

# OR and ICU teams 'running in parallel' at the end of cardiothoracic surgery improves perceptions of handoff safety

Safraz Hamid ,<sup>1</sup> Frederic Joyce,<sup>1</sup> Aaliya Burza,<sup>2</sup> Billy Yang,<sup>1</sup> Alexander Le,<sup>1</sup> Ahmad Saleh,<sup>1</sup> Robert S Poston<sup>1</sup>

**To cite:** Hamid S, Joyce F, Burza A, *et al.* OR and ICU teams 'running in parallel' at the end of cardiothoracic surgery improves perceptions of handoff safety. *BMJ Open Quality* 2021;**10**:e001001. doi:10.1136/bmjopen-2020-001001

► Prepublication history and additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2020-001001>).

Received 27 April 2020

Revised 19 January 2021

Accepted 25 January 2021

## ABSTRACT

The transfer of a cardiac surgery patient from the operating room (OR) to the intensive care unit (ICU) is both a challenging process and a critical period for outcomes. Information transferred between these two teams—known as the 'handoff'—has been a focus of efforts to improve patient safety. At our institution, staff have poor perceptions of handoff safety, as measured by low positive response rates to questions found in the Agency for Health Care Research and Quality (AHRQ) Hospital Survey on Patient Safety Culture (HSOPS). In this quality improvement project, we developed a novel handoff protocol after cardiac surgery where we invited the ICU nurse and intensivist into the OR to receive a face-to-face handoff from the circulating nurse, observe the final 30 min of the case, and participate in the end-of-case debrief discussions. Our aim was to increase the positive response rates to handoff safety questions to meet or surpass the reported AHRQ national averages. We used plan, do, study, act cycles over the course of 123 surgical cases to test how our handoff protocol was leading to changes in perceptions of safety. After a 10-month period, we achieved our aim for four out of the five HSOPS questions assessing safety of handoff. Our results suggest that having an ICU team 'run in parallel' with the cardiac surgical team positively impacts safety culture.

## PROBLEM

Handoffs immediately following cardiothoracic surgery (CTS) involve the transfer of the patient and patient information from the operating room (OR) to the intensive care unit (ICU). This process is important for patient safety yet it is often characterised by poor communication and teamwork.<sup>1 2</sup> OR-ICU handoffs that are weak increase the risk for incorrect treatment plans, diagnostic delays, and morbidity.<sup>3 4</sup>

SUNY Downstate is an urban, academic teaching hospital in Brooklyn, New York with an active CTS service. The culture of patient safety in our CTS programme was assessed in July 2018 using the Hospital Survey on Patient Safety Culture (HSOPS).<sup>5</sup> The survey results showed an unfavourable evaluation of our existing OR-ICU handoff (table 1). These findings were reviewed at our weekly

multidisciplinary CTS team meeting where staff members confirmed that the handoff protocol was unstructured and incomplete. Our quality improvement team identified this as an area for improvement.

In this project, we designed and implemented a protocol to improve our OR-ICU handoff process. Our aim was to increase positive response rates to the five HSOPS questions assessing perceptions of handoff safety to meet or surpass the reported Agency for Health Care Research and Quality (AHRQ) national averages in a 1 year period.

## BACKGROUND

The OR-ICU handoff process is both critically important to patient safety and highly complex. The appropriate monitors, lines, tubes and equipment must be transferred without getting disrupted. In addition, complex information concerning the patient's history, intraoperative course and treatment plans must be relayed and understood. This all happens while actively managing an often critically ill patient on arrival to the ICU.

Several groups have targeted the OR-ICU handoff using various techniques including standardised checklists and structured protocols to improve communication and facilitate the required tasks. Interventions have been modelled after pit stops in a Formula 1 race<sup>1</sup> or on checklists based on process improvement techniques from the finance industry.<sup>2</sup> They have led to improvements in handoff effectiveness, as measured by decreased technical errors, fewer interruptions and improvements in communication. Some showed clinical outcomes such as reductions in post-operative haemodynamic and respiratory complications and earlier extubation times.<sup>6 7</sup> Many of these positive results have not been reproduced at other institutions.

