Published in final edited form as:

Pediatr Crit Care Med. 2016 January ; 17(1): 58–66. doi:10.1097/PCC.0000000000000539.

Transforming the Morbidity and Mortality Conference to Promote Safety and Quality in a Pediatric Intensive Care Unit

Christina L. Cifra, MD¹, Melania M. Bembea, MD, PhD², James C. Fackler, MD², and Marlene R. Miller, MD, MSc³

¹Department of Pediatrics, University of Iowa Carver College of Medicine

²Department of Anesthesiology and Critical Care Medicine, Johns Hopkins University School of Medicine

³Department of Pediatrics, Johns Hopkins University School of Medicine

Abstract

Objective—Determine the effectiveness of a structured systems-oriented morbidity and mortality conference (MMC) in improving the process of reviewing and responding to adverse events in a pediatric intensive care unit (PICU).

Design—Prospective time series analysis before and after implementation of a systems-oriented MMC.

Setting—Single tertiary referral PICU in Baltimore, Maryland.

Patients—33 patients discussed before and 31 after implementation of a systems-oriented MMC over a total of 20 MMCs, from April 2013 to March 2014.

Interventions—Systems-oriented MMC incorporating elements of medical incident analysis.

Measurements and Main Results—There was a significant increase in meeting attendance (mean of 12 vs. 31 attendees per MMC, $p<0.001$) after the systems-oriented MMC was instituted. There was no significant difference in the mean number of cases suggested (4.2 vs. 4.6) or discussed (3.3 vs. 3.1) per MMC. There was also no significant difference in the mean number of adverse events identified per MMC (3.4 vs. 4.3). However, there was an increase in the proportion of cases discussed using a standard case review tool but this did not reach statistical significance (27% vs. 45%, $p=0.231$). Nevertheless, we observed a significant increase in the mean number of quality improvement interventions suggested (2.4 vs. 5.6, $p<0.001$) and implemented (1.7 vs. 4.4, $p<0.001$) per MMC. All adverse event categories identified had corresponding interventions suggested after the systems-oriented MMC was instituted compared to before (80% vs. 100%). Intervention-to-adverse event ratios per category were also higher (mean of 0.6 vs. 1.5).

Conclusions—A structured systems-oriented PICU MMC incorporating elements of medical incident analysis improves the process of reviewing and responding to adverse events by

Corresponding Author: Christina L. Cifra, MD, University of Iowa, 200 Hawkins Drive, 2JCP, Iowa City, IA 52242, Phone: (319)-384-8659, christina-cifra@uiowa.edu.

Work was performed at the Johns Hopkins Hospital.

significantly increasing quality improvement interventions suggested and implemented. Future work would involve testing locally adapted versions of the systems-oriented MMC in multiple inpatient settings.

Keywords

medical errors; pediatric intensive care unit; patient care team; patient safety; quality improvement

INTRODUCTION

Preventable adverse events continue to be common in healthcare, causing substantial patient harm and even death (1–3). Children in particular remain vulnerable to medical errors with serious events occurring mostly in the complex environment of the pediatric intensive care unit (PICU) (4–6).

As part of the effort to ameliorate harm, several studies have explored the potential of the traditional morbidity and mortality conference (MMC) to become an important resource for care improvement (7–15). This is evident in the growing trend reflecting evolution of the conference into a forum not only for trainee education, but also for systems-based improvement (16–18). Among studies seeking to improve care by implementing a systems-oriented MMC, elements of medical incident analysis are commonly incorporated into the new MMC process. These elements include 1) eliciting input from all staff involved in an incident, 2) using a structured framework to investigate underlying contributing factors to adverse events, and 3) assigning responsibility for follow-up on improvements made (19, 20). While these studies showed that a systems-oriented MMC served to tangibly improve meeting attendance (8), volume of cases discussed (8, 12), adverse events identified (12, 13, 21), trainee awareness of the systems-based approach (11), and safety culture (10), only a few showed increased implementation of solutions to address adverse events (7, 12) or actual improved patient outcomes (22).

In the intensive care unit, studies on the use of MMCs to improve patient safety and quality are scarce (20–24); we found no prospective work that has been performed in the PICU. Indeed, our prior research shows that there is wide variation in the conduct of MMCs among PICUs in the United States, with no consistent presence of the elements of medical incident analysis (25). This identifies a missed opportunity to improve care, given that we have also shown that even before emphasizing systems, the PICU MMC can be an important complementary adverse event surveillance tool due to its ability to identify broad and pervasive problems affecting wider aspects of care compared to those identified by traditional surveillance (26).

In this project, we sought to promote patient safety in the PICU by implementing a standard, structured, systems-oriented MMC incorporating elements of medical incident analysis. We hypothesized that this new MMC process will improve our PICU's practice of reviewing and responding to patient adverse events.

MATERIALS AND METHODS

We conducted a prospective time series analysis of the effects of a structured systems-oriented MMC on our PICU's process of reviewing and responding to adverse events. To do so, we compared the proportions of cases discussed using a standard case review tool and proportions of quality improvement interventions implemented before and after institution of the systems-oriented MMC. This work was reviewed by the Johns Hopkins Institutional Review Board and acknowledged as a quality improvement project.

