2018) write that poor vigilance and a delay in patient assessment may be responsible for breakdown in communication. One of the limitations of the study, mentioned by the authors, was the use of a single reviewer to select included claims, which may have excluded other relevant cases. Additionally, in looking at the data retrospectively, causation cannot be proven, and utilization of a closed-claims database only allows for exploration of TOC events associated with a malpractice claim.

Lowe and George-Gay (2017) describe additional aspects of anesthesia TOC. Their study involved analysis of a convenience sample of 60 high-fidelity, simulated, intraoperative anesthesia TOC events at Virginia Commonwealth University. The researchers looked for the presence of latent conditions during TOC and examined the impact of these conditions on handoff quality. Latent conditions are defined by the authors as conditions that may lead to subsequent error but are not easily linked to adverse outcomes. These conditions were distraction, production pressure, noninteractive or "one-way" communication, and poorly timed handoff. Researchers scored each simulated TOC in terms of adequacy based on a 10-

item checklist. Overall, Lowe and George-Gay (2017) found that presence of noninteractive communication was most associated with a lower TOC score. Also, handoff quality greatly decreased when three or more latent conditions were present. Although not discussed by the authors, a limitation of their study was the fact that the research was based on simulated TOC events, rather than real ones.

Anesthesia TOC and Adverse Outcomes. There is evidence in the literature that an increased frequency of intraoperative anesthesia TOC events is associated with an increase in adverse outcomes. Saager et. al. (2014) wrote that the omission of critical information during handoffs could lead to delays, inefficiencies, sub-optimal quality of care, and patient harm. In a large-scale, retrospective observational study conducted by Saager et. al. (2014), the researchers found that intraoperative anesthesia handoffs were significantly associated with a higher chance of subsequent in-hospital morbidity and/or mortality. Overall, the authors found that each TOC increased these odds by a statistically significant eight percent. The authors took confounding variables into account, including the severity of the surgery. Saager et. al. (2014) discussed the inability to prove causation and confinement to a single research site as limitations of the study. Additionally, the authors mentioned that inadequate communication is a common precursor to sentinel events, and suggested formalization of the TOC process as a way to improve safety.

A systematic review by Boet et. al. (2020) rendered a conclusion similar to the findings of Saager et. al. (2014). The purpose of the review was to evaluate the impact of intraoperative anesthesia TOC on patient outcomes. The sample consisted of eight prospective and retrospective studies that explored the relationship between intraoperative anesthesia

TOC and patient morbidity and mortality. The authors concluded that in general, intraoperative anesthesia TOC was associated with increased morbidity and mortality. One of the studies within the systematic review found that anesthesia handoff may be beneficial to the patient, in that it allows for identification and remediation of a problem. Boet et. al. (2020) wrote that the studies included in their review focused mainly on whether or not a TOC took place, rather than the specific nature of the TOC. The authors did not discuss the components of the TOC that may have led to a poor outcome. Limitations of the review, noted by Boet et. al. (2020), were analysis of observational studies, a vast array of surgeries, and varied methods and outcome definitions between studies in their sample.

Intraoperative Checklist Use by Anesthesia Providers

Currently, the routine use of a standardized checklist by anesthesia providers for intraoperative TOC is not a mainstay of practice, despite the notion that handoffs are prone to error (Wright, 2013). In exploring the literature related to the subject, several themes were identified.

Checklist Use and Quality of TOC. Four research articles investigated whether or not the use of a standardized checklist by anesthesia providers improved the quality of the TOC. Agarwala et. al. (2015) conducted a quality improvement (QI) initiative with an aim to improve the quality of intraoperative handoffs between anesthesiologists. The study compared the relay and retention of information before and after the implementation of an electronic checklist. The sample consisted of all anesthesia providers at Massachusetts General Hospital. Agarwala et. al. (2015) concluded that the relay and retention of pertinent information was improved when using the tool. Additionally, the electronic checklist was associated with improved interpersonal communication and discussion of concerns during the TOC, as well as improved provider satisfaction with the handoff (Agarwala et. al., 2015). Limitations of the research, cited by the authors, included a small sample size, lack of statistical significance, and non-random sampling.

Gillikin and Apatov (2016) also reported the apparent effectiveness of an electronic anesthesia handoff tool in improving handoff quality. Utilizing a pre-intervention/post-intervention observational design, the authors compared the incidence of patient information inaccuracies and omissions during TOCs before and after implementation of their tool. The sample consisted of a group of 10 Certified Registered Nurse Anesthetists (CRNAs), who completed 82 pre-intervention TOCs and 75 post-intervention TOCs at a hospital in Virginia. Gillikin and Apatov (2016) found significant decreases in omission of information following implementation. A small sample size and single site are limitations of the research.

Similar to the above studies, Lambert and Adams (2018) implemented a QI project with a pretest/posttest design. Their purpose was to identify barriers and omissions during handoffs between CRNAs and post anesthesia care unit registered nurses (PACU RNs), as well as between CRNAs, before and after implementation of a written handoff anesthesia tool (WHAT). The study was conducted at a 350-bed hospital in the southeastern United States. The sample included 22 CRNAs and 15 PACU RNs. Following WHAT implementation, the authors found a decrease in the "defective" rate for both CRNA to PACU RN and CRNA to CRNA TOC, as well as a statistically significant increase in satisfaction of the handoff and improved provider perceptions of TOC adequacy. A TOC was considered "defective" if it was deemed inadequate by either the sender or the receiver (Lambert & Adams, 2018). Participants used the Targeted Solutions Tool, created by the Joint Commission Center for Transforming Healthcare, to identify which factors contributed to inadequacy of the TOC. These factors fell into two categories: contributing factors (for instance, interruptions and inadequate staffing) and omission of information (for example, patient name, date of birth and allergies). Lambert and Adams (2018) mention the single site and convenience sample as limitations of their research. Notably, the authors do not explain the development or validation of the WHAT. Also, while these findings are reported quantitatively, the authors do not discuss the fact that the designation of a TOC being "defective" was based on the subjective perception of the provider.

A QI project by Boat and Spaeth (2013) aimed to improve the reliability of anesthesia TOCs in the OR and the PACU at Cincinnati Children's Hospital Medical Center. Following a TOC observation period, a handoff protocol was developed and implemented. For the project, "reliability" of the TOC was defined as an all-or-none phenomenon. In other words, either the tool was used, or it was not used. Specific data related to omission and retention of information was not evaluated, making a link between tool use and TOC quality difficult. The authors cite 100 percent compliance with the handoff tool for the duration of the six-month initiative. The authors do not discuss limitations of the study. Boat and Spaeth (2013) do address that having "buy in" from the anesthesia department was a key factor in the project's success. As far as relating use of a standardized tool to improving the quality of an intraoperative anesthesia handoff, Boat and Spaeth's (2013) research provides little evidence of improved handoff quality.

Checklist Use and Provider Satisfaction/Perceptions. Another facet of the literature around anesthesia TOC checklist use is the relationship between tool use and provider satisfaction, as well as provider perceptions of the TOC. As previously mentioned, Agarwala et. al. (2015) wrote that their checklist was associated with improved provider satisfaction. They also found that there was a decreased perception by anesthesia providers that the handoff was rushed when the checklist was used. Satisfaction was reportedly improved in the project completed by Lambert and Adams (2018) as well. The work of Gillikin and Apatov (2016) did not address provider satisfaction.

Research by Wright (2013) aimed to understand the nature of current intraoperative anesthesia TOC practice, and then implement and evaluate a communication checklist tool designed to improve the TOC. Wright (2013) described her research as a two phase, nonexperimental, exploratory study. Following a mixed-methods questionnaire completed by 302 CRNAs to understand current TOC practices, Wright (2013) developed a standardized checklist she called the “PATIENT” (a pneumonic) protocol. Components included in the pneumonic were identification of the patient, as well as discussion of the airway, temperature monitoring, intravenous access/intake and output, end-tidal carbon dioxide, narcotic administration, and neuromuscular blockade status. After implementation of the checklist, the author collected data via a second mixed-methods survey related to provider views of the tool. One key takeaway from Wright’s (2013) work was that overall, the tool was viewed favorably by providers. Additionally, most providers reported that they did not currently use a systematic process for TOC. A limitation addressed by Wright (2013) is the fact that the study did not objectively determine impact of the PATIENT protocol on handoff quality. Conclusions were made based solely on provider perceptions of TOC.

Canale (2018) adapted Wright's (2013) PATIENT pneumonic as part of an evidence based practice improvement project, with a purpose to improve quality and continuity of information during TOC, and improve provider perceptions and satisfaction with handoffs. Although Canale (2018) found statistically significant improvement in the quality of TOC, her finding was based only on provider perceptions of the handoff, not on objective measurement. Canale (2018) found that after implementation of the checklist, providers reported statistically significant improvement in their perceptions of patient safety and overall satisfaction. Canale (2018) reiterated that her findings were based on provider perceptions, and that the limitation of the study was confinement to one site.

Lack of Standardization During TOC. In each of the previously mentioned research articles, the authors made a point that current intraoperative anesthesia handoff practices are lacking standardization, and several of the studies discussed how poor communication coupled with lack of TOC uniformity may lead to devastating outcomes. For example, Wright (2013) explained that although there is possibility of communication failure between anesthesia providers intraoperatively, current TOC practice is not standardized or well defined. Agarwala et. al. (2015) discussed how intraoperative handoffs may be a source of errors and that there is minimal literature on the topic. Additionally, Gillikin and Apatov (2016) wrote that there may be considerable variation in which any two anesthesia providers practice TOC.

The review of the literature found that the standardization of nursing TOC is not only well established, but also has been found to improve handoff quality and provider satisfaction. Alternatively, routine use of a checklist for intraoperative anesthesia TOC is uncommon, despite the evidence that increased incidence of these handoffs correlates with adverse events. The literature review did find evidence that checklist use during TOC may improve anesthesia provider satisfaction and subjective perception of handoff quality. Insight gained from the literature review underscores the importance of investigating the objective effectiveness of intraoperative anesthesia TOC checklists, in order to understand their effectiveness in improving TOC quality.

Theoretical Framework

In reviewing the published literature surrounding intraoperative anesthesia TOC practice, it is clear that at present, the routine use of a standardized handoff checklist between anesthesia providers is uncommon. As previously mentioned, the purpose of the major paper is to complete a mixed-studies review of current literature, in order to answer the question, "How does the use of a checklist by anesthesia providers for post-anesthesia TOC impact the objective quality of the handoff?" After synthesizing findings to answer the question, a connection to anesthesia checklist use during intraoperative TOC is made. The conclusions gleaned from the review will provide one small step towards creation of an evidence base for the use of anesthesia checklists in the operating room. However, it is important to remember that findings from the paper may support or refute use of these tools. Should the findings favor the use of a checklist, future efforts may be made by anesthesia leaders to integrate these checklists into everyday practice. Since checklists are not routinely used by anesthesia providers in the intraoperative environment, implementation would require a practice change. Kurt Lewin's Planned Change Theory (McEwen & Wills, 2019) provides a framework for understanding dynamics at play when trying to change practice.

Within the healthcare environment, continuous change is common (McEwen & Wills, 2019). In addition, McEwen and Wills (2019) write that any change can bring about feelings of anxiety and turmoil in individual people. The German psychologist Kurt Lewin devised a method of planned change (McEwen & Wills, 2019). In other words, Lewin's theory details a strategy for implementing controlled change, as opposed to change that happens organically. McEwen and Wills (2019) note that application of Lewin's framework can influence change to an entire group of people.

McEwen and Wills (2019) detail the components of Lewin's theory. Two main forces influence change, known as driving forces and restraining forces. A driving force is any factor that promotes the intended change, while a restraining force hinders movement towards the change. When the driving forces and restraining forces are balanced, status quo is maintained. Successful implementation of a change to a system requires an understanding and strengthening of the driving forces and a mitigation of the restraining forces. When the influence of the promoting factors outweighs that of the restraining factors, a shift towards the planned change occurs.

Lewin also described three phases that need to take place in order for change to be successful (McEwen & Wills, 2019). These include the unfreezing of the status quo, moving to a new state, and refreezing the change to make it permanent. The unfreezing and movement stages are dependent on the driving forces overpowering the restraining forces. During the refreezing stage, the change is successfully implemented within the system, and the driving and restraining forces are again at equilibrium.

Viewing Lewin's theory through the lens of checklist implementation for intraoperative anesthesia TOC provides some insight into how such a change could take place. Should these tools be found to be beneficial to practice, future research looking into the driving and restraining forces influencing anesthesia providers would be helpful in designing a strategy to change practice. Examples of factors that may promote checklist use by these providers include the belief that the tool will positively benefit patients, or that it will improve ease of the TOC. Potential restraining forces from the view of the anesthesia provider may be a belief that the checklist is cumbersome, or that it is a threat to the provider's autonomy. New research would likely uncover other factors that would influence change.

A final takeaway from Lewin's framework is the notion that any change in a system will likely be met with resistance, due to the disruption of the "comfort zone" created by the status quo (McEwen & Wills, 2019). Anesthesia practice is a discipline rooted in different methodical routines by individual providers, each with their own unique approach to care. Due to these factors, a smooth and unopposed change to practice would be unlikely.

Methods

Purpose

The purpose of this paper is to conduct a mixed-studies review of current published literature in order to answer the question, "How does the use of a checklist by anesthesia providers for post-anesthesia TOC impact the objective quality of the handoff?

Design

A systematic, mixed-studies review (MSR) of current published literature was the design utilized to answer the question of interest. An MSR incorporates findings from both quantitative and qualitative studies, in a systematic fashion, to answer the question of interest (Polit & Beck, 2017). Polit and Beck (2017) write that the development of an MSR design is relatively recent, and that terms and approaches to the method are still growing. A key feature of an MSR is the integration of quantitative and qualitative research findings (Polit & Beck, 2017). For instance, the use of a standardized checklist by healthcare providers may influence both objective patient outcomes and subjective patient perceptions of care, among other impacts. Both of these relationships are important to consider when exploring impacts on patient outcomes, but the research needed to glean insight into each will utilize different methods. Polit and Beck (2017) explain that pragmatism is the paradigm commonly connected with mixed-methods research. Pragmatism centers around the notion that the research question itself should direct the method of exploration, rather than a pre-set, rigid methodology (Polit & Beck, 2017).

As the MSR design for this paper evolved, it honed a sample of studies that were all quantitative in nature, but with two different quantitative methods. Three of the studies chosen for inclusion were randomized controlled trials (RCTs), and the fourth study was a QI initiative. Thus, in synthesizing findings from these studies, the MSR design used mirrored that of a traditional systematic review. The inclusion of the QI study was the key deviation from the usual systematic review design, thus designating the design of this paper as an MSR.

The Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA) checklist provided the framework for the study design (PRISMA, 2021). PRISMA guidelines were developed in response to a need for standardization among the design of systematic reviews, with an aim to strengthen the validity of their conclusions. Following the PRISMA checklist, current literature was systematically searched to find relevant RCTs for inclusion in the systematic review. Data was extracted, analyzed, evaluated for quality, and reported in a manner consistent with the PRISMA guidelines.

Literature Search and Selection

In conducting the literature search, the following terms were used: “post-anesthesia,” “transfer of care,” “handoff,” “checklist,” “standardized checklist,” “anesthesia,” and “patient safety.” These terms were entered into the Cochrane database, CINAHL, CINAHL Plus with Full Text, Google Scholar, and PubMed.

Inclusion Criteria

Inclusion criteria limited results to:

a) randomized controlled trials,

b) studies investigating the use of a standardized checklist for post-anesthesia TOC,

c) studies aimed at examining how checklist use impacts objective outcomes related to the TOC itself,

d) articles published from 2011-present, and

e) articles published in English.

Exclusion Criteria

Studies were excluded from the review if they:

a) did not include a discussion by the investigators regarding study limitations, or

b) did not study TOC events in a tertiary-care setting

Data Collection and Evaluation

Following the selection of articles to be utilized in the review, data was extracted for critical appraisal, and summarized in data tables. The data tables can be found in appendices A and B. The first set of data tables provides a summary of the purpose, design, site, sample, methods, and outcomes examined for each article. A template of this data table is provided in Table 1. Appendix B provides tables summarizing the findings from each of the studies, and includes the outcomes examined, a comparison of data between groups in the study, and significance levels of findings. A template for the outcome data tables is provided below in Table 2. The data pulled and analyzed from each study was comprehensive, and included the study's design, site, sample, methods, outcomes examined, results, and limitations. Each of the articles was critically appraised using the Critical Appraisal Skills Programme (CASP) tool. CASP is a checklist that lays out a systematic framework to evaluate the strength and quality of a given research study's design (Singh, 2013). The strength of each study was taken into account when drawing conclusions from the review. An example of a CASP table is provided in Table 3.

Table 1

Data from included studies

First author, year published	
Design	
Purpose	
Site, sample	
Methods	
Outcomes examined	

Table 2

Outcome Data Collection

Outcome	Group A	Group B (C,…etc.)	Significance
[outcome 1]			
[outcome 2]			

Table 3

Critical Appraisal Skills Programme (CASP)

Question	Yes	Can't Tell	No	Comments
1. Did the study address a clearly focused research question?				
2. Was the assignment of participants to interventions randomized?				
3. Were all participants who entered the study accounted for at its conclusion?				
4. Were study participants and investigators 'blind' to group assignment?				
5. Were the groups similar at the start of the trial?				
6. Apart from the experimental intervention, did each study group receive the same level of care?				
7. Were the effects of the intervention reported comprehensively?				
8. Was the precision of the estimate of the intervention or treatment effect reported?				
9. Do the benefits of the experimental intervention outweigh the harms and costs?				
10. Can the results be applied to your local population/in your context?				
11. Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?				

Data Analysis

Using the PRISMA framework as a guide, a cross-study analysis was performed. The analysis is provided in both narrative and table forms, comparing all aspects of each of the included studies. A template of the cross-study analysis table is provided below. Similarities and differences between studies are compared and discussed following the cross-study analysis. Also discussed are the limitations of the studies and the limitations of the systematic review itself. Finally, a link to implications for intraoperative nurse anesthesia TOC is made based on these findings.

Table 4

Cross-study Analysis

First author, year published	Study Comparisons	Outcome A (B…etc.)	Comments

Results

After completion of the literature search, 12 articles were reviewed for the inclusion and exclusion criteria. Following review, three articles remained. In order to augment the sample size for the review, a fourth study was included, despite the fact that it was designed as a quality improvement initiative and not an RCT. The results from each article, as well as a discussion of the quality of each study, are presented below.

In the first study, Potestio et. al. (2015) implemented a standardized OR to PACU checklist for TOC by anesthesia residents. A total of 100 handoffs were observed, divided into two groups of 50. In group A, residents completed their PACU handoff without the use of a checklist, while those in group B used a checklist for TOC. Six of the anesthesia residents provided handoffs in both groups. Potestio et. al. (2015) describe a four-step, methodical approach used in checklist development. The first step was the development of an all-inclusive 42 item list based on anesthesia literature. Potestio et. al. (2015) then modified their list down to 17 items based on elements of handoff specific to their institution. The third step of checklist development involved observation of 10 PACU handoffs to check for additional items appropriate for inclusion. Finally, Potestio et. al. (2015) added a "closed loop communication" item to acknowledge two-way communication between the anesthesia provider and PACU nurse. A summary of the design, site, sample, and methods of the study is provided in Appendix A. Potestio et. al. (2015) examined four outcomes; the percentage of overall items handed off, the percentage of specific items handed off, duration of the handoff, and the average time spent per item.

The results from Potestio et. al.'s (2015) study are presented in Appendix B. Potestio et. al. (2015) found that the mean percentage of items handed over increased with the use of the checklist, and that the finding was statistically significant (51.50% v. 69.5% in groups A and B, respectively, P = 0.018). Anesthesia residents handed over eight specific items more frequently and to a statistically significant degree when the checklist was used, compared to the control group. A list of these items and their respective P-values is noted in Appendix B. Also, the investigators concluded that the use of a checklist was associated with a longer mean duration of the TOC, and that the finding was significant (100.86 seconds v. 126.4 seconds in groups A and B, respectively, P = 0.011). In terms of the average time spent per item, checklist use correlated with less time per item, but not to a significant degree (mean 8.23 seconds v. 7.71 seconds per item in groups A and B, respectively, P = 0.366). Notably, although Potestio et. al. 2015 state that their finding was not statistically significant, they make no mention of what P-value was used to determine significance. Potestio et. al. (2015) performed a subgroup analysis of only handoffs provided by the residents who participated in both groups. The authors analyzed both the mean percentage of items handed over and the duration of handoffs in the subgroup (Potestio et. al., 2015). Outcomes in the subgroup were found to mirror those of the group as a whole, as described in Appendix B.

The quality of Potestio et. al.'s (2015) study was evaluated using the CASP tool, as outlined in Appendix C. During the quality improvement initiative, the standard of care was maintained, independent of whether or not the checklist was used. Potestio et. al. (2015) do not discuss their method for assigning participants to groups, and there is no indication that randomization was used. Additionally, it is not clear based on the article whether or not the investigators were blinded to these assignments. The investigators do not discuss the justification of their sample size, nor an estimation of treatment effect. The authors do discuss several limitations to their study. One limitation was that data collection did not include any qualitative information related to the handoff. For instance, the design of the study does not assess whether or not errors were made during the TOC. The authors write that these checklists are not always equally appropriate for each case, due to the unique presentation of each patient. Allocation of some anesthesia residents to both the control and experimental groups may have impacted the results. Plus, the Hawthorne effect may have improved TOC performance in either group. The Hawthorne effect occurs when a participant knows that they are being observed, and their awareness influences performance. Despite the lack of randomization and limitations of the study, it is still clinically pertinent to the aims of this MSR.

The second study was a randomized controlled trial by Robins and Dai (2015). The authors examined how utilization of a checklist by anesthesia providers during OR to PACU handoffs impacted four TOC-related outcomes. In their study, 60 handoffs were included, divided into two groups of 30. Robins and Dai (2015) used computer randomization to assign providers to groups. In group 1, providers used the checklist during the TOC, while providers in group 2 performed PACU handoff without the checklist. The study design and methods are summarized in Appendix A. All of the providers were educated on how to use a checklist for TOC, but they were blinded to the content of the checklist. The outcomes studied were the information score, handoff adequacy, need for clarification, and handoff duration. The results from the study are noted in Appendix B. A P-value of less than 0.05 was considered statistically significant. In looking at information score, Robins and Dai (2015) found that use of the checklist associated with a greater proportion of PACU RNs correctly recalling all six elements of the TOC (92% vs. 54% in groups 1 and 2, respectively) to a statistically significant degree (P = 0.0039). Key elements were patient identification, allergies, antibiotics, intake and output, estimated blood loss, and pain management. In terms of handoff adequacy, 100% of the handoffs in group 1 were rated as “adequate” by the PACU RN, while only 85% of handoffs in group 2 were deemed “adequate.” However, the finding was not significant (P = 0.11). Robins and Dai (2015) also found that when the checklist was used, the PACU RN was less likely to need clarification from the provider after completion of the handoff (0% vs. 69% in groups 1 and 2, respectively, P=0.0042). The median duration of the handoff was longer when the checklist was used, but the difference was not statistically significant (6 minutes vs. 5.5 minutes in groups 1 and 2, respectively, P = 0.13).

The work of Robins and Dai (2015) was appraised for quality with the CASP tool. The appraisal is outlined in Appendix C. In Robins and Dai’s (2015) study, the control group provided PACU TOC in the same manner as they normally would have, so the standard of care was preserved. While the providers in the study were blinded to their group assignment until the morning of surgery, once they received it, they were no longer blinded. Due to the need-to-know nature of the study’s intervention, participant blinding to group assignment was not possible. The authors do not discuss whether or not they themselves were blinded to provider assignments. However, the mention of computer randomization suggests that they were blinded. Robins and Dai (2015) write that a sample size of 26 participants per group was estimated have 80% power to detect a difference of 28% at a 2-sided significance level of 0.05.

To take missing data into consideration, Robins and Dai (2015) expanded their sample to 60 providers. There were several limitations to the study that were addressed by the authors. For one, CRNAs in the study had a minimum of one year of experience. Therefore, their ability to give a thorough handoff without the checklist may have been bolstered from their clinical experience. Also, the PACU RN rating of each TOC's "adequacy" is subjective, and it may have varied from one RN to the next. The authors mention that the experience of the PACU RNs ranged from new graduate to greater than 30 years. The experience level of the RN may have altered the threshold for what was deemed as "adequate handoff." Additionally, Robins and Dai (2015) point out that there was incongruency with documentation practice of the "time into PACU" and "anesthesia end" times by providers, which may have influenced the findings around handoff duration.

The third study was a prospective randomized controlled trial conducted by Salzwedel et. al. (2013) investigating the use of a checklist for anesthesia to PACU handover, and subsequent quality of the handover. 120 post-anesthesia handovers were observed, divided evenly into three groups. Two of these groups did not use the checklist for the transfer of care (TOC), while one group did use the checklist, as summarized in Appendix A. The investigators were blinded to the group assignment of each handoff. Outcomes examined by the researchers were the overall number of items included in the handoff, specific items handed over, and the duration of the handoff. The results of the study are summarized in Appendix B. Salzwedel et. al. (2013) found statistically significant differences in the percentage of items handed over, the handover of certain items, and in the duration of the handover when the checklist was used. P-values of <0.05 were considered statistically significant. Providers that utilized a checklist for the TOC (group C) included a median of 48.7% of checklist items, compared with a median of 32.4% during handoffs where a checklist had been introduced, but not used (group B, P<0.001). In investigating the inclusion of specific items in the handoff, there were a number of items which were included more often with use of the checklist to a statistically significant degree (P<0.05). Other items did not show a significant increase with checklist use. Among the items where inclusion did not increase significantly with use of the checklist, a subset of these items were included in a majority of handovers, regardless of whether or not the checklist was used. Alternatively, other items were rarely included in either group. The frequency of specific items handed over is included in Table B-1. Salzwedel et al. (2013) found that handovers took significantly longer when the checklist was used (group C, median 120.5 seconds) as opposed to when a checklist was introduced, but not used (group B, median 85.5 seconds, P=0.003). Additionally, handovers recorded prior to implementation of the checklist (group A) had a shorter median duration (59.5 seconds) than those in group B, but the difference was not considered significant (P=0.076) (Salzwedel et. al., 2013).

The CASP tool was used to appraise the quality of Salzwedel's (2013) study, as noted in Appendix C. Within the research design, the usual standard of care was maintained, regardless of whether or not the checklist was used in the handoff. Stated differently, an anesthesia to PACU handover in any form is a routine part of post-operative care. Due to the need for each anesthesia provider to know whether or not to use the checklist, providers were not blinded to their group assignment. Although the investigators were blinded to the status of each handover, Salwedel et. al. (2013) mentioned that there were both visual and verbal cues on the videos that hinted as to whether or not a checklist was being used. For example, during some of the handoffs, it was clear that the provider was reading from a laminated card. The 80 handovers that were recorded following implementation of the checklist were randomized into either group B or C using an internet-generated randomization list. Salwedel et. al. (2013) do not discuss their estimation of the treatment effect, nor the rationale for their sample size. One limitation of their study was the lack of blinding of anesthesia providers, and in some instances, of the investigators. Also, it is possible that not all of the providers had ample practice with the tool prior to its use, which may have influenced handover quality. The researchers note that the Hawthorne effect may have influenced their findings. In other words, the providers may have given higher quality handoffs in the setting of being observed by the investigators. Additionally, Salwedel et. al. (2013) wrote that the investigators knew the providers personally, which may have been a source of bias.

In the final study, Salzwedel et. al. (2016) conducted a prospective randomized controlled trial investigating the use of a checklist for patient handover from the OR to the intensive care unit (ICU). The researchers aimed to determine the impact of the checklist on the overall quality of the handover. Salzwedel et. al. (2016) observed 121 OR-to-ICU handoffs, divided into two groups. In the control group, anesthesia providers did not use the checklist during their TOC. Providers in the intervention group did use a checklist during handoff. The design and methods of Salzwedel et. al.'s (2016) study are described in Appendix A. For each surgical case, the supervising anesthesiologist completed an assessment sheet, assigning specific handover items as either "red" or "yellow". These designations indicated that these items "must be handed over" or "should be handed over", respectively. These sheets were completed for each case, regardless of the group assignment. The outcomes examined by Salzwedel et. al. (2016) were the percentages of red and yellow items handed over, the handover duration, and the handover of specific items. The results of the study are summarized in Appendix B. Salzwedel et. al. (2016) found that a greater percentage of red items were handed over when the checklist was used during the TOC, and the finding was statistically significant (P=0.005). Although the median percentage of yellow items included in the handover was higher in the intervention group, the finding was not statistically significant (P=0.203). In terms of handover duration, the median duration of handovers with a checklist was longer than in the control group, but not to a statistically significant degree (P=0.201). When Salzwedel et. al. (2016) looked at the handover of specific items with and without the checklist, only the items "age", "fluids", and "mental status preoperatively" were found to be handed over more frequently in the intervention group to a statistically significant degree (P-values of <0.001, P= 0.006, and P=0.011, respectively).

A CASP analysis of the above study can be found in Appendix C. Salzwedel et. al. (2016) maintained the usual standard of care, independent of whether or not the checklist was utilized during TOC. The sign out of patient care from the OR to the ICU team is a typical practice during perioperative care. The researchers maintained blinding of the anesthesia providers to their group assignment up until immediately before the TOC took place, and the authors themselves were blinded to the group assignments when they were analyzing their data. Additionally, Salzwedel et. al. (2016) note that the anesthesia providers did not view the assessment sheet for their case at any point during the study. Participant group assignments were random. The authors do discuss their rationale for the sample size. A limitation of the study cited by the investigators was that there was poor compliance with the checklist, meaning that when the checklist was used, there was still some omission of pertinent information. Salzwedel et. al. (2016) cite subjectivity of what is considered "important" to include in the handover as a possible explanation for the gap. Salzwedel et. al. (2016) also note that each supervising anesthesiologist subjectively completed the assessment sheet, which may have led to altered prioritization of items for different cases. Also, the awareness of the study by hospital staff may have been a source of bias. Salzwedel et. al. (2016) point out that although their study examined the impact of checklist use on quality of TOC, it does not make any meaningful connection between checklist use and patient safety.

Cross-Study Analysis

A cross-study analysis was performed to compare and contrast the design, methods, examined outcomes, results, and limitations of the included studies. The analysis is outlined in Appendix D. Common to each study was an aim by the investigators to explore how the use of checklist for TOC by anesthesia providers impacted objective outcomes within the handoff. Each study examined the clinical question uniquely.

In terms of study design, three of the four studies included in this review were conducted as RCTs. These are the studies published by Robins and Dai (2015), Salzwedel et. al. (2013), and Salzwedel et. al. (2016). Potestio et. al (2015) designed their study as a QI initiative.

Each of the four studies was conducted in a hospital setting. Potestio et. al. (2015) conducted their project at Medstar Georgetown University Hospital in Washington, D.C. The RCT by Robins and Dai (2015) took place at Yale-New Haven Hospital in New Haven, CT. Salzwedel et. al. (2013) and Salzwedel et. al. (2016) set both studies at the Hamburg-Eppendorf University Medical Centre in Hamburg, Germany. Notably, the RCTs by Salzwedel (2013) and Salzwedel (2016) took place outside of the United States.

Additionally, the makeup of each sample varied between study. Potestio et. al.'s (2015) study enrolled two groups of anesthesia residents. The control and experimental groups were made up of 14 and 8 residents, respectively. Six of the residents participated in both the control and experimental group. For each group, Potestio et. al. (2015) examined 50 anesthesia TOC events. Robins and Dai (2015) collected data from the OR to PACU handoffs of 60 anesthesia providers, divided into two groups of 30. Participants were anesthesiologists, or CRNAs with at least one year of experience. Unlike Potestio et. al.'s (2015) study, Robins and Dai (2015) did not include anesthesia residents. In Salzwedel et. al.'s (2013) RCT, the sample consisted of 120 post-anesthesia handovers, divided into three groups of 40 handovers. Although Salzwedel et. al. (2013) write that anesthesia residents participated in the study, the authors do not state the specific number of providers included in each group. Case-specific criteria for inclusion were patients age 18 or over undergoing elective surgery, as well as consent of the supervising anesthesiologist. Exclusion criteria were patients under the age of 18, or adults who were admitted directly to the intensive care unit (ICU) following surgery. Salzwedel et. al. (2016) examined 121 OR to ICU handoffs by anesthesia residents. These handoffs were divided into a control group and intervention group of 60 and 61 handovers, respectively. The authors cite handoff inclusion criteria as patients age 18 or older with a direct admission to the ICU postoperatively. Attending anesthesiologist and critical care provider consent were also required for inclusion. Exclusion criteria were patients under the age of 18, patients who were previously known to the ICU, and physician refusal. Robins and Dai's (2015) RCT was the only study that observed handoffs of attending anesthesiologists and CRNAs. The other three studies focused solely on TOC events by anesthesia residents.

Potestio et. al. (2015) developed a TOC checklist following a review of the literature and anesthesia textbooks and modified the tool to reflect hospital-specific handoff practice. The researchers also observed OR to PACU handoff by anesthesia providers to note additional items important for checklist inclusion and added a "closed loop communication" item to promote two-way handoff. Upon completion, the checklist contained 20 items. Anesthesia residents were allocated to either group A or group B, which were the control and intervention groups, respectively. As previously mentioned, six residents participated in both group A and group B. Potestio et. al. (2015) do not mention the use of randomization in group assignment of participants. Volunteer medical students observed the TOC events and collected data in the study. Items were counted as "included" in the handoff if they were mentioned in any way. The quality of item inclusion was not evaluated by the authors. The data collectors used a stopwatch to measure the duration of the handoff, rounding to the nearest second. Potestio et. al. (2015) write that control group handoff and data collection occurred prior to checklist introduction and observation of TOC for the experimental group. The investigators aggregated and analyzed the data, and reported mean values for each outcome, as well as margins of error and the corresponding P-values. The investigators also conducted a subgroup analysis of residents who participated in both groups and reported these findings for two of the three outcomes measured in the study.

Robins and Dai (2015) also created their own checklist for TOC. Input from PACU RNs, CRNAs, and the patient safety committee guided tool development. The authors validated the clarity and appropriateness of the checklist in a pilot study with PACU RNs and CRNAs. Once the checklist was ready to use, participants were assigned to one of two groups via computer randomization. The participants received a sealed envelope containing their group assignment the morning of surgery. If a checklist was used during handoff, it was collected immediately following the handoff to prevent recirculation to the control group. Collection of pertinent data was done by the PACU RNs, and patient-identifiable information was removed prior to analysis. The authors reported the number and percentage of handoffs that fell within each particular outcome variation, as well as median and interquartile range (IQR) values. P-values for each finding were also provided.

Salzwedel et. al. (2013) also drew upon anesthesia staff and PACU RNs to create their checklist, though the authors do not outline a specific development methodology. The study was conducted in three phases. In phase 1, investigators observed 40 anesthesia to PACU handovers where the anesthesia provider did not use, nor have any knowledge of, a checklist. Phase 1 included participants assigned to group A. Phase 2 was a non-data collection phase, involving introduction and implementation of the checklist. During the third phase, the researchers observed 80 TOC events by participants in groups B and C (40 handovers per group). While both of these groups were introduced to the checklist during phase 2, group C used a checklist for TOC during phase 3, and group B did not use a checklist. The investigators randomized the group assignments using an internet-generated randomization list. TOC events were videotaped and scored independently by each of the lead investigators. If appropriate to the outcome measured, median and IQR values were reported by the authors, and P-values were reported for all of the outcomes.

In the later RCT by Salzwedel et. al. (2016), the researchers developed two tools. The first was the TOC checklist with 13 patient information items, which was used by residents in the intervention group during handoff. The second document was an assessment sheet, completed by the attending anesthesiologist for each case included in the study, regardless of the resident's group assignment. Prior to the end of the case, each attending anesthesiologist used the assessment sheet to assign items on the checklist as "red items" or "yellow items." These designations indicated items that "must be handed over" and "should be handed over", respectively. As the surgical case was finishing, the researchers randomly assigned participants to either the control or intervention group. If the resident was part of the intervention group, the checklist was provided for use during the TOC, while residents in the control group did not use a checklist for handoff. The investigators used the corresponding assessment sheet for each case to collect data on resident handover of "red" and "yellow" items. The TOC events were video recorded, and the duration of the handoff was measured in seconds. In the same fashion as their 2013 RCT, Salzwedel et. al. (2016) reported median and IQR values for outcomes when applicable to the measurement, and published P-values for each of the outcomes.

In comparing the above methods of these studies, Potestio et. al.'s (2015) project is the only study to not mention the use of randomization of group assignments. While each of the included studies implemented a novel checklist during TOC, neither of the studies by Salzwedel et. al. (2013, 2016) detail a process for creation of the tool. The studies of Potestio et. al. (2015) and Robins and Dai (2015) describe a similar process for checklist creation. Both groups of authors utilized input from various providers involved in the perioperative care of patients.

While some of the outcomes examined in these studies were the same, others were different. Outcomes common to each of the studies were the percentage of overall items handed over, and the duration of the TOC. All of the studies except for that of Robins and Dai (2015) looked at the rate of handover of specific items on the checklist between groups. In addition to the duration of the handoff, Potestio et. al. (2015) also examined the amount of time spent per checklist item. Robins and Dai (2015) reported overall item handover in terms of the percentage of handovers that were complete (all six items included) or incomplete (less than six items included). Unique to Robins and Dai's study was examination the adequacy rating of handoffs by the receiving providers, as well as the need for clarification post-TOC. In terms of the adequacy rating, the PACU RN rated each TOC as either "adequate" or "inadequate" (Robins and Dai, 2015). The adequacy rating was the only subjective outcome measured across studies. Salzwedel et. al. (2016) compared the overall percentages of "red" and "yellow" items handed over between groups separately.

In comparing the percentages of overall items handed over between groups, each of the four studies found that the use of a checklist for TOC correlated with an increase in overall item handover to a statistically significant degree. Robins and Dai (2015) reported that the percentage of complete handoffs was significantly higher when the tool was used.

Salzwedel et. al. (2016) found that the handover of "red" items was significantly increased with checklist use. The authors did not find significant difference in the handover of "yellow" items with checklist use (Salzwedel et. al., 2016). Handovers took significantly longer when a checklist was used in the studies of Potestio et. al. (2015) and Salzwedel et. al (2013). Alternatively, Robins and Dai (2015) and Salzwedel et. al. (2016) did not find a significant difference in handover duration between groups. According to Potestio et. al. (2015), checklist use did not significantly impact the amount of TOC time spent per item. Three of the studies examined the handover of specific items between groups. Among these studies, each cited certain items that were handed over more frequently to a significant degree when the checklist was used. These items varied from study to study. Analysis of specific item handover can be found in the outcome data collection Tables B-1, B-3, and B-4, located in Appendix B. In the RCT by Robins and Dai (2015), checklist use did not significantly impact the rate of handoffs that were deemed as "adequate" by the PACU RN. However, checklist use was associated with a decreased need for information clarification.

There were limitations of each of these studies. A limitation common to all four studies was a lack of double-blinding of the participants and the investigators. Due to the design of these studies, blinding of the participants to their group assignment was not possible. In order to use a checklist, the provider must have knowledge that they are using the checklist, making ignorance to group allocation not feasible. According to Salzwedel et. al. (2016) and Salzwedel et. al (2013), the investigators were blind to the group assignments of the participants during data analysis. However, in their 2013 study, Salzwedel et. al. write that there were often verbal and visual cues on the video recordings, indicating that the provider was using a checklist. Neither Potestio et. al. (2015) nor Robins and Dai (2015) mention whether or not the investigators were blinded during their study. As previously discussed, a limitation of Potestio et. al.'s (2015) quality improvement initiative was a lack of randomization of participants to groups. The knowledge that a study was taking place may have impacted the TOC performance of providers across all of these studies. This phenomenon is known as the "Hawthorne effect" (Salzwedel et. al., 2013). Both Robins and Dai (2015) and Salzwedel et. al. (2016) designed parts of their studies that were based on subjectivity, which makes drawing a meaningful correlation more difficult for these outcomes. The opinion of the PACU RN determined the adequacy score in Robins and Dai's (2015) study. In Salzwedel et. al.'s RCT, the designation of individual checklist items as either "red" or "yellow" was based on attending anesthesiologist judgement. A limitation inherent to all four of these studies is the inability to show the impact of the checklist downstream from the TOC itself. In other words, these studies only examined outcomes directly related to the TOC event. The findings do not provide insight into whether or not these checklists improve patient safety, quality of care, or cost.

Summary and Conclusions

The post-anesthesia TOC is a critical point in the continuum of perioperative patient care, during which effective relay of pertinent information is of paramount importance. The complexity of the handoff process creates a risk for omission of information, which may compromise patient safety and quality of care. Although the formal use of a checklist for intraoperative TOC by anesthesia providers is not yet a mainstay of practice, these tools may be beneficial in improving the quality of these events. At present, there is limited published literature examining intraoperative anesthesia handoff practice in a robust, quantitative manner.

In order to glean insight into how these handoff checklists may impact intraoperative anesthesia TOC, the review analyzed literature investigating checklist use for post-anesthesia handoff by anesthesia providers. The purpose of the review was to answer the question, "How does the use of a checklist by anesthesia providers for post-anesthesia TOC impact the objective quality of the handoff? Following a systematic search and review, four studies were selected for inclusion and review. Three of these studies were RCTs. The fourth article was published as a QI initiative. Once the results of these studies were noted, a cross-study analysis was completed to compare and contrast the research, in order to draw conclusions and answer the question of interest.

The cross-study analysis found that overall, the use of a checklist by anesthesia providers for post-anesthesia TOC was effective in increasing the percentage of overall items included in the handoff. Each of the four studies reported that the association was statistically significant. Additionally, in each of the three studies examining the handover of specific items, a checklist was found to increase the inclusion rate of certain items to a statistically significant degree. The specific items included more often with the checklist varied between studies. In terms of the impact of checklist use on the duration of the TOC, two studies found that the checklist lengthened handoff duration, while the other two studies did not find a meaningful difference in TOC duration between groups. In light of these discrepancies, it is difficult to draw a meaningful conclusion around TOC duration based on these studies.

There were flaws inherent to the designs of each of the included studies. The blinding of both the participants and the investigators to group assignment is considered a gold-standard within quantitative research design, and none of the included studies accomplished complete blinding. As previously noted, use of a checklist by participants required their knowledge of group assignment. It is possible that the knowledge of group assignment influenced results. Additionally, the Hawthorne effect may have played a role in the performance of the participants.

When considering the impact of the findings of this review on patient safety and quality of care, the ability to extrapolate these conclusions is limited. Although the notion that checklist use may beneficial to patient outcomes has been reported in the literature, these studies did not examine how checklists impacted these patients following the TOC. The studies only examined outcomes related to the nature of the TOC itself. Further research is needed to understand how the use of a checklist for post-anesthesia TOC impacts patient outcomes. Outcomes of interest for research would include patient morbidity and mortality rates, as well as hospital length-of-stay. In the same manner, the findings regarding checklist use and handoff duration do not provide any insight into how the length of the TOC impacts patient care, anesthesia workflow, or cost.

Another limitation of these studies noted by Potestio et. al. (2015), but common to each study, was that the quality of the information handover during TOC was not assessed. The “inclusion” of a given item was counted as an all-or-nothing event. In other words, each item was either included or omitted from the TOC. While the above method of data collection allows for objective comparison of inclusion rates between groups, it does not garner data regarding the adequacy or thoroughness of that information. A quantitative analysis of information quality is difficult, since what is considered sufficient for item TOC varies from person to person. Robins and Dai’s (2015) study was the only study in the review to report handoff quality. Each handoff was rated as either “adequate” or “inadequate” by the PACU RN (Robins & Dai, 2015). Robins and Dai (2015) did not find a significant difference in handoff adequacy between groups. Studies with qualitative designs would better relate checklist use with quality of information handover. Thus, the ability to draw such conclusions from the cross-study analysis is limited.

To sum up, the MSR found that the use of a checklist by anesthesia providers for post-anesthesia TOC events correlates with an increased percentage of overall items included in the handoff, as well as an increased rate of inclusion of certain individual items. It is unclear from the review how the use of a checklist influences the amount of time that it takes to complete the TOC. The application of these findings to intraoperative anesthesia TOC practice will be discussed in the next section of the paper.

Implications for Advanced Nursing Practice

The intraoperative handoff of a patient's care from one anesthesia provider to another is a common practice. Nurse anesthetists are a subset of anesthesia providers who both hand over and assume the care of anesthetized patients. Examples of situations where the intraoperative TOC of a patient is necessary include provider breaks, changes to staffing structure, and the end of a shift. The complex and dynamic nature of intraoperative anesthesia care highlights the importance of a TOC that is thorough, reliable, and safe. The use of a standardized checklist for the intraoperative TOC of patients between nurse anesthetists is a strategy to improve handover quality. Although there is published literature on implementation of these checklists for intraoperative anesthesia TOC, there is very limited quantitative research from which to synthesize findings. Due to the paucity, this MSR examined the findings of four quantitative studies linking checklist use with post-anesthesia TOC events, with a secondary aim to relate these findings to intraoperative handoff by nurse anesthetists.

The review found that the use of a checklist by anesthesia providers for post-anesthesia patient handoff increased the percentage of overall items included during the TOC, as well as increased inclusion of certain items. Creating a link to intraoperative anesthesia TOC, the finding suggests that similar tools may increase item inclusion during anesthesia handoff in the OR. In considering the effect of a checklist on intraoperative TOC duration, the review does not provide strong insight, as the findings from included studies on this outcome were inconclusive.

As previously mentioned, the findings from this review do not explain how checklists impact patient outcomes. Therefore, it is not clear how checklists used intraoperatively would affect these outcomes. New research comparing handoff checklist use with long-term outcomes would be helpful in linking these variables.

At present, checklists are rarely used during postoperative TOC by nurse anesthetists, despite the published literature championing their role in improving patient safety. The MSR suggests that TOC checklists are effective in increasing information transfer during this process, and future research may find that checklists used postoperatively improve patient outcomes. Even if there were irrefutable evidence that checklists are beneficial to patients, nurse anesthetists may resist utilizing these tools in their daily practice. Research identifying and understanding driving and restraining forces from the nurse anesthetist perspective would be helpful in developing strategies to implement change.

In a similar manner to other advanced practice nursing roles, nurse anesthetists have a high degree of autonomy while providing patient care. Nurse anesthetists must continuously absorb and respond to myriad incoming data points related to the patient and the patient's response to an anesthetic. The consequences of a mistake made intraoperatively may be devastating. The high-pressure environment necessitates that the nurse anesthetist take individual responsibility for the safety of their care. A focus by the nurse anesthetist on current evidence-based recommendations for practice is one way to accomplish the task. Findings from this review, as well as future research, can be instrumental in shaping the quality of anesthesia practice. In terms of policy, leaders within nurse anesthesia teams should consider best practice guidelines when implementing changes to current practice. In addition to impacting patient care, utilization of best practices by anesthesia providers can influence their non-anesthesia colleagues in the perioperative area by promoting culture of patient safety.

In conclusion, while the findings from the MSR can be related to both postoperative and intraoperative nurse anesthesia handoff, limitations apply. New research linking the use of TOC checklists and patient outcomes would be helpful in supporting or discouraging their use in the OR. Regardless of the evidence base surrounding these tools, their successful implementation into everyday nurse anesthesia practice would likely be met with resistance.

Thus, a thorough understanding of the factors that surround nurse anesthesia practice would be needed to make a change.

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Appendix A

Descriptive Data Tables

Table A-1	
First author, year published	Potestio, C., 2015
Design	Quality improvement initiative
Purpose	"To create a succinct checklist to help expedite the handoff process while increasing meaningful communication between anesthesia provider and PACU nurse (p. 1)
Site, sample	Medstar Georgetown University Hospital, Washington D.C. Resident anesthesiologists, divided into two groups • Group A (control group, 14 residents)—50 OR to PACU patient handoffs without use of checklist • Group B (experimental group, 8 residents)—50 OR to PACU patient handoffs using a checklist • 6 residents participated in handoffs in both groups
Methods	Checklist development • Creation of a 42-item checklist based on literature review and anesthesia texts • Modification down to a 17-item checklist, reflective of hospital-specific handoff process • Random PACU handoff observation to note additional pertinent items • Addition of "closed loop communication" item (based on ASA and Joint Commission guidelines) • Final checklist—20 items Data collection • Observation and data collection by volunteer medical students • Item counted as successfully exchanged if mentioned in any capacity • No assessment of quality of information exchange • Stopwatch used to record time from handoff start to finish, with times rounded to nearest second Following handoff observations of group A, checklist introduced and reviewed with residents for implementation with group B Statistical analysis by investigators
Outcomes examined	Percentage of overall items handed off, percentage of specific items handed off, duration of handoff, time spent per item

Note. PACU—post anesthesia care unit, OR—operating room, ASA—American Society of Anesthesiologists

Table A-2	
First author, year published	Robins, H., 2015
Design	Prospective randomized controlled trial
Purpose	"To determine if the utilization of a formulated checklist with objective measures during the handoff from the operating room to the PACU decreased information loss, the need for information clarification, and anesthesia providers' time spent in the transfer of care, with improved adequacy of the handoff" (p. 264)
Site, sample	Yale-New Haven Hospital, New Haven, CT, USA 60 anesthesia providers, divided into two groups • Group 1: 30 providers, performed handoff with checklist • Group 2: 30 providers, performed handoff without checklist Inclusion criteria: anesthesiologist, or CRNA with minimum one year of experience Exclusion criteria: anesthesia residents
Methods	Checklist creation by PACU RNs, CRNAs, and patient safety committee Pilot study with PACU RNs and CRNAs to evaluate of clarity and representativeness of key handoff components Computer randomization of participants into two groups • In morning, providers opened sealed envelope containing group assignment • Checklists collected immediately after handoff to prevent recirculation to control group • Post-handoff data collection by PACU RNs • Patient-identifiable information removed prior to data analysis

Outcomes examined	Information score, handoff adequacy, need for clarification, handoff duration
Note. PACU—post-anesthesia care unit, CRNA—certified registered nurse anesthetist, RN—registered nurse	

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Table A-3	
First author, year published	Salzwedel, C., 2013
Design	Prospective randomized controlled trial
Purpose	To investigate use of a checklist for anesthesia-to-PACU patient handover on the quality of the handover.
Site, sample	University Hospital Hamburg-Eppendorf, Hamburg, Germany 120 post-anesthesia patient handovers, divided into three groups. • Group A: 40 handovers, no knowledge or use of checklist • Group B: 40 handovers, knowledge of checklist but no checklist use • Group C: 40 handovers, with the use of the checklist Inclusion criteria: Patient 18 years or older, undergoing elective surgery, consent of participating anesthesiologist Exclusion criteria: Children, adults requiring ICU admission postoperatively
Methods	Development of a checklist of pertinent handoff items by anesthesiologists and PACU nurses Study conducted in three phases. • Phase 1: Videotaping of patient handover from anesthesia to PACU nurse (40 handovers, no randomization) • Phase 2: Introduction and implementation of handover checklist (76 randomized handovers, no data collected) • Phase 3: Videotaping of patient handover in the PACU with and without use of a checklist (80 handovers, randomized) Videos examined independently and scored by two investigators
Outcomes examined	Overall number of items handed over, handover of specific items, and duration of the handover
Note. PACU—post anesthesia care unit, ICU—intensive care unit	

Table A-4

First author, year published	Salzwedel, C., 2016
Design	Prospective randomized controlled trial
Purpose	"To investigate the effect of the use of a checklist for postanesthesia handover in the ICU" (p. 170)
Site, sample	Hamburg-Eppendorf University Medical Centre, Hamburg, Germany 121 patient handovers from OR to ICU, divided randomly into two groups • Control group: 60 handovers, no use of checklist • Intervention group: 61 handovers, checklist used Inclusion criteria: patient ≥ 18 years old, post-operative transfer to ICU, written informed consent of anesthesiologist and critical care physician Exclusion criteria: patient < 18 years old, patient known to the ICU, physician refusal to participate

Methods	Development of two documents:
	• Checklist with 13 patient information categories, utilized by intervention group during postoperative handover
	• Assessment sheet—used in both groups
	    ○ Completed by supervising anesthesia attending prior to patient handover
	    ○ Individualization of pertinent handover items for each case
	    ○ "Red" and "yellow" items—"must be handed over" and "should be handed over," respectively
	• Intraoperatively, investigators provided the assessment sheet for the anesthesia attending to complete
	At surgery end, investigators randomly allocated each caregiving anesthesiologist to either control or intervention group
	Upon ICU arrival, checklist either provided to caregiving anesthesiologist (intervention group), or not provided (control group)
	Handovers audio recorded and independently analyzed by two investigators
	• Specificity of items handed over in both groups compared with assessment sheet for each patient
	• Investigators blinded to caregiving anesthesiologist group assignment
	Handover duration recorded in seconds

Outcomes Examined	Percentage of red items handed over, percentage of yellow items handed over, handover of specific items, handover duration
Note. ICU—intensive care unit, OR—operating room	

Appendix B

Outcome Data Collection

Table B-1 **Outcome Data Collection** (Potestio, C., 2015)			
Outcomes	Group A	Group B	Significance
Overall items handed off (%)	Mean 51.50 (+/- 8.28*)	Mean 69.5 (+/- 16.5*)	P = 0.018
Duration of handoff (seconds)	Mean 100.86 (+/- 36*)	Mean 126.4 (+/- 52.25*)	P = 0.011
Time spent per item (seconds)	Mean 8.23 (+/- 2.70*)	Mean 7.71 (+/- 3.17*)	P = 0.366**
Percentage of specific items handed over: Group B handed off 8 items with a significantly higher frequency compared to Group A • Antibiotics (P = 0.016), standing medications (P < 0.001), preoperative cognitive function (P < 0.001), complications (P < 0.001), preoperative activity level (P < 0.001), completion of closed-loop communication (P< 0.001)			

Outcomes	Subgroup A (crossover residents***)	Subgroup B (crossover residents***)	Significance
Overall items handed off (%)	52.23 (+/- 8.96*)	69.96 (+/- 12.62*)	P = 0.014
Duration of handoff (seconds)	106.61 (+/- 40.44*)	131.5 (+/- 56.43*)	P = 0.002
Notes—*Indicates margin of error **Investigators state that the finding did not reach statistical significance ***Analysis of the handoffs by residents that participated in both groups (n= 28 and 20 handoffs in groups A and B, respectively) The authors do not mention which P-value was used to determine statistical significance			

Table B-2—Outcome Data Collection (Robins, H., 2015)			
Outcomes	Group 1—# of handoffs (% of total handoffs within group)	Group 2—# of handoffs (% of total handoffs within group	Significance
Information score (# of the six key elements correctly recalled by PACU RN post-handoff) • Score of 6 • Score <6	 24 (92) 2 (8)	 14 (54) 12 (46)	Checklist use associated with a higher percentage of handoffs in which all six key items were recalled vs. when the checklist was not used (group 1 vs. group 2, P= 0.0039)
Median # of items handed over in group 1 and group 2 were 6 and 6, respectively • IQR values of the # of items handed over in group 1 and group 2 were 6-6 and 5-6, respectively • Significance level for difference in IQR between groups is P = 0.0015			
Handoff adequacy (Was the handoff deemed adequate?—yes or no) • Yes • No	 26 (100) 0 (0)	 22 (85) 4 (15)	Checklist use did not improve the percentage of handoffs deemed adequate to a significant degree (P = 0.11)
Information clarification (Was there a need to clarify information with the provider following			Checklist use was found to decrease the need for further clarification (P = 0.0042)

completion of the handoff?—yes or no) • Yes • No	0 (0) 26 (100)	18(69) 8 (31)	
Handoff duration—median # minutes provider spent in PACU (IQR)	6 (6-8)*	5.5 (4-7.8)*	Checklist use did not significantly increase the duration of the handoff (P = 0.13)
Note. PACU RN—post anesthesia care unit registered nurse, IQR—interquartile range (25-75 percentiles) *Data presented as median # minutes spent in PACU by provider (IQR) P-values < 0.05 were considered statistically significant			

Table B-3—Outcome Data Collection (Salzwedel, C., 2013)				
Outcomes	Group A	Group B	Group C	Significance
Overall number items handed over (% of total items)	Median 32.4 25-75 percentiles—24.3-37.2	Median 32.4 25-75 percentiles—27.0-40.5	Median 48.7 25-75 percentiles—37.8-70.9	Increase in percentage of overall items handed over with use of checklist (group C versus group B, P < 0.001) Instruction on items to be included in handovers, but without use of checklist—no increase in number items handed over (group B vs. group A, P = 0.303)
Handover of specific items (% of handovers in which item was included)	Name—95 Age—78 Underlying condition—78 Surgical procedure—95 Positioning—5	Name—98 Age—95* Underlying condition—88 Surgical procedure—98 Positioning—8	Name—95 Age—98 Underlying condition—83 Surgical procedure—98 Positioning—30* Changes in initial OR list—45 ASA status—65*	Comparison of handovers with and without use of checklist (groups C and B, respectively)

	Changes in initial OR list—23 ASA status—0 MET—28 Allergies—35 Co-morbidities—88 Preoperative cognitive function—8 Medication—15 Line and catheter location—25 Failed punctures—13 Line and catheter inspection—3 Airway type—48 Conditions during intubation—40 Anesthesia type—65 Deviation from standards—80 Fluid management—40 Urine output—15 Catecholamines—53 Ventilation—20 Oxygenation—10 Baseline oxygen saturation under 21%—3 Final ABG analysis—10 Surgical problems—15 EBL—10 Antibiotics—20 Follow-up dose—8 Analgesia—90 Antiemetics—18	Changes in initial OR list—25 ASA status—3 MET—35 Allergies—35 Co-morbidities—95 Preoperative cognitive function—0 Medication—23 Line and catheter location—50* Failed punctures—10 Line and catheter inspection—3 Airway type—60 Conditions during intubation—43 Anesthesia type—68 Deviation from standards—65 Fluid management—35 Urine output—28 Catecholamines—28* Ventilation—20 Oxygenation—8 Baseline oxygen saturation under 21%—8 Final ABG analysis—13 Surgical problems—33 EBL—13 Antibiotics—30 Follow-up dose—3 Analgesia—83 Antiemetics—5 Original blood group certificate—0 Blood products' availability—3 Patient transfer—13	MET—60* Allergies—73* Co-morbidities—95 Pre-operative cognitive function—13* Medication—53* Line and catheter location—73* Failed punctures—40* Line and catheter inspection—10 Airway type—83 Conditions during intubation—50 Anesthesia type—70 Deviation from standards—73 Fluid management—58* Urine output—40 Catecholamines—65* Ventilation—53* Oxygenation—40* Baseline oxygen saturation under 21%—23 Final ABG analysis—45* Surgical problems—53 EBL—30 Antibiotics—60* Follow-up dose—20* Analgesia—85 Antiemetics—20* Original blood group certificate—30* Blood products' availability—30* Patient transfer—45* Personal belongings—25* Post-operative investigations—33	*P<0.05—significant increase in inclusion of item when the checklist was used

	Original blood group certificate—3 Blood products' availability—3 Patient transfer—18 Personal belongings—0 Post-operative investigations—13	Personal belongings—3 Post-operative investigations—25		
Handover duration (seconds)	Median 59.5 25-75 percentiles—43.3-97.8	Median 85.5 25-75 percentiles—55.3-106.0	Median 120.5 25-75 percentiles—80.5-170.5	Handovers utilizing checklist were significantly longer than those without (group C vs. group B, P=0.003) No significant difference in handover duration before checklist implementation and after implementation but without use of checklist (group B vs. group A, P = 0.076)
Note. OR-operating room, ASA-American Society of Anesthesiologists, MET-metabolic equivalents (functional status), ABG-arterial blood gas, EBL-estimated blood loss				