An unstated assumption of current thinking about the OR-ICU handoff is that it must fit within the limited time that the two teams



© Author(s) (or their employer(s)) 2021. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

<sup>1</sup>Division of Cardiothoracic Surgery, SUNY Downstate Health Sciences University, Brooklyn, New York, USA

<sup>2</sup>Division of Pulmonary and Critical Care Medicine, SUNY Downstate Health Sciences University, Brooklyn, New York, USA

## Correspondence to

Dr Robert S Poston;  
[postonlab@gmail.com](mailto:postonlab@gmail.com)

are together in the ICU after transporting the patient out of the OR, which at our institution is usually <10 min. This approach overlooks the often dynamic course of a CTS patient. Events that happen during the final part of surgery (eg, while weaning cardiopulmonary bypass and securing haemostasis) often predict the patient's early course in the ICU but can be hard to appreciate without first-hand observation. In addition, an increasing number of teams have adopted the OR checklist protocol<sup>8</sup> mandated by the WHO which includes a debrief at the end of the case while still in the OR to review intraoperative events. The rationale for this debrief is to improve situational awareness about those key events and predict how that might influence the postoperative course. For these reasons, a handoff limited only to the ICU and not in the OR represents a lost opportunity to gain better situational awareness and improve patient outcomes.

## MEASURES

An important outcome measure of handoff efficacy is how staff perceive its impact on safety.<sup>9</sup> Hospitals with robust safety cultures have staff that are more likely to adopt attitudes and behaviours that reduce patient harm<sup>10</sup> and show fewer surgical site infections and other complications.<sup>11</sup> Thus, our efforts to improve the handoff process might have a sustainable influence on the overall culture of safety long after the study period is over.

The HSOPS<sup>5</sup> contains 50 questions with responses rated on a Likert scale ranging from 'strongly disagree' to 'neutral' to 'strongly agree'. At each timepoint of data collection, we administered the complete survey but focused our analysis on the five questions relevant to handoff safety. Responses were categorised as positive ('agree' and 'strongly agree') or negative ('neutral', 'disagree' and 'strongly disagree'). Our outcome measure of perceptions of handoff safety was operationalised by the positive response rate to each question (number of positive responses divided by total number of responses).

To establish a baseline, we administered the HSOPS to the CTS team in July 2018. The positive response rates for the five questions related to safety of the handoff process

were all below the reported AHRQ national averages<sup>12</sup> (table 1). We repeated these measures at two additional timepoints and used them to assess how effectively our PDSA (plan, do, study, act) cycles were leading to change.

## DESIGN

Our pre-existing handoff protocol prior to this quality improvement (QI) project was like many other CTS programmes. At the end of the case, the circulating OR nurse called the ICU nurse to provide information on the phone based on a standard 'Cardiac Surgery Transfer Form' (online supplemental appendix figure 1). After the OR timeout, the surgical team then transported the patient out of the OR to the ICU where the ICU nurse would then discuss important details about the case with the surgical team face-to-face. The entire handoff—including both the phone and in person communications—was typically completed within 10 min.

Our novel method required the OR and ICU teams to handoff face-to-face while the patient was still in the OR. At the start of all CTS cases there is a brief 'timeout' to cover the surgical checklist protocol. This checklist was modified to include announcing the name of the ICU nurse and intensivist scheduled to receive the patient after surgery and the surgeon's estimate for when they should both be called. Our goal was for these team members to be present in the OR with approximately 30 min remaining in a surgical case. Once present in the OR, the ICU nurse and intensivist would receive a handoff from the circulating nurse and then directly seek out relevant information in real time during their 30 min observation period (eg, findings of the intraoperative echo, responses to inotropes/vasopressors, cerebral oximetry tracing during the case, amount of blood products given). Finally, the ICU nurse and intensivist would participate in the end-of-case debrief discussions with the surgeons, anaesthesiologists, perfusionists and OR staff and then help transport the patient to the ICU.