Environment and Context

The Johns Hopkins Children's Center PICU is a 36-bed mixed medical-surgical and cardiac unit, admitting ~1,700 patients per year between 0 to 21 years of age, and serves as a tertiary referral institution for local and international centers. It is staffed by 1 to 3 pediatric critical care physicians and 3 fellows for 24 hours each day divided into two 12-hour shifts. The multidisciplinary PICU staff (190 total) is primarily composed of nurses (77%), followed by physicians (16%).

In April 2012, the PICU moved to a new hospital building, greatly expanding its physical space and bed capacity, which required the addition of many new multidisciplinary staff. This led to unplanned changes in workflow and communication patterns leading to the perception of inefficient care and increased patient adverse events. As a response, the PICU Safety and Quality group was formed, composed of multidisciplinary frontline staff who leads all quality improvement activities in the PICU. Many other clinical areas in the institution have their own local safety groups with similar functions. It was also recognized that there was a need to more efficiently address patient adverse events, with the consensus of re-structuring the existing MMC for systems improvement. Aside from a handful of adverse events that are elevated to a hospital-level root cause analysis, the MMC is the only formal mechanism through which the PICU analyzes selected events and collectively brainstorms possible improvements.

Before this project, the PICU held twice-monthly MMCs where 3–5 cases were discussed in each one-hour session. All PICU staff plus relevant consulting services were invited to attend. Reminder emails were sent before each scheduled MMC. Cases were suggested for discussion by PICU clinicians, most of which were discussed at conference. Beyond mortalities, there were no set criteria for selecting cases. Most suggested cases involved a preventable medical error that led to or had the potential to lead to patient harm. Before the project, there was no set MMC structure aside from sporadic use of the Learning from Defects (27) adverse event review tool. There was no set process for implementing interventions, monitoring progress, and disseminating information discussed.

Conceptual Framework and the Systems-Oriented MMC

Conceptual Framework—A multidisciplinary group representative of all PICU staff developed a standard systems-oriented MMC structure and process. We aimed to align the new MMC with the overarching goals of systematic identification, reduction, and prevention of adverse events. Specifically, our goal was to leverage the MMC to improve our process of

reviewing and responding to adverse events. Because the MMC was intended to function mainly as a tool for quality improvement, we deferred traditional discussions of pathophysiology to a separate educational conference. For this project, an adverse event was defined as unintended injury that resulted in prolongation of hospital stay, temporary/permanent disability, or death, caused by healthcare management rather than disease. The new MMC process was based on existing models incorporating elements of medical incident analysis (7, 12, 28). Figure 1 shows our conceptual framework. Six weeks prior to implementation, multiple presentations were made to the PICU staff introducing and soliciting feedback on the new MMC format including the Learning from Defects tool.

MMC Preparation—We kept the existing conference schedule and continued to rely on case suggestions from PICU clinicians, employing no specific case selection criteria. Our PICU staff is a high-reporting group (as evidenced by our higher incident reporting rates compared to similar units in our hospital), and most cases suggested usually involve the occurrence of a preventable adverse event. The multidisciplinary MMC core group ensured adequate preparation prior to each MMC. They actively solicited cases for discussion and delineated the necessary preparation tasks for each case. A core group member assisted individual presenters (usually PICU fellows), re-orienting them to the systems-oriented MMC format and training them in the use of the structured tool. A short presentation was prepared per case, using the Learning from Defects tool as a guide (20, 27). Figure 2 illustrates a case that was analyzed and presented using this process. A few days before the MMC, invitation emails were sent to all PICU staff and relevant consulting services. This was not different from the prior practice as described.

MC Structure—Each meeting was moderated by the MMC core group leader (a PICU fellow). Another core group member recorded attendance and minutes for each MMC. We defined quality improvement interventions (i.e. “interventions”) to include any action intended to prevent future adverse events. An important component of the new process was the explicit requirement to provide updates on interventions being pursued from previous MMCs.

The components of the conference proper are:

1. Welcome and reminder of confidentiality and system-based nature of discussions
2. Updates provided on quality improvement interventions initiated from prior MMCs
3. Cases with adverse events discussed using the Learning from Defects tool with audience participation
4. Identification and prioritization of possible quality improvement interventions for each adverse event given the contributing factors identified
5. Identification of persons responsible for coordinating improvement efforts and for updating the larger group
6. Adjournment with reminder for next MMC date and time

MMC Dissemination and Follow-up—An email summary containing important points from each MMC discussion was sent out to all PICU staff after each conference.

Data Collection

Data were collected before and after implementation of the systems-oriented MMC. Ten consecutive MMCs were included before, and 10 consecutive MMCs were included after, over a period of 12 months (April 2013 to March 2014). We were unable to institute a washout period before implementation due to time and resource constraints. Data before implementation were collected retrospectively. Most MMC participants became aware of the project at most 6 weeks before implