Participation in a System-Thinking Simulation Experience Changes Adverse Event Reporting

Jill S. Sanko, PhD, MS, APRN, CHSE-A, FSSH;

Mary Mckay, DNP, APRN, CNE

Introduction: System failures are contributing factors in the thousands of adverse events occurring in US healthcare institutions yearly. This study explored the premise that exposure to a simulation experience designed to improve system thinking (ST) would impact adverse event reporting patterns.

Methods: An intervention-control study was used to explore impacts of participation in a simulation designed to improve ST on adverse event reporting. Each summer Bachelor in Nursing Science students along with medical students participate in a week-long simulation-based interprofessional patient safety course. During the 2017 course, Friday Night in the ER, a table-top simulation designed to develop ST was included. As part of the school nursing's simulation program, students are asked to report adverse events observed or committed during simulation encounters into a simulated adverse event reporting system outside the simulation-based interprofessional patient safety course. Adverse event reporting system data were used to examine patterns of adverse event reporting in control and intervention groups studied.

Results: Findings demonstrated differences in proportions of reported adverse events. The proportion of reported adverse events by students with the second and terminal semesters of course work combined and the 2016 and 2018 control groups combined demonstrated statistically significant differences, $P < 0.001$. Additional analysis revealed that the intervention group reported more medication-related events, whereas the control group reported more failure to rescue and airway-related events.

Conclusions: Exposure to a simulation designed to develop ST seems to impact adverse event reporting. These findings support the idea that ST may change safety monitoring behaviors.

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Key Words: Adverse event reporting, system thinking, simulation, adverse events, reporting.

System failures are significant contributing factors in the hundreds of thousands of adverse events occurring in US healthcare institutions each year. Despite persuasive evidence that changing systems would reduce harm, altering healthcare systems is especially challenging.[1] Healthcare systems are some of the most complex organizational structures, involving continually evolving, intricate technology used by a menagerie of highly self-directed individuals[1] to care for complicated and often quite infirm patients. Lucian Leap is noted to have said; systems cannot be improved if they are not understood[1]; thus, system thinking (ST) is needed if there is a desire to better existing systems.[2] Richmond, a well-known leader in the field of systems dynamics, is credited with coining the term "system thinking."[3] Richmond recognized that as society becomes more reliant on greater interdependencies, society must learn that paying attention to only their particular "piece of the rock" and only solving problems at the local level will stifle the evolutionary progress humans have enjoyed since the beginning of time. This way of thinking is important in general[4,5] but vital in healthcare because of the multiple complex systems that are interdependent upon each other for good outcomes to occur.[6,7]

System thinking has numerous definitions but at its core is an understanding that outcomes of systems are products of the interrelationships and interactions of system parts.[8] System thinking is fundamental to quality improvement efforts,[7] can be measured, and has been suggested as a key element in improving patient safety.[9] Recent research demonstrated a relationship between ST and safety practices.[10] A study by Hwang and Park[10] showed that nurses with higher ST measured by the System Thinking Scale (STS)[11] scores had a greater tendency to report medical errors.

Under reporting of adverse events occurring in healthcare is a well-known problem.[12] The failure to capture the facts associated with errors and near misses significantly reduces the possibility that a complete understanding of the causes of these events can be fully known. An increase in error reporting may lead to a decrease in the number of errors occurrences because of the ability to develop and deploy possible targeted prevention efforts that could come from uncovering the causes. The need for more reporting as well as an increase in the quality of reporting is suggested.[13,14] Moreover, there are noteworthy examples of learning and subsequent improvements that have been made after reporting of serious patient safety events.[15] One of the major recommendations of the landmark 1999 Institute of Medicine report, *To Err is Human*, was to focus on incident reporting.[16]

From the University of Miami School of Nursing and Health Studies, Coral Gables, FL.

Correspondence to: Jill S. Sanko, PhD, MS, APRN, CHSE-A, FSSH (e-mail: j.sanko@miami.edu).

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This study explored the hypothesis that exposure to a simulation experience aimed at improving ST would impact adverse event reporting patterns in undergraduate nursing students. Furthermore, it was hypothesized that differences in reporting patterns of specific types of adverse events based on having or not having exposure to a simulation designed to teach ST would be found. Finally, we hypothesized that the effects of the exposure would be impacted by time.

METHODS

After institutional review board approval, an intervention-control study design using secondary data from 3 cohorts of undergraduate Accelerated Option Bachelor of Science of Nursing (AO-BSN) students were used to explore the impacts of participation in a simulation experience aimed at developing ST on adverse event reporting. Students enrolled in the AO-BSN program are second-degree students, who have completed a prior degree in a field other than nursing but are now seeking a BSN degree through a 1-year accelerated program.

For this study, data from 2 cohorts of students served as the control group and data from a third as an intervention group. Because randomization was not used to select the intervention group, 2 rather than 1 comparison year were selected to increase the probability that the findings represented actual differences in behaviors rather than falsely detecting a treatment bias.[17] The data from these 2 groups were combined to form the control group.

Patient Safety Course

Each summer (the second semester of course work 1 of 3), students admitted in our spring semester who are enrolled in the university's AO-BSN program participate in a week-long simulation-based interprofessional patient safety course (SBE-PS-IPE) with students from the school of medicine entering their third year of medical school. This annual course has the objective of providing students foundational knowledge and skills on the topics of patient safety and teamwork in an interprofessional context. The SBE-PS-IPE course is an adaptation of an original course developed at our university for preclinical medical students[18] and has been running since 2013. During the summer of 2017, students enrolled in the SBE-PS-IPE course participated in Friday Night in the ER (FNER)[19] as one of the course simulation activities. During the course, students from nursing and medicine are grouped into mixed discipline teams in which they encounter most course simulation activities. Year to year, few substantial changes are made to the overall SBE-PS-IPE course objectives or activities. Most of the changes made from year to year include tightening scenario objectives, updating scenarios, and tweaking scheduling of activities to improve course flow. In 2017, however, the opportunity to add FNER as a simulation experience was presented, affording the ability to study differences in adverse event reporting in groups who experienced FNER and those who did not.

Friday Night in the ER was not included subsequent course years because of factors related to limited space and faculty resources needed to be able to include it. Outside of the addition of the FNER activity, the only changes made to the course from 2016 to 2018 included eliminating a scenario in 2017 and beyond that had poor evaluations, which was focused on safety for patients with dementia, and adding a discharge planning case in 2017 as part of a follow-through scenario activity for an already included scenario; this new scenario continues to be included as part of the course. We additionally made a change to the course group-graded assignment. Before 2018, the assignment was a group root cause analysis of a case assigned to each team. In 2018, this assignment was changed to one where the teams were tasked with identifying adverse event found in a literature search and presenting an evidence-based solution that would help prevent a future occurrence of the event. In addition, there were no changes to the core faculty running or facilitating the courses across all 3 years of this study.