Our rationale for proposing this protocol is best explained using the metaphor of a relay race. An OR-ICU handoff that happens face-to-face only in the ICU—the

**Table 1** Comparison of SUNY Downstate CTS team to national benchmarks: to establish a baseline, we administered the Hospital Survey on Patient Safety Culture to the CTS team in July 2018

	SUNY Downstate CTS July 2018 (%)	AHRQ National Average (%)
1. Problems do not occur in the exchange of information across hospital units.	26	47
2. Things do not 'fall between the cracks' when transferring patients from one unit to another.	23	42
3. Hospital units work well with each other to provide the best care for patients.	23	72
4. There is good cooperation among hospital units that need to work well with each other.	33	62
5. Hospital units coordinate well with each other.	26	49

Benchmark comparisons reflect results from 630 hospitals nationwide.  
AHRQ, Agency for Health Care Research and Quality; CTS, cardiothoracic surgery.

status quo method—is analogous to a relay race with the sprinters coming to a complete stop prior to passing the baton. Indeed, prior authors have used the model of a Formula 1 pit crew<sup>1</sup> to illustrate the need for a quick and abrupt stop prior to the handoff. Our novel method is more consistent with what is done in an actual relay race. The transition includes a period of ‘running in parallel’ that hopefully enables the sprinter receiving the baton to reach full speed more efficiently.

## STRATEGY

This project was led by the CT surgeon and medical student. PDSA cycles were used to assess the impact of our proposed intervention on the handoff process and make ongoing modifications. The progress of our handoff project was reviewed weekly at multidisciplinary meetings with the entire CTS team, which allowed the impact to be evaluated and any concerns or compliance issues to be addressed.

Video recordings were obtained during the initial 50 cases to assess compliance with the proposed intervention and help troubleshoot problems. The consent form for each patient included the following statement: ‘I consent to the recording, photography, closed circuit monitoring or filming for the purposes of treatment or quality of care and teaching’. The recorded cases were stored on an isolated password-protected computer and subsequently evaluated by the lead surgeon for evidence of team member assertiveness using the methods described by Weiss *et al.*<sup>13</sup>

### PDSA cycle 1: cases 1–10, August–September 2018

Our novel handoff was proposed at a CTS multidisciplinary meeting as a corrective action for pre-existing survey concerns (table 1). The OR staff was apprehensive that the ICU nurses and intensivists were not trained and credentialed to work in an OR. This issue, along with the greater traffic in the OR that it would entail, raised concerns about maintaining the sterile field in the context of an institution that already had a high rate of postoperative infections. OR staff also feared that having to monitor this added traffic would increase their stress.

Our handoff structure was initiated only after the OR staff provided the ICU team with training in sterile technique sufficient for their limited role in the OR. The effectiveness of this training was verified by video recording each of the initial cases in order to monitor the actions of ICU team while in the OR and rule out concerns about sterile field violations. Concerns about excess OR traffic were mitigated by requiring students and other non-essential team members to observe the cases via a glass balcony so they were not physically present in the OR. At a weekly CTS team meeting after the first several cases using the novel handoff structure, we provided feedback about the findings of video review. This prompted a senior circulating nurse in the OR to express her enthusiasm

for this change, which had an impact on the opinions of other OR team members.

### PDSA cycle 2: cases 11–20, October 2018

Video review of the cases by the lead surgeon revealed that many of the ICU team members did not feel comfortable or welcomed in the OR, suggesting problems with psychological safety in an unfamiliar environment. While we expected nurses to proactively approach members of the anaesthesia, perfusion and OR teams, many nurses lacked assertiveness at seeking out information and speaking up with questions during the debriefing session with the OR team at the end of the case, thus lessening the benefit of our intervention.

This finding was discussed at a weekly team meeting and a corrective plan was developed. The circulating nurse agreed to greet the ICU nurse on arrival into the OR and verbally introduce her arrival to the team. Once the lead surgeon was scrubbed out, he agreed to provide one-on-one coaching to each of the ICU nurses about the type of information that is available in the OR and showed the nurse where to find it (eg, transesophageal echocardiography (TEE) images, cerebral oximetry tracing, blood loss on sponges, etc). Anaesthesiologists were encouraged to explain the status of the patient to the ICU nurse. Follow-up reviews of the video recordings and team discussions confirmed that these changes happened as planned and revealed more proactive ICU nurses after this corrective action. We noted nurses gathering relevant information about the patient from the perfusionist and anaesthesiologist, such as a direct review of the intraoperative echocardiogram images (figure 1, top left) or by asking questions about haemodynamics and electrocardiogram (EKG) readings (figure 1, top right). ICU nurses were also more consistently offering suggestions for medication dosages, appropriate extubation timelines and other postoperative care issues during end-of-case debrief discussions (figure 1, bottom).

At this point in the project, we noted modest improvements in the positive response rates for some of the HSOPS questions assessing handoff safety, though we were below our goal of reaching the reported national averages (figure 2A–E).

### PDSA cycle 3: cases 21–60, November 2018–January 2019

While our intent was to have the ICU nurse in the OR for the last 30 min of the case, several incidents were discussed at our team meetings where the nurse was required in the OR for over an hour. This caused excess workload on the nurses that remained in the ICU without the support of their colleague. The HSOPS results from the past revealed chronic concerns about understaffing of nurses, so any requirement for a nurse to be off the unit impacts the safety of other ICU patients.

Review of the video recordings confirmed that the ICU nurses were present in the OR for greater than an hour on three occasions. This happened when unexpected surgical events slowed down completion of the





**Figure 1** Top left: robotic coronary artery bypass grafting (CABG) 11/16/18; intensive care unit (ICU) nurse (green arrow) discussing intraoperative echocardiogram imaging with the anaesthesia team. Top right: robotic CABG 11/16/18; ICU nurse (green arrow) monitoring and recording haemodynamics. Bottom: robotic CABG 10/12/18; ICU nurse (green arrow) participates in the end-of-case 'timeout' with the surgeon, anaesthesiologists, perfusionists and or circulating nurses.

case. During discussion at a weekly team meeting, it was disclosed that those ICU nurses that were in the OR during these cases did not ask to leave, in part because they did not know how to identify cases that were likely to take longer than expected. The circulating nurse in the OR felt more confident in being able to identify such cases and was empowered to excuse the ICU nurse from the OR and call her back closer to the time of the debriefing. This eliminated future prolonged observation periods (figure 3). In addition, the nurse manager in the ICU agreed to recruit new nurses to cross cover for the time that the ICU nurse was required to be away from the unit.

#### PDSA cycle 4: cases 61–80, February– March 2019

A complication happened to a patient immediately after arrival to the ICU that prompted a team discussion about possible underlying causes. It was agreed that an unintended consequence of focusing on the handoff in the OR is that it might underemphasise the importance of close observation and management of the patient during transport to the ICU.

A root cause analysis was performed by the institutional quality improvement team and concluded that the case with the complication resulted from a lack of appropriate attention to the patient during and after transport from the OR to the ICU. Our corrective action plan was to require that all team members travel with the patient during transport and participate in a second brief handoff that reassesses the patient in the ICU.

#### PDSA cycle 5: cases 81–123, April– June 2019

While the rationale for the novel handoff structure was increasingly accepted by all members of the CTS team, there were persistent complaints from ICU nurses that being present in the OR was an inefficient use of time.

ICU nurses were interviewed individually in order to determine the value they perceived from this intervention. Semistructured interviews consisting of 10 questions (online supplemental appendix figure 2) were conducted with the 12 ICU nurses on the CTS team. These interviews aimed to assess the perceived quality of handoff based on three subscales described previously by O'Connell and colleagues<sup>14</sup>: (1) quality and information, (2) interaction and support and (3) efficiency. Responses related to quality of information included 11 ICU nurses who mentioned, in some form, that more detailed information concerning patient haemodynamics were conveyed in the new handoff structure.

In the old handoff, they wouldn't tell you if there was a dip in cerebral perfusion or if the patient was hypotensive for a prolonged while. We can get this information now.

Nurses also mentioned the ability to gather pertinent information on their own just by being present for handoff in the OR.

For me, it was valuable to learn that the patient was hypotensive in the OR. I looked to see what pressors and inotropes the patient was on and whether the patient was responding to boluses of volume and blood; these are the things that the anesthesiologists use to get the blood pressure to go up and these were the things I kept in mind for handling the patient's hypotensive episodes in the ICU.

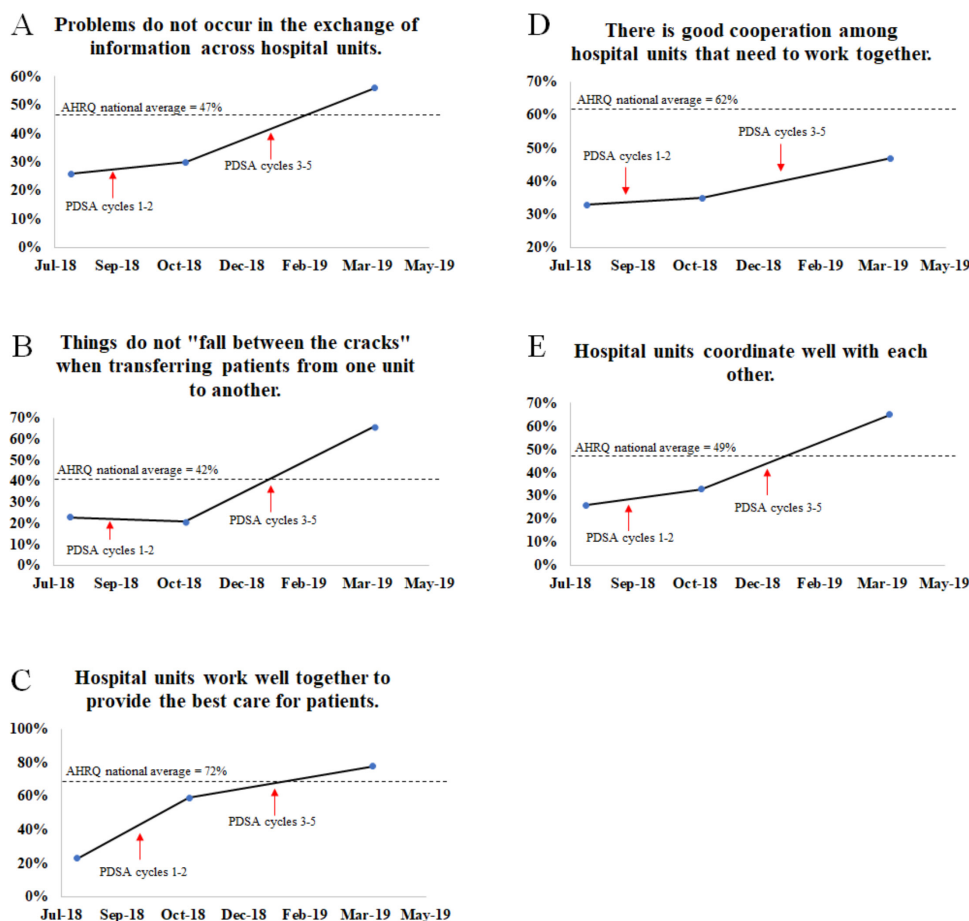
They [the patients] have all these drips and lines and you get to see where the drips are and where the tubes are. You can monitor the flow of the chest tube—did it start oozing? was it too much? You basically get a feel for the patient a little bit sooner; gets you thinking in the OR. Oh, the patient was hypotensive in OR, what's the max dose of that pressor they used.

Three nurses mentioned that the new handoff gave them the ability to familiarise themselves with their patients earlier.

I get a better picture of what is happening overall to the patient. I get handoff from an 'OR perspective'.

We can visualize the patient in the OR. It is easier for us to document. We can assess the patient there; assess the pulses, the drips, the lines. We get to know what the baseline of the patient is in regard to the OR. We know whether the patient is responding well to either pressors or fluids.

Responses related to interaction and support were generally all positive with nurses reporting improvements in collaboration and teamwork.



**Figure 2** (A–E) Line charts of the positive response rates (y-axis) for the five Hospital Survey on Patient Safety Culture questions assessing perceptions of handoff safety from cardiothoracic surgery staff. The dashed lines represent the AHRQ national average for each question. AHRQ, Agency for Health Care Research and Quality; PDSA, plan, do, study, act.

Before, if I needed to ask anesthesia a question, I would page them. Now, they are right there in the OR, I just ask them directly. It's more convenient.

There's definitely more support. It's nice reviewing the plan with everyone before getting started in the ICU.

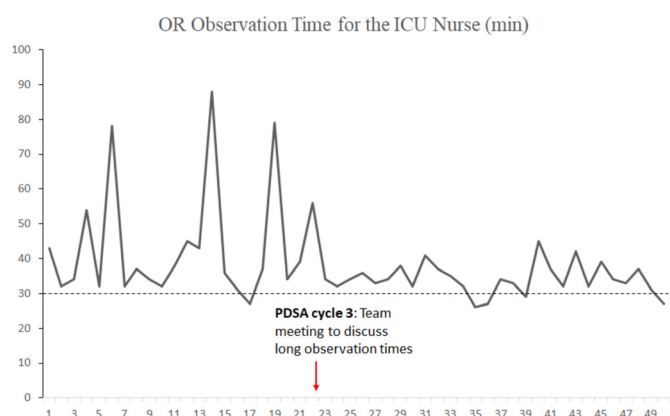
Responses related to efficiency included six ICU nurses who mentioned issues related to coverage of patients in the ICU while another nurse is away receiving handoff in the OR.

It's tough picking up someone's [another nurse's] patients when I already have two patients to take care off. I don't get time for lunch.

The new way [handoff structure] is nice, but there needs to be enough staff to support this.

What happens if the other nurse who's covering for us is also very busy? We need adequate amount of staff. Sometimes the other nurses don't get a break or don't leave on time.

At this point in the project, we also reassessed the HSOPS and noted improvements in the positive response rates, specifically the way patient information was transferred between hospital units and in cooperation between different units. Both the survey results and responses received during semistructured interviews suggested that



**Figure 3** Run chart of ICU nurse time (in minutes) in the OR during the observation phase of the handoff. X-axis indicates the number of cases since the start of the project. The dashed line represents our target time of 30 min. ICU, intensive care unit; OR, operating room; PDSA, plan, do, study, act.

participation in the project was an important use of an ICU nurse's time.

## RESULTS

For four out the five HSOPS questions assessing handoff safety, we demonstrated improvements in positive response rates at the second assessment (end of PDSA cycle 2) (figure 2A–E). At the end of a 10-month period (end of PDSA cycle 5), we achieved our aim of reaching or surpassing the AHRQ national average positive response rates<sup>12</sup> for all questions except 'there is good cooperation among hospital units that need to work together' (national average=62%, CTS staff=47%) (figure 2A–E). It is possible that perceptions of cooperation among other units such as cardiology or radiology were taken into account when our staff responded to this question. We can mitigate this by tailoring future HSOPS questions to be more specific to the needs of our department.

The amount of time the ICU nurse spent in the OR during the observation phase of the handoff was measured by video review and review of the operative records. A control chart of these times over the course of the project demonstrates the effectiveness of our team deliberations during PDSA cycle 3 at addressing this issue (figure 3).

## LESSONS AND LIMITATIONS

Previously, case handoffs for our CTS programme occurred in the ICU, after the case was completed and the patient had been transferred out of the OR. This quality improvement project tested a novel method of the ICU team 'running in parallel' with the surgical team in the OR before completing the handover process in the ICU. Our improvements in staff perceptions of handoff safety and comments from ICU staff interviewed about this change clearly reflect important advantages. This approach was judged as providing a more complete profile of the patient to the ICU team as opposed to a snapshot of the postoperative status that is typically conveyed using the standard approach. These findings are important because improved perceptions about handoff safety such as this are a powerful way to transform the culture of safety.

Selecting an outcome measure such as the number of handoff disruptions or the number of postoperative complications might have made it easier for us to report more frequent measurements throughout the project. However, the primary purpose of our new approach was to improve the attitudes, values and behaviours of CTS staff about OR-ICU handoffs that were below AHRQ benchmarks at the outset. Perceptions of an improved culture of safety are valuable because they promote an environment in which staff feel like they can speak up about their ideas, thoughts and concerns. Oftentimes in surgery, team members, including nurses, fail to speak up about problems in a way that would improve patient safety. When there are team members who do not speak up, a potential result is normalised deviance, learnt

helplessness and other behaviours that pose latent threats to patient safety. Our findings suggest that this handoff protocol is a powerful way to mitigate these behavioural threats.

An unanticipated issue implementing our handoff protocol was optimising the use of ICU nurse time. ICU nurses spending time in the OR for handoff were away from helping with other patients in the ICU. A practical reality is that efficiency is critical for safety and effectiveness. Our ICU nurses reported that being in the OR for longer than 30 min led to issues with coverage for their other patients in a chronically short-staffed ICU. One ICU nurse observing in the OR often meant that other nurses remaining in the ICU were unable to take lunch breaks. While our handoff envisioned nurses being in the OR for only 30 min, operative complications often prolonged the end of the case and thus prolonged the time many nurses spent in the OR. We addressed this issue during PDSA cycle 3. Our run charts showed that we were able to significantly reduce the time ICU nurses were in the OR and sustain this reduction (figure 3). Still, the ICU nurse observation time was consistently over 30 min. Improving this aspect of our handoff will require continued coordination with nursing administrators to address issues related to staffing.

Another unanticipated problem implementing our handoff related to the complication that occurred during the transport period. It is understood that intrahospital transport of critically ill patients often provokes adverse alterations in cardiopulmonary stability. A handoff overly focused on OR events could increase the risk that a major change in patient status during transport is overlooked after arrival to the ICU. In PDSA cycle 4, we mitigated this problem by amending our protocol to mandate a team reassessment of the patient's status on arrival in the ICU.

## CONCLUSIONS

Our description and assessment of a novel handoff structure adds to a growing body of literature examining ways to optimise the transfer of complex, time-sensitive information that is critical for decision making after arrival to the ICU. This quality improvement project achieved its aim of increasing staff perceptions of handoff safety to meet the national standards of the AHRQ. Although we do not have enough datapoints to suggest sustainability, the impact of our protocol on the culture of safety implies changes in staff attitudes, values and behaviours that could have lasting impacts in a surgical department. The permanent restructuring of our pre-incision checklist in the OR to include announcing the name of the ICU nurse and intensivist who will be receiving the patient will ensure continued compliance with our intervention, even when new surgeons and OR staff are hired at our programme. Moreover, the HSOPS will continued to be administered annually, as is the regular protocol for all departments at our institution. We speculate that this handoff protocol can be adopted by other high-acuity surgical fields such



as neurosurgery and paediatric surgery that also require timely communication between large, multidisciplinary teams. However, further optimisation of ICU nurse time in the OR is required before our protocol would be practical for smaller hospital settings with more limited staffing resources.

## Permission statement

The authors attest that prior to the use of videotaping in the OR, all members of the cardiac surgical team at SUNY Downstate, including those pictured in [figure 1](#), provided their consent to be taped. This consent included the use of the recordings for all educational purposes. Similarly, all patients also provided consent. As indicated in the manuscript (Strategy section), the consent form for each patient included the following statement: 'I consent to the recording, photography, closed circuit monitoring or filming for the purposes of treatment or quality of care and teaching'.

**Contributors** RSP conceptualised the handoff protocol; SH, RSP, FJ and AB led the improvement cycles; SH, BY, AL and AS performed survey data collection; SH conducted staff interviews; SH, RSP, BY, AL and AS performed data analysis and interpretation; SH and RSP wrote original draft; SH, RSP, FJ, AB, BY, AL and AS reviewed and edited draft.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially,

and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

## ORCID iD

Safraz Hamid <http://orcid.org/0000-0001-8342-7760>

## REFERENCES

- 1 Catchpole KR, de Leval MR, McEwan A, *et al*. Patient handover from surgery to intensive care: using formula 1 pit-stop and aviation models to improve safety and quality. *Paediatr Anaesth* 2007;17:470–8.
- 2 Mistry KP, Landrigan CP, Goldmann DA, *et al*. Communication error during post-operative patient hand off in the pediatric intensive care unit. *Crit Care Med* 2005;33:A12.
- 3 Lingard L, Espin S, Whyte S, *et al*. Communication failures in the operating room: an observational classification of recurrent types and effects. *Qual Saf Health Care* 2004;13:330–4.
- 4 Nagpal K, Vats A, Lamb B, *et al*. Information transfer and communication in surgery: a systematic review. *Ann Surg* 2010;252:225–39.
- 5 AHRQ. Hospital survey on patient safety culture. Available: <https://www.ahrq.gov/sops/surveys/hospital/index.html> [Accessed 16 Apr 2020].
- 6 Agarwal HS, Saville BR, Slayton JM, *et al*. Standardized postoperative handover process improves outcomes in the intensive care unit. *Crit Care Med* 2012;40:2109–15.
- 7 Breuer RK, Taicher B, Turner DA, *et al*. Standardizing postoperative PICU handovers improves handover metrics and patient outcomes. *Pediatr Crit Care Med* 2015;16:256–63.
- 8 Haynes AB, Weiser TG, Berry WR, *et al*. A surgical safety checklist to reduce morbidity and mortality in a global population. *N Engl J Med* 2009;360:491–9.
- 9 Lee S-H, Phan PH, Dorman T, *et al*. Handoffs, safety culture, and practices: evidence from the hospital survey on patient safety culture. *BMC Health Serv Res* 2016;16:254.
- 10 Boan DM, Nadzam D, Clapp JR. The impact of variance in perception of the organization on capacity to improve in hospital work groups. *Group Dynamics: Theory, Research, and Practice* 2012;16:206–17.
- 11 Fan CJ, Pawlik TM, Daniels T, *et al*. Association of safety culture with surgical site infection outcomes. *J Am Coll Surg* 2016;222:122–8.
- 12 Famolaro T, Yount N, Hare R. *Hospital survey on patient safety culture 2018 user database report. (prepared by Westat, Rockville, MD, under contract No. HHSA 290201300003C.* Rockville, MD: Agency for Healthcare Research and Quality, 2018.
- 13 Weiss M, Kolbe M, Grote G, *et al*. Why didn't you say something? Effects of after-event reviews on voice behaviour and hierarchy beliefs in multi-professional action teams. *Eur J Work Organ Psychol* 2017;26:66–80.
- 14 O'Connell B, Ockerby C, Hawkins M. Construct validity and reliability of the handover evaluation scale. *J Clin Nurs* 2014;23:560–70.