Table B-4—**Outcome Data Collection** (Salzwedel, C., 2016)			
Outcomes	Control group	Intervention group	Significance
Red items handed over (%)	Median—75.0 IQR—66.7-88.6	Median—87.1 IQR—77.1-90.0	Checklist use correlated with an increased median percentage of red items handed over (P = 0.005)
Yellow items handed over (%)	Median—50.0 IQR—33.3-69	Median—60.0 IQR—36.7-100	Checklist use did not significantly correlate with increased median

			percentage of yellow items handed over (P = 0.203
Handover duration (seconds)	Median—174 IQR—115-255	Median—208 IQR—142-276	Checklist use did not significantly correlate with increased handoff duration (P = 0.201)
Handover of specific items	Only the items "age" (P < 0.001), "fluids" (P = 0.006), and "mental status preoperatively" (P = 0.011) were handed over more often in the intervention group vs. the control group to a statistically significant degree		
Note. Red and yellow items were assigned as "must be handed over" and "should be handed over", respectively by the supervising anesthesiologist IQR—interquartile range (25-75 percentiles) P-values < 0.05 were considered statistically significant			

Appendix C

Critical Appraisal Skills Programme (CASP) Tables

Table C-1. Potestio et. al., 2015 (*Note*: N/A—not applicable—Due to the "no" response in question 2, the study does not meet the criteria of a randomized controlled trial. Thus, further appraisal with the CASP tool is not appropriate (questions 3-11))

Question	Yes	Can't Tell	No	Comments
1. Did the study address a clearly focused research question?	X			-Study was conducted as a quality improvement initiative, not a randomized controlled trial
2. Was the assignment of participants to interventions randomized?			X	
3. Were all participants who entered the study accounted for at its conclusion?	X			
4. Were study participants and investigators 'blind' to group assignment?				N/A
5. Were the groups similar at the start of the trial?				N/A
6. Apart from the experimental intervention, did each study group receive the same level of care?				N/A
7. Were the effects of the intervention reported comprehensively?				N/A
8. Was the precision of the estimate of the intervention or treatment effect reported?				N/A
9. Do the benefits of the experimental intervention outweigh the harms and costs?				N/A
10. Can the results be applied to your local population/in your context?				N/A
11. Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?				N/A

Table C-2. Robins and Dai, 2015

Question	Yes	Can't Tell	No	Comments
1. Did the study address a clearly focused research question?	X			
2. Was the assignment of participants to interventions randomized?	X			-Computer-randomization
3. Were all participants who entered the study accounted for at its conclusion?	X			-One-time data collection, no follow up needed
4. Were study participants and investigators 'blind' to group assignment?			X	-Participants were blinded up until day of surgery; knowledge of assignment by participants was necessary for checklist use -Blinding of investigators is unclear
5. Were the groups similar at the start of the trial?	X			
6. Apart from the experimental intervention, did each study group receive the same level of care?	X			-All providers with checklist use instruction prior to group assignment
7. Were the effects of the intervention reported comprehensively?	X			-To detect 28% difference between control and intervention groups at 80% power, a sample size of 26 participants per group needed—30 participants per group enrolled to account for missing data -$p < .05$ -Descriptive statistics compared between groups (number, percent, median, IQR) -Fisher exact test for comparison of binary outcomes -Potential biases addressed
8. Was the precision of the estimate of the intervention or treatment effect reported?			X	
9. Do the benefits of the experimental intervention outweigh the harms and costs?		X		-Study does not examine impact of checklist use on patient outcomes or cost

10. Can the results be applied to your local population/in your context?	X			-Anesthesia to PACU handoff is a part of my daily practice
11. Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?		X		-Impact of checklist use on patient safety, outcomes, or cost is not clear

Table C-3. Salzwedel et. al., 2013

Question	Yes	Can't Tell	No	Comments
1. Did the study address a clearly focused research question?	X			
2. Was the assignment of participants to interventions randomized?	X			-internet-generated randomization list
3. Were all participants who entered the study accounted for at its conclusion?	X			
4. Were study participants and investigators 'blind' to group assignment?			X	-Knowledge of group assignment by participants was necessary for the trial -Investigators blinded as much as possible—however, checklist use was apparent at times
5. Were the groups similar at the start of the trial?	X			
6. Apart from the experimental intervention, did each study group receive the same level of care?	X			-During Phase 2 (pre-intervention), all participants were educated regarding checklist use
7. Were the effects of the intervention reported comprehensively?	X			-Mann-Whitney test for comparison of overall items handed over - χ^2 test for comparison of specific items handed over - median and IQR values reported for each outcome ($P< 0.5$) -Rationale for sample size not discussed -Study limitations discussed
8. Was the precision of the estimate of the intervention or treatment effect reported?			X	-Confidence intervals not reported
9. Do the benefits of the experimental intervention outweigh the harms and costs?		X		-Unable to assess, since the study does not evaluate impact of checklist use on quality, safety, or cost
10. Can the results be applied to your local population/in your context?	X			

11. Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?		X		

Table C-4. Salzwedel et. al., 2016

Question	Yes	Can't Tell	No	Comments
1. Did the study address a clearly focused research question?	X			
2. Was the assignment of participants to interventions randomized?	X			-Randomization by investigator via closed envelope method
3. Were all participants who entered the study accounted for at its conclusion?	X			
4. Were study participants and investigators 'blind' to group assignment?			X	-Participants received group assignment at the end of surgery, knowledge of group assignment necessary for tool use -Investigators were blind to group assignment
5. Were the groups similar at the start of the trial?	X			
6. Apart from the experimental intervention, did each study group receive the same level of care?	X			
7. Were the effects of the intervention reported comprehensively?	X			-To detect a 20% difference between control and intervention groups at 80% power, 56 participants per group needed -$p < .05$ -Descriptive statistical analysis for each outcome (median, IQR) -Normality distribution tested - χ^2 or Fisher exact test for comparison of specific items between groups

				-t test or Mann Whitney rank sum test for comparison of overall items, subgroup analysis, and handover duration -Study limitations discussed
8. Was the precision of the estimate of the intervention or treatment effect reported?			X	
9. Do the benefits of the experimental intervention outweigh the harms and costs?		X		- Study does not examine impact of checklist use on patient outcomes or cost
10. Can the results be applied to your local population/in your context?	X			-Anesthesia to PACU handoff is a part of my daily practice
11. Would the experimental intervention provide greater value to the people in your care than any of the existing interventions?		X		Impact of checklist use on patient safety ,outcomes, or cost is not clear

Appendix D

Cross-study Analysis

First Author, year published	Study comparisons	Outcome #1: % of overall items handed over	Outcome #2: % of specific items handed over	Outcome # 3: Handoff duration	Comments
Potestio, C., 2015	OR to PACU handoff with a checklist vs. without a checklist	-Checklist use associated with a higher mean percentage of overall items handed over	-Eight checklist items handed over more frequently in the intervention group vs. the control group	-Longer handoff duration when a checklist was used	-Subgroup analysis of outcomes 1 & 3 yielded same findings as whole sample -Study also measured time spent per item, with no significant difference noted between groups -Quality improvement project, no randomization or blinding
Robins, H., 2015	OR to PACU handoff with a checklist vs. without a checklist	-Increased percentage of handoffs with all six key items included when checklist used	-Not measured	-No significant difference found between groups	-Outcomes unique to the study were information score and handoff adequacy
Salzwedel, C., 2013	OR to PACU handoff: 1.) without knowledge of checklist (group A) vs. 2. with knowledge of checklist, but no use of checklist (group B) vs. 3.) use of a checklist (group C)	-Checklist associated with higher median percentage of overall items handed over compared with group B - Mere knowledge of checklist not found to increase item	-Certain items with significant increase in inclusion rate when checklist was used	-Checklist handover took longer than handover without checklist (group C vs. group B) -Mere knowledge of checklist did not impact handover duration (group B vs. group A	-Checklist use found to increase the number of items of patient information transferred during the handoff -Suggestion that the knowledge of a checklist is not in itself sufficient to increase item handover

		handover (group B vs. group A)			
Salzwedel, C., 2016	OR to ICU handoff with a checklist vs. without a checklist	-Checklist associated with increased percentage of red items* handed over	-Three items were handed over more frequently in the intervention group vs. the control group	-No significant difference found between groups	-No significant increase in percentage of yellow items* handed over in intervention vs. control group -Checklist use found to increase both the quantity and quality of information transfer during handoff
Notes. OR—operating room, PACU—post anesthesia care unit, ICU—intensive care unit *Red and yellow items were assigned as "must be handed over" and "should be handed over", respectively by the supervising anesthesiologist					