Higher ST scores measured using the STS[11] have been found in nursing, medical, pharmacy, and physical therapy students after participation in an FNER simulation[20,21]; thus, it was presumed that ST was different in the control and intervention groups. It was further hypothesized that this difference would also result in an observable difference in adverse event reporting. As part of the SBE-PS-IPE course, students in the intervention group were administered the STS[11] before and after exposure to FNER. Administration of the STS was done for the purposes of evaluating the learning impacts of the activity, but students were asked if their data could be used for the purposes of research. Data from students indicating that they did not wish for their data to be included in research were excluded from analysis. The results of this analysis are included in the results section.

Friday Night at the ER

Friday Night at the ER is a commercially available tabletop simulation used to teach and developing ST.[19,22] Friday Night at the ER has a global following, with more than 1000 licensed users, more than 20 years of use, and has been used in a multitude of disciplines both within and outside healthcare to teach ST.[19–23] Despite its healthcare context and name, the ability to play and subsequently learn from FNER does not require learners to have healthcare knowledge. Friday Night at the ER engages teams of 4 players at a board representing a simulated hospital composed of 4 hospital departments (emergency department, surgery, step-down, and critical care).[19] Friday Night at the ER challenges teams to manage a busy hospital during a simulated 24-hour period.[19,22] Each player handles patient flow and staffing needs of their department, deals with any emergencies that arise, and documents performance based on prescribed metrics that are tracked as a department manager.[19] Multiple boards can be played during a session to simulate a multihospital system context. Friday Night at the ER sessions commences with a prebriefing that includes how and why to play and culminates with an in depth debrief. Sessions are carried out by trained facilitators using provided program power point slides that guide the debriefing keeping it aligned with the simulation's objectives but are fluid enough to allow program-specific discussions to unfold and examples to be used. In total, an FNER session takes approximately 2 hours to run. Formal training is not a requirement to facilitate the activity; however, formal training is available. The faculty who facilitated the sessions was a formally trained

facilitator. Requirements to run a session include space with appropriately sized tables (20 inches by 20 inches), chairs for each participant, print outs of the tracking paper work used as part of the metrics collected during the game, writing utensils, and a screen and projector to display the power point slides.

Given the large number of students participating in the 2017 SB-PS-IPE, 2 sessions of FNER were run to accommodate all students participating in the course. To facilitate the 2 sessions of large groups, we needed to find adequate space to fit 27 tables of approximately 4 players. Adjustments can be made to accommodate groups that are not divisible by 4 by "overstaffing or understaffing" a simulated hospital. This condition can be incorporated into debriefing to bring about discussions on the impacts of such circumstances on systems.

Although we were able to find a space large enough to run the FNER activity in 2017, we were not as fortunate in subsequent years and therefore had to make the decision to drop this activity from the SB-PS-IPE course. Friday Night at the ER is still used in other courses, however, throughout the year where smaller groups can be arranged.

Measures

The STS

The STS was developed by Moore and Dolansky[11] (2010) originally as a 30-item 3-factor tool. Initial psychometric analysis demonstrated low factor loadings for 2 of the 3 factors, therefore items for these factors were not included in their subsequent psychometric analysis of the tool. Secondary analysis of the tool undertaken by Moore et al[11] included only the 20 items included as part of the factor titled System Interdependencies. This analysis demonstrated a single factor tool with a Cronbach α value of 0.89 and test-retest reliability of 0.74. As part of a multisite study exploring the impacts of FNER on ST,[21] further psychometric scale analysis of the 20-item tool was undertaken. This analysis found good evidence of validity and reliability of the STS. All interitem correlations were greater than 0.410; Cronbach α value was equal to 0.994.[21]

Adverse Event Reporting System

As part of the usual school of nursing simulation program, all nursing students are encouraged to report adverse events observed or committed during simulation encounters in a simulated adverse event reporting system (AERS)[24–26] embedded into the simulation program. The goals for developing and embedding AERS into the simulation program were 2-fold: (1) to provide a place where students could practice adverse event reporting and (2) as a tool to collect data to direct evidence-based improvements in curricula. Validation of this system was completed in a feasibility study conducted before the full-scale launch.[24] For this current study, all adverse events reported by students participating in the 2016 (control, n = 68), 2017 (intervention, n = 85), and 2018 (control, n = 78) patient safety courses were extracted from the system and analyzed to explore the impacts of exposure to FNER on adverse event reporting behaviors. Two semesters of adverse event reporting data {the semester in which students participated in the patient safety course (second semester of course work) and the subsequent semester [the last (third, terminal) semester of course work]} were analyzed from 3 cohorts of students enrolled in the AO-BSN program and admitted during the spring semester.

Statistical Analysis

System Thinking Scores

Paired *t* tests were used to analyze pre-post ST scores in the intervention group using statistical software following extraction of the data from the electronic web-based system used to collect the data.

Adverse Event Reporting Rates

Data from the 3 cohorts of students included in the study were extracted from the adverse event reporting database used as part of the school of nursing simulation program. Descriptive statistics was used to describe the characteristics of study cases and calculate rates of adverse event reporting. To control for differences in the samples sizes among the groups compared, proportions were calculated using raw data for each group and condition. Proportion comparisons were completed using χ^2 tests to examine differences in adverse events reported by participants in the groups studied.

Data Analysis Procedures

Multiple tests were performed to be able to detect where and how long impacts of exposure to FNER on reporting patterns would be found. To determine whether there would be washout of the effect of exposure comparisons were made in the semester in which students encountered the simulation as well as the subsequent semester following the intervention. To determine whether one group reported more often than the other, the proportions of the total number of adverse events made in each semester were examined. To determine whether exposure impacted reporting patterns of only certain types and categories of adverse events, stratification of the data was completed and then analyzed.

The stratifications were as follows: (1) comparisons of adverse events reported as error, near miss, sentinel, or other types and (2) comparisons of adverse events reported in the categories (scope of practice events, medication events, confidentiality breach events, fall events, order execution events, failure to rescue events, and airway events). In total, 24 separate χ^2 tests were performed. To control for the use of multiple comparisons to uncover where and under what time frame changes were occurring the Benjamini-Hochberg (BH) procedure was used to control the false discovery rate.[27] This procedure decreases the probability that an incorrect rejection of the true null hypothesis would occur because of the use of multiple comparisons.[27] The BH procedure adjusts the *P* value. The BH *P* value is notated in all reported results.

RESULTS

Data Analysis

System Thinking

System thinking was measured in the intervention group before and after the intervention using the STS.[11] Analysis showed a time effect (premean = 48.00, postmean = 65.81, $P < 0.001$) with a large effect size ($d = 1.42$).

Reporting of an Event Proportions Comparisons

Findings demonstrated differences in the proportions of reported adverse events based on exposure to FNER. In both semesters, the intervention group reported proportionally

more adverse events than the control. The findings point to a somewhat longitudinal impact of the intervention on adverse event reporting; however, there is a noted drop-off in the differences from the semester where the exposure occurred in the following one. In semester where the exposure occurred, there was a 17.37% difference in the number of reports made (intervention = 66.27% Adverse event reporting rate (AERR), combined control years = 48.9% AERR, χ^2 = 31.03, 95% confidence interval = 11.35 to 23.11), $P < 0.001$, BH $P = 0.002$); however, in the terminal semester, this difference although remaining significant shrunk to only a 5.8% difference, intervention group (55.8% AERR) reporting proportionally more adverse events compared with the combined controls [50.0% AERR, χ^2 = 3.38, 95% confidence interval = −0.034% to 11.56%, $P = 0.052$, BH $P = 0.143$ (significant)].

Results by Adverse Event Type

Stratified comparisons examining reporting patterns across adverse event type (error, near miss, sentinel event) with control groups combined failed to show statistically significant differences in all analyses completed.

Results by Adverse Event Categories

Stratified comparisons examining reporting patterns across adverse event categories (medication events, scope of practice events, failure to rescue events, order execution events, airway events, fall events, and confidentiality breaches) without stratification of these events into the adverse event type (error, near miss, sentinel event) showed interesting patterns of differences (Tables 1–3).

There were differences in medication event reporting patterns. Medication events were found to be reported statistically more often by the intervention group compared with the control group (Table 1) but was solely found to be significant in the semester where the FNER intervention occurred. This finding further supports the notion that there may be a washout effect of the interventional impact.

Failure to rescue and airway events were also found to have statistically significant differences when comparing the groups. The control group reported more failure to rescue events in the semester where FNER occurred; however, this effect was not found in the terminal semester (Table 2). Finally, there were statistically significant differences in reporting of airway events, with the control group reporting statistically more airway events than the intervention group; however, this is only found in the terminal semester (Table 3).

DISCUSSION

Participation in FNER as a simulation experience has been found to increase ST in this study as well as others[21] and also seems to alter adverse event reporting frequency in general as well as for certain types of adverse events. In this study, findings demonstrated patterns of adverse event reporting that were different among the groups studied when events were stratified into their constituent categories. These pattern differences seem to be influenced by having had or not had exposure to FNER. This finding seems to suggest that those with presumably higher levels of ST related to exposure to FNER notice and subsequently report different categories of events.

The intervention group reported medication events more often than the control group (Table 1). This finding reflects what might be expected based on studies found in the literature reporting the association of most medication errors occurring related to systems factors.[28] Moreover, medication errors have been described as having multidimensional causes.[29] Thus, the conclusion that individuals with higher levels of ST might notice events more closely influenced by systems is plausible and also supported by systems theory.[30]

The control group was found to have statistically significant greater reporting of events categorized as failure to rescue and airway associated events. According to the literature, these types of errors tend to stem from breaches in cognition, and failure to fully monitor the situation, and subsequently missing changes in a patient's status.[31–33] Unlike medication events, failure to rescue and airway events have a greater tendency to be caused by singular person process issues transpiring at the sharp end (the patient's bedside) of the care spectrum as opposed to systems related failures. Given the study findings, and supporting literature, it may be feasible to conclude that there is an association between individuals' level of ST and the noticing of certain categories of adverse events, whereas those with lower levels of ST may make or notice more events stemming from causes that do not involve system workings. This study also demonstrated that the effects of learning ST may be time limited; thus, attempts to teach or strengthen these skills should not occur only as a single event. Having repeated opportunities to reinforce learned concepts spanning over time may prove to be important in maintaining the skills and knowledge.

This study had several limitations including the use of a simulated AERS to capture data, the use of a student population, the inclusion of a single site, and using an approach that relied on multiple tests of stratified data even despite having used a technique for correcting this. Despite the significant history of the AERS and the prior work validating it, there remains the possibility that the data may be substantially

TABLE 1. Proportions of Medication Event Reporting by Condition

	Reporting Rate Intervention	Reporting Rate Combined Control	*P*	BH Corrected *P*
Second semester	33.30%	22.22%	0.002	0.018*
Terminal semester	26.40%	22.50%	0.197	0.526

*Significant.

TABLE 2. Proportions of Failure to Rescue Reporting by Condition

	Reporting Rate Intervention	Reporting Rate Combined Control	*P*	BH Corrected *P*
Second semester	10.20%	**17.50%**	0.002	0.076*
Terminal semester	23.00%	21.83%	0.694	0.833

*Significant.

TABLE 3. Proportions of Airway Event Reporting by Condition

	Reporting Rate Intervention	Reporting Rate Combined Control	*P*	BH Corrected *P*
Second semester	17.20%	13.71%	0.218	0.523
Terminal semester	16.00%	**23.14%**	0.015	0.091*

*Significant.

different than what might be found in data collected from actual clinical adverse event reporting. Furthermore, the use of students and a single site could impact potential generalizability of the study findings. The study did not allow for a determination of differences in the commission versus the observation of adverse events because the data did not capture whether the person reporting had committed or noticed the reported event. Finally, to fully explore the potential changes in adverse event reporting at a detailed level, the use of multiple tests was used to explore stratified data. Although a BH correction procedure with a 25% false discovery rate was performed, it is still possible that one of the significant findings could have been falsely found.

Strengths of this study include the use of simulation as both an intervention and a method capture data challenging to otherwise obtain. This is one of the first attempts to examine the impacts of ST on adverse event reporting, thus providing a possible model for the future to explore the relationship between ST and safety monitoring.

CONCLUSIONS

The findings of this study may begin to support the notion that developing ST could change safety monitoring behaviors like what was found in a 2017 study by Hwang and Park.[10] The findings of this research as well as those of the Hwang and Park[10] study taken together support the premise that development of ST improves error reporting leading to enhanced error prevention strategies. Based on these findings, it may be of benefit to patient safety efforts to begin including ST content and regular reinforcement of its principles in prelicensure healthcare curricula as well as professional development programming.

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Interdisciplinary clinical debriefing in the emergency department: an observational study of learning topics and outcomes

Andrew Coggins*, Aaron De Los Santos, Ramez Zaklama and Margaret Murphy

Abstract

Background: Defined as a 'guided reflective learning conversation', 'debriefing' is most often undertaken in small groups following healthcare simulation training. Clinical debriefing (CD) following experiences in the working environment has the potential to enhance learning and improve performance.

Methods: Prior to the study, a literature review was completed resulting in a standardised approach to CD that was used for training faculty. A pilot study of CD ($n = 10$) was then performed to derive a list of discussion topics and optimise the faculty training. The resulting debriefing approach was based on the "S.T.O.P." structure (Summarise the case; Things that went well; Opportunities for improvement; Points of action). A debriefing aid, with suggested scripting, was provided. A subsequent observational study assessed CD within 1-h of clinical events. 'Significantly distressing' or 'violent' events were excluded. Data was collected on participant characteristics, discussion topics, and team recommendations. Study forms were non-identifiable. Subsequent analysis was performed by two investigators using content analysis of the debriefing forms ($n = 71$). Discussion topics (learning points) were coded using a modified version of the Promoting Excellence and Reflective Learning in Simulation (PEARLS) framework. One month after completion of the study, ED management staff were surveyed for reports of "harm" as the result of CD.

Results: During the study period, 71 CDs were recorded with a total of 506 participants. Mean debriefing length was 10.93 min (SD 5.6). Mean attendance was 7.13 (SD 3.3) participants. CD topics discussed were divided into 'plus' (well-done) and 'delta' (need to improve) groupings. 232 plus domains were recorded of which 195 (84.1%) aligned with the PEARLS debriefing framework, suggesting simulation debriefing skills may be translatable to a clinical setting. Topics discussed outside the PEARLS framework included family issues, patient outcome and environmental factors. CD reports led to preventative interventions for equipment problems and to changes in existing protocols. There were no recorded incidents of participant harm resulting from CD.

Conclusions: Topics discussed in CD predominantly aligned to those commonly observed in simulation-based medical education. Collective recommendations from CD can be used as evidence for improving existing protocols and models of care.

Keywords: Debriefing, Professional education, Training programs, Quality improvement

* Correspondence: andrew.coggins@health.nsw.gov.au
Department of Emergency Medicine, Westmead Hospital, Hawkesbury Road, Sydney, NSW 2145, Australia

Background

Debriefing can be defined as a deliberate '*learning conversation*' or as a '*guided reflection in the cycle of experiential learning*'. [1, 2] When taken from its familiar use for simulation based medical education (SBME) to clinical environments such as an Emergency Department (ED), it has been associated with observed improvements in team performance [3–5]. Furthermore, in a clinical setting, the potential benefits of debriefing can be delivered at a relatively low cost compared to a face-to-face SBME course and without a requirement to travel to a designated simulation centre. Further benefits of Clinical Debriefing (CD) may include improved interdisciplinary understanding, development of team reflexivity and recognition of latent patient safety threats providing opportunities for pre-emptive interventions [6–9]. As a result, CD is a current area of interest in the medical education literature [6, 10].

Although debriefing has potential benefits, there is also a historically perceived risk of unintended harm [11, 12]. Concerns about immediate *'hot'* debriefing stem from a 2002 Cochrane review. This review suggested single debriefing interventions in non-healthcare staff may be harmful [13]. The Cochrane review also suggested there is an association between debriefing and a risk of post-traumatic stress disorder (PTSD) [13]. While these concerns should be acknowledged, recent studies of CD for healthcare providers did not report harm in over 300 debriefings [14]. Moreover, there are other reports that describe new programs, which aim to improve the performance of frontline healthcare teams. Many of these programs build in approaches to ensure provider well-being and foster individual resilience [15–17].

Prior to this study, CD in our institution typically occurred on an ad-hoc basis [18]. When CD was offered, most debriefings were not structured and were either solely formative (i.e. for learning), or primarily undertaken later in an attempt to mitigate distress (i.e. for well-being) [10]. This observed tension of competing "learning" and "emotional" needs in each debriefing, may be a barrier for facilitators seeking to translate their existing simulation skills to a clinical setting. Our main research objective was to assess to what extent the content discussed overlapped with simulation. To this end, the typical content of simulation debriefings are well documented [19, 20]. However, the current literature on CD most often reflects the '*need for*' debriefing or *'how to facilitate'*, rather than what is disucssed [4, 5, 21, 22]. This study therefore addresses a gap in the literature by examining the topics and content discussed in clinical event debriefing. Our formal hypotheses were (A) *"providers involved in clinical debriefing discuss similar topics to those generated by simulated clinical events"*, and (B) *"immediate interdisciplinary debriefing using a structured approach may result in team-based learning with a low-risk of harm"*.

Methods

Study setting and debriefing approach

This was a prospective observational study setting conducted at an Australian tertiary referral centre between 1st January 2019 and 30th September 2019. Protocols were approved by the local Human Research Ethics Committee as a quality assurance (QA) project. The study adhered to the Australian National Statement on Ethical Conduct in Human Research.

A small pilot study ($n = 10$) of clinical debriefing was carried out between September and October 2018. All of the pilot cases were adult cardiac arrests. We observed that discussions in the pilot CDs appeared to align with a simulation debriefing framework known as PEARLS (Promoting Excellence and Reflective Learning in Simulation) [17]. However, a series of other discussion topics were also observed and a collated list of topics relevant to CD was tabulated (Table 1). This list was used as the reference for coding in the prospective study.

Further, as a result of the observations of the pilot study (supplemented by a review of the literature aided by a senior librarian) we assembled a locally appropriate blended approach to CD facilitation (Fig. 1). This CD facilitation approach blended two published debriefing models. We used the psychological safety focus from "*I.N.F.O.*" (*Immediate*, *Not* for personal assessment, *Fast* facilitated feedback, and *Opportunity* to ask questions) [23] and the structure from "*S.T.O.P.*" (*Summarise* the case; *Things* that went well; *Opportunities* for improvement; *Points* of action) [14].

This blended model was used for faculty development with 13 ED specialists, 1 social worker, 5 senior nurses and 18 ED registrars (residents) trained in CD. The total length of faculty training for debriefing was 40 min, although many of the pool of debriefers had additional prior simulation or CD training and experience [7]. Facilitators conducting debriefings were regularly reminded of the availability of scripted instructions and suggested facilitation approaches. Debriefers were asked to standardise the opening of CDs, but not given instructions on 'what to discuss'. Prior to commencement of the study, we undertook a 4-week period of advertising of the CD project. This period orientated many permanent staff to the listed inclusion and exclusion criteria. In addition, each month during the study, a re-orientation email was sent to our regular staff, along with reminders at local team meetings.

Inclusion criteria

The study inclusion criteria were: (1) Debriefing occurring in an acute care setting; (2) Debriefing of a clinical

Table 1 Modified PEARLS content domains derived from pilot study (n = 10)

Simulation PEARLS Domains [19]	Debriefing Topic	Additional Pilot Study CD Domains	Debriefing Topic
1	Decision Making	8	Family / Social
2	Technical Skills	9	Bad Outcomes / Distress
3	Communication	10	Preparation / Pre-arrival factors
4	Resource Utilisation	11	Space / Equipment / Environmental
5	Leadership		
6	Situational Awareness	12	Unclassifiable Clinical Issue / Other Discussion
7	Teamwork		

event; (3) Debriefing includes ≥3 persons; (4) Debriefing occurring < 1-h post event. The study exclusion criteria were: (1) Simulated event debriefings; formal 'late' debriefings; (2) morbidity and mortality and formal meeting discussions; (3) events involving injury to staff; (4) events associated with significant distress (i.e. an extremely distressing event).

No restrictions were placed on the clinical content of discussion or location of the event. No limits were placed on the time of day that the debriefing took place. All participants were healthcare providers or students – and the facilitators were all ED staff. All known debriefings in the study window were included but given the lack of documentation in medical records, it is possible that debriefings that occurred were not included. We mitigated this potential bias by ensuring a systematic implementation with widespread and regular communication as outlined above.

Outcome measures and analysis

The primary outcome measure of this study was the content analysis of discussion topics in CDs against the list of domains identified in the pilot study (Table 1). Qualitative analysis, content analysis and coding were performed by a single investigator and cross-checked by a second investigator for accuracy and errors. Using consensus between two investigators (AC and ADS), topics were allocated a PEARLS domain code. Secondary outcomes included other reported data points on the audit form such as length of debriefings, time of commencement, number of staff present, designation of debriefer, designation of instigator, *'plus'* points discussed, *'delta'* points discussed, points of action (including further debriefing) and team recommendations. The case description was defined under six predefined headings (i.e. Trauma, Airway, Resuscitation, Psychiatric, Medical and Surgical) with a further three categories added at the

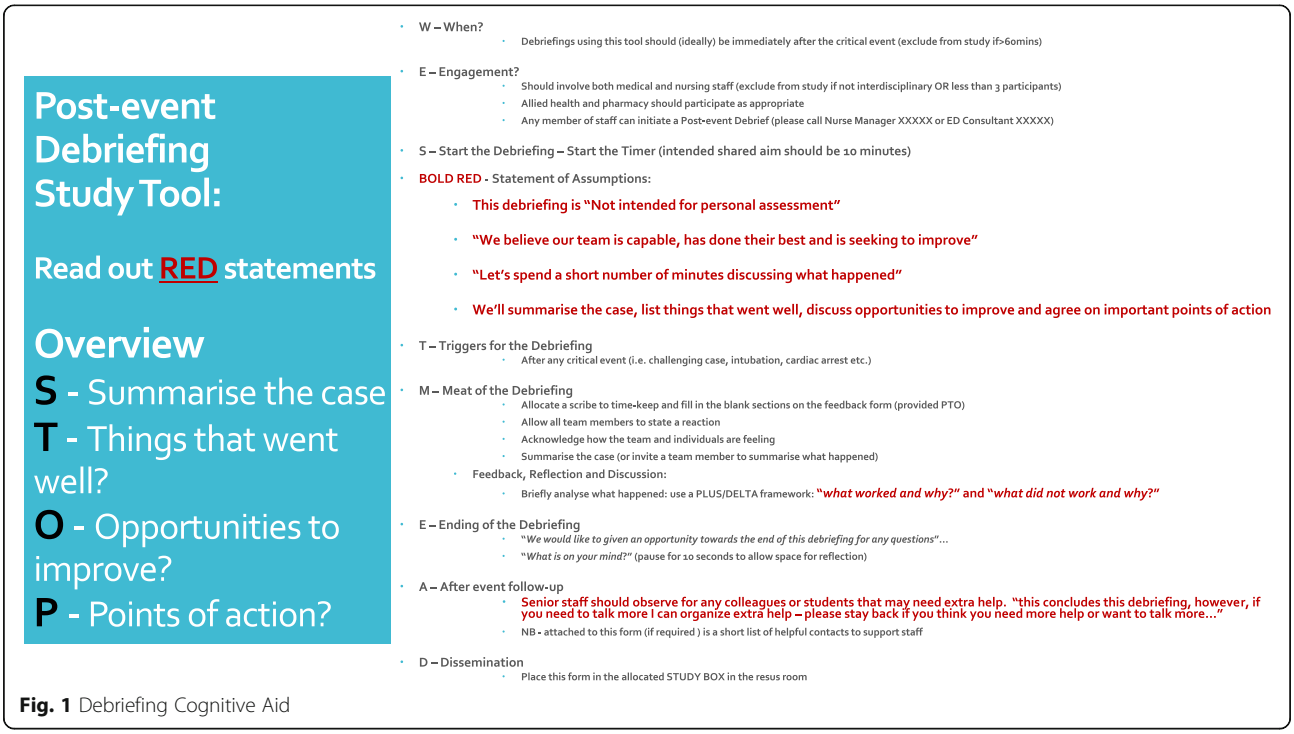

Fig. 1 Debriefing Cognitive Aid

conclusion of the study for appropriate coding (Thoracotomy, Obstetric and Unclassified). CD 'harm' was assessed 1 month after the conclusion of the study by checking with ED managers and reviewing the hospital incident management system (IMS) for *'reports of harm from debriefings'*.

To reduce the risk of observer bias, an independent member of the clinical team was asked to fill in the data form (i.e. a debriefing scribe working with the CD debriefer). The data collection form (Fig. 2) was designed to be straight forward to complete for busy providers. Written instructions were provided to scribes to ensure standardisation of reporting.

Results

A total of 76 study forms were submitted by healthcare staff during a 9-month pre-defined window. 5 forms were excluded from the final analysis (3 for debriefing >60mins after event and 2 due to forms being left blank).

Table 2 reports on the baseline characteristics of the debriefings observed. The total time of reported debriefings was 776 min with a total of 506 staff attending. The lead debriefers were drawn from medical, social work and nursing backgrounds with a total of 16 debriefers participating in all. All of the debriefers had received the standardised training on the suggested approach to debriefing (Fig. 1).

The primary outcome measure (domains discussed) is reported in Table 3. Domains discussed were divided into plus (well done) and delta (challenges). 232 *'plus'* learning points were recorded of which 195 (84.1%) were coded to one of the PEARLS simulation debriefing domains [19]. 164 *'delta'* learning points were observed of which 107 entries (61.5%) were coded to a PEARLS simulation-based debriefing domain [19].

Table 4 provides a supplementary overview of the debriefings reported in terms of specific discussion topics. A broad variety of clinical cases were discussed during debriefings of which cardiac arrest (31%), medical emergencies (19.7%), airway (19.7%) and trauma (18.3%) were the most prevalent.

In the comments section of the data collection form, 37/71 teams documented that the clinical debriefing was useful, and participants anecdotally reported that the CD experience was positive. Table 5 summarises the quality improvement reporting generated from CDs. The reports were managed by investigators on a fortnightly basis. Team reporting from CD led to practice changes that are detailed in Table 5.

Discussion

Historically, debriefing occurs after simulated events and is considered to be a time for individual reactions, team reflection, shared learning and discussion [24, 25]. Similarly, rich opportunities for learning also exist, albeit less

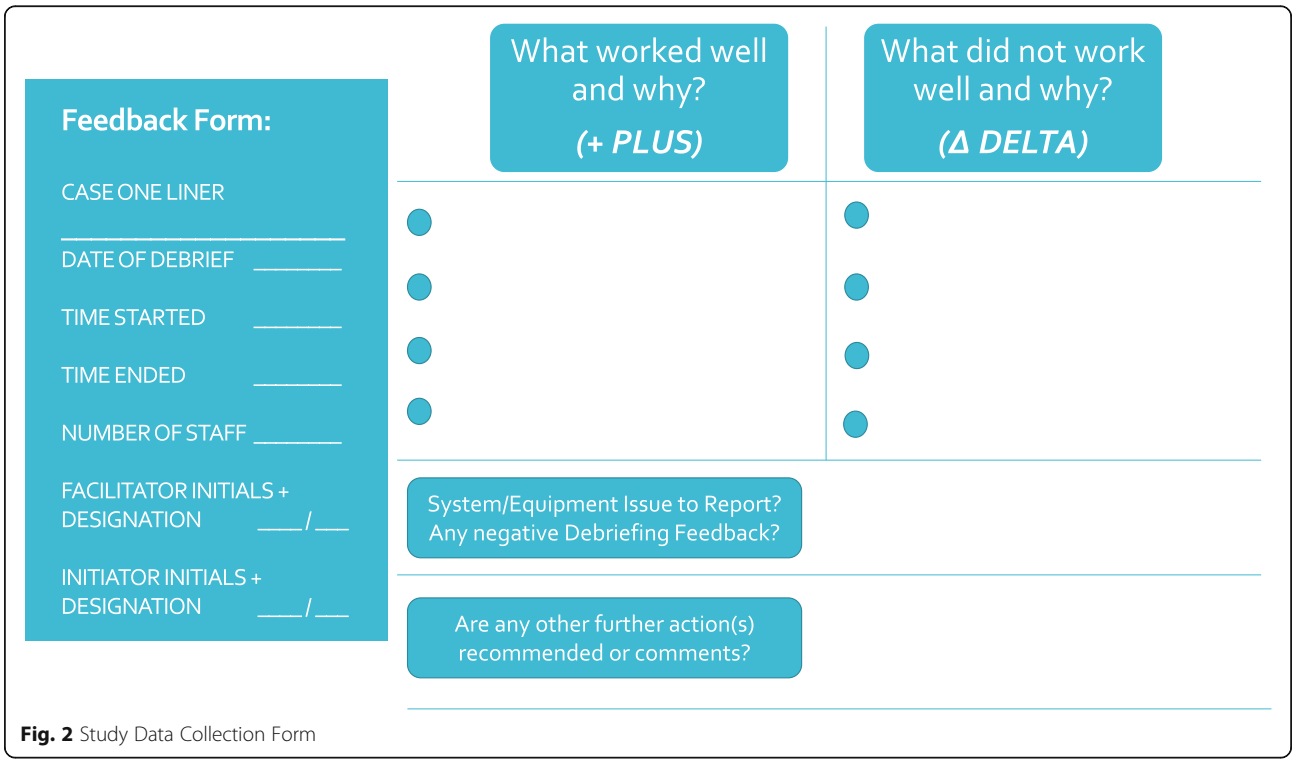

Fig. 2 Study Data Collection Form

Table 2 Participant baseline characteristics ($n = 71$)

Characteristics	Result
Debriefings and location (n/%)[a]	71 events
	- 63 in ED (88.7%)
	- 5 in Ward (7.0%)
	- 2 in Theatres (2.8%)
	- 1 in Clinics (1.4%)
Debriefings occurring on weekdays 0800–1800 (n/%)	41 (57.7%)
Mean debriefing length (minutes/SD)	10.93 (SD 5.59)
Mean participants per debriefing (n/SD)	7.13 (SD 3.30)
Recommendations for formal delayed debriefings (n/%)	2 (2.81%)
Designation of CD facilitator (n/%)	49 Medical (69.0%)
	21 Nursing (29.5%)
	1 Social Worker (1.4%)
Designation of CD prompter (n/%)	36 Medical (50.7%)
	32 Nursing (45.1%)
	2 Social Worker (2.8%)
	1 Other (1.4%)

[a]All CDs were facilitated and prompted by Emergency Department (ED) staff

predictably, in the real life clinical environment [26]. Previous studies report CD rates after resuscitation of between 6 and 31% [5]. In this study only 22/68 (31%) of our reported cardiac arrests were debriefed. These findings highlight a potential opportunity missed in our current approaches to clinical education. In addition, the literature suggests that while CD is desirable and feasible in healthcare settings, there is little reporting on what is actually discussed [26, 27]. This study investigated a convenience sample of 71 CDs. In this discussion of the results we focus on four central topics; firstly, the study's primary outcome of '*what was discussed?*' in comparison to SBME debriefings, secondly, the effectiveness of the facilitation approaches adopted, thirdly, the local impact

Table 3 Discussion domains ($n = 71$)

PLUS (good or positive performance) discussion				DELTA (case changes or poor performance) discussion			
Discussion Domain	n	%	PEARLS versus non-PEARLS Total	**Discussion Domain**	n	%	PEARLS versus non-PEARLS Total
Decision Making[a]	40	17.24%	SIMULATION 'PEARLS' FRAMEWORK DISCUSSION REPORTS	Decision Making[a]	22	13.41%	SIMULATION 'PEARLS' FRAMEWORK DISCUSSION REPORTS
Technical Skills[a]	29	12.50%		Technical Skills[a]	24	14.63%	
Communication[a]	33	14.22%		Communication[a]	22	13.41%	
Resource Utilisation[a]	26	11.21%		Resource Utilisation[a]	18	10.98%	
Leadership[a]	20	8.62%	Total 195 (84.05%)	Leadership[a]	7	4.27%	Total 107 (65.24%)
Situational Awareness[a]	10	4.31%		Situational Awareness[a]	9	5.49%	
Teamwork[a]	37	15.95%		Teamwork[a]	5	3.05%	
Family / Social	2	0.86%	NON-SIMULATION FRAMEWORK DISCUSSION REPORTS	Family / Social	7	4.27%	NON-SIMULATION FRAMEWORK DISCUSSION REPORTS
Bad Outcome / Distress	4	1.72%		Bad Outcome / Distress	11	6.71%	
Preparation / Pre-arrival	21	9.05%	Total 37 (15.95%)	Preparation / Pre-arrival	5	3.05%	Total 57 (34.76%)
Space / Equipment / Environmental	6	2.59%		Space / Equipment / Environmental	21	12.8%	
Unclassified / Other	4	1.72%		Unclassified / Other	13	7.93%	
TOTAL	100%		232	TOTAL	100%		164

[a]Promoting Excellence and Reflective Learning in *Simulation (PEARLS)* [19].

Table 4 Characteristics of cases ($n = 71$)

Clinical event type	Number of debriefings	No. participants (μ)	Length (μ / minutes)
Major Trauma (n/%)	13 (18.3%)	11.0 (SD 6.42)	6.7 (SD 3.22)
Airway (n/%)	14 (19.7%)	10.1 (SD 4.03)	6.4 (SD 1.34)
Cardiac Arrest (n/%)	22 (31.0%)	11.0 (SD 4.05)	8.4 (SD 3.75)
Psychiatric Emergency (n/%)	2 (2.8%)	6.5 (–)	9 (–)
Medical Emergency (n/%)	14 (19.7%)	11.9 (SD 8.79)	5.5 (SD 1.61)
Surgical Emergency (n/%)	1 (1.4%)	10 (–)	7 (–)
Thoracotomy (n/%)	1 (1.4%)	15 (–)	5 (–)
Obstetric (n/%)	4 (5.6%)	11.5 (SD 5)	9.3 (7.85)
Other / Unclassified (n/%)	0 (0%)	0 (–)	0 (–)

observed after implementation of the CD program, and finally, the potential issue of 'harm' associated with immediate CD.

What content is discussed in clinical debriefings?

The PEARLS framework, often used in simulation, can be used as a universal debriefing structure [17]. In addition, PEARLS is a useful tool for facilitators to self-assess the quality and content of debriefings. The PEAR LS approach aids facilitators to blend various debriefing strategies, including learner self-assessment and focused facilitation, whilst also providing a list of common topic discussion domains [19]. The PEARLS discussion domains include decision making, technical skills, communication, resource utilisation, leadership, situational awareness and teamwork. In our study we found that the majority of topics discussed during CD were in line with those described in the literature as occurring in simulation (Table 3) [19]. This is an important finding because it implies that simulation facilitation skills may be transferable to CD. In addition, the combined list of content domains presented in Table 3 may aid prospective facilitators by providing insight into the topics teams discuss during clinical debriefings [4, 19, 28].

The domains of 'decision making' and 'communication' were observed as the most common areas for positive discussions and as the most frequent area that teams would seek to improve in the future. Published evidence suggests that suboptimal communication can lead to adverse outcomes [25, 29]. Decision making errors can be magnified by the *'framing effect'* which suggests that variance in how information is communicated, stress, workload, seniority and culture can significantly change the decisions clinical teams make [25, 30]. Strategies such as clear team structures, shared mental models and better communication have all been shown to improve the decision making of clinical teams [17, 25, 31].

In the wider context of training resuscitation teams, it is apparent that despite most staff attending face to face educational programs (e.g. Advanced Life Support), much work is needed to optimise consistency in our local teams [8, 31]. In this regard, Schmulz and Eppich

Table 5 Quality assurance reporting from debriefings ($n = 49$)

Debriefing Report Type	Total number of relevant reports	Example(s) of group recommendation	Documented Practice Changes	Potential Outcomes
Equipment failure or deficit reported	20 (40.8%)	End-tidal Co2 not routinely available for transport of intubated patients	EMMA™ end tidal Co2 device added to transport packs	Redundancy built into transfer pack for intubated patients
Targeted education required or recommended	13 (26.5%)	Inappropriately low triage category Unfamiliarity with obstetric medications	Individual feedback and education by mentor Shortcuts available for rarely used medications	Reduced future risk of '*undertriage*" and increased team familiarity with medications
Breach in standard operating procedure(s) or protocol(s)	2 (4.1%)	Use of a LUCAS-3™ compression device (contraindicated in trauma)	Laminated guidelines attached to storage area and mechanical CPR device	Reduce risk of inappropriate use of devices in future cases
Further debriefing opportunities organised	2 (4.1%)	(Poor outcome (a premature neonate died in ED), noise level was a concern to some team members	Identified need to for formal emotional debriefing	Additional debriefs to provide psychological support for affected staff
Other(s)	12 (24.5%)	Massive Transfusion Protocol (MTP) unavailable on arrival	Patient medical record number and blood available pre-arrival	Reduce risk of MTP being delayed in future cases

(2017) describe the concept of "*team reflexivity*" amongst healthcare teams. They view healthcare teams as groups of well-trained experts that, without dedicated training, often form non-expert teams [32]. Team reflexivity describes the team's collective ability to reflect on shared goals, processes, and outcomes of their experiences and adapt accordingly. CD may have a specific role in promoting team reflexivity, both directly from facilitated discussion, and from changes in culture resulting from routine learning conversations. To this end, in this study we observed that teamwork was commonly discussed, and evidence suggests that teamwork is pivotal in reducing healthcare errors [33, 34].

While the listed PEARLS domains covered the majority of content discussed in CDs, during the pilot study we also observed additional domains not covered by PEARLS (Table 1). These included family issues, social issues, poor outcomes, pre-arrival preparation and environmental issues. Educators leading CDs seeking to use existing SBME debriefing skills, or the PEARLS framework, should anticipate that the listed additional areas may be raised by teams, both in terms of positive and negative performance. In particular, the frequent discussion of environmental factors observed during CDs highlights the importance of the facilitator highlighting the wider applications and implications of learning during SBME activities [35, 36]. Future versions of the PEARLS framework modified for clinical environments could consider adding the additional domains mapped in our study [19].

In summary, the domains listed in Table 3 are all areas that could be discussed during CD to ensure improvements in performance and increased team reflexivity. The adoption of new educational strategies such as targeted SBME and a raised awareness of crisis resource management principles are associated with observed improvement in team performance [4, 35]. CD may have a future role in supporting existing ALS training by reinforcement of good habits, revision of prior learning and aiding translation of known best practices to a clinical setting [4–6, 36].

What were the practical implications of the facilitation methods described?

Although reported debriefing times in this study were relatively short, the use of a cognitive aid and a structured approach appeared to assist with facilitating brief yet high-yield debriefings [23]. There is currently a wide range of well-designed feedback tools and instructional aids that address 'how to debrief' in various contexts [37–39]. The approaches described in the literature include 'INFO', 'PEARLS', 'TALK' 'TEAMSTEPPS' and 'TeamGAINS' [14, 39–43]. There is, however, no universally applicable clinical debriefing method. All methods listed have pros and cons and should be applied wisely, with consideration given to local historical, clinical and cultural context.

In addition, there is a paucity of evidence on the optimal length of CD with systematic reviews reporting length of debriefings ranging from 2 to 30 min [44]. In this study, the CDs (mean length 10.93 min) appeared to foster learning in a typically time constrained Emergency Department environment. These findings are consistent with previous studies of a structured CD where numerous topics were addressed within a ten-minute timeframe [14, 22].

Despite the limitation of our study being conducted at a single centre, reports of similar programs being implemented successfully suggest that CD is feasible in busy clinical settings. Furthermore, despite the short reported CD lengths, all staff and students involved in debriefings were given the opportunity to ask questions or seek further follow-up as part of the "*points of action*" heading [23]. For example, the facilitator sharing links to the correct local protocols for similar future events may be all that is required in regards to closing the loop.

In the reported literature, although active team leaders commonly take charge of post-event debriefings, their busy role during the case may potentially bias or inhibit their ability to effectively faciliate [4, 34]. To mitigate this, it has been suggested that a less active member within the team or external provider facilitate discussions [4, 14]. This alternative approach could provide an opportunity for multiple members of the interdisciplinary team to both instigate and deliver CD [23]. Our study reveals that, while the majority of CDs were led by medical staff (Table 2), more than half of CDs were prompted by other members of the interdisciplinary team. We believe that this encouraging finding highlights the importance of interdisciplinary involvement, for the successful implementation and ongoing sustainability of a structured CD program [14].

What local changes were observed following implementation of the debriefing program?

The practicalities and ergonomics of the resuscitation environment have a significant impact on performance [43]. Further, standardised operating procedures (SOP) significantly influence how a team delivers emergency care [17]. This is relevant to CD because errors in the application of SOPs may be identified by experienced teams familiar with the work on the frontline. In this study we found a number of examples of errors in existing SOPs and potential latent safety threats (Table 5). We acted to resolve the various issues arising. Assuming that confidentiality is maintained, CD has the potential to provide useful quality assurance information and allow for pre-emptive actions to avoid adverse outcomes.

This is a topic that could be explored in more detail with studies that analyse how CD can be used as a quality reporting tool.

In this study, significant changes in practice resulted from points flagged during CD, including the redesign of the paediatric arrest trolley, the availability of end-tidal CO2 monitoring for transferring intubated patients, and blood to resuscitate the exsanguinating trauma patient. As the data collection of each debriefing was non-identifiable, groups of learners may have been more likely to feel confident that they could speak up safely in relation to which system factors should change [6].

In summary, clinical environments that are well designed and align with the needs of teams, facilitate optimal management of critically unwell patients [34, 45]. In this study, providers were asked by each debriefer whether they wanted to report system issues. These questions led to a series of pragmatic learning points which appeared to enhance team-based learning and, through reporting (Table 4), the wider patient safety needs of the institution [8].

Does clinical debriefing cause harm?

In regard to harm associated with CD, while equipoise remains around the negative effects of compulsory debriefing in lay people, healthcare staff in this study reported that their debriefing experience was anecdotally positive [12]. In this study all team members were given an 'opt out' if desired, and where applicable, opportunity to speak during the debriefing. The *'points of action'* section ended the debriefing and included the offer of further support if required [23]. Educators leading the program and clinical managers observed for adverse events associated with CD. However, we are not aware of any reported incidences of staff seeking further assistance from our faculty or in-house psychological support services as the result of a negative CD experiences [16, 46].

It is our view, based on the results of this study and the wider literature, that CD is likely to produce positive outcomes including an increase in team performance, but that implementation is a key consideration to ensure success [47]. While healthcare staff are likely to be relatively resilient in the face of challenging situations [44], the potential negative effects on both psychological safety, team culture and individuals (including burnout) require further study in a range of clinical environments [46, 48, 49]. Furthermore, we acknowledge that unintended negative consequences and staff dissatisfaction are a risk if CD programs are implemented poorly [16, 44].

Limitations

This study reports on indirect observation of debriefing practices at a single institution, so caution must be used in extrapolating the results. Various forms of bias may have compromised our results, notably the Hawthorne effect may have changed behaviour of our facilitators. Furthermore, we note there are limitations of using forms to report the subtleties of a typical debriefing conversation. Therefore, we acknowledge that some of our conclusions should be considered anecdotal. Finally, the local culture and the risk of harm, highlighted in other studies, should always be considered when conducting any form of debriefing. To this end, in keeping with contemporary studies of CD, while no harm was reported in this study, the long term consequences of clinical debriefing remain uncertain.

Conclusion

Facilitation of CD is an emerging skill for frontline clinical educators and the wider simulation educator community, who may be increasingly asked to use their skills in clinical settings. Results from this study suggest that many of the skills typically used in simulation debriefing overlap with those required for CD. Implementation of a CD program using a structured approach appears to be feasible when supported by faculty development and interdisciplinary engagement. In addition, CD has the potential to provide useful quality improvement insights from frontline healthcare workers.

Abbreviations

CDs: Clinical debriefings; S.T.O.P.: Summarise the case; Things that went well; Opportunities for improvement; Points of action; PEARLS: Promoting Excellence and Reflective Learning in Simulation; SBME: Simulation Based Medical Education; PTSD: Post-Traumatic Stress Disorder; HREC: Human Research Ethics Committee; ED: Emergency Department; I.N.F.O.: Immediate; Not for personal assessment; Fast facilitated feedback; Opportunity to ask questions; MTP: Massive Transfusion Protocol; LUCAS-3: Lund University Compression Assist Device; SOP: Standardised Operating Procedure

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Authors' contributions

AC and MM conceived the concept and audit/study. AC collated and entered data from audit forms to an electronic format. MM, AC and AS performed the analysis of results. RZ drafted the discussion. All authors contributed to, and have approved the final manuscript and manage the legacy of the project.

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Availability of data and materials

No additional data is available. Components of the presented debriefing dataset are available from the authors on request.

Ethics approval and consent to participate

The protocols for this study were examined and approved by the Western Sydney Local Health District (WSLHD) research and ethics committee (2018). Given the nature of the study (observational study of in-situ clinical debriefing), a formal waiver of individual consent and an approval of the study form were granted by both the ethics and governance committees.

Consent for publication
Not applicable.

Competing interests
None declared.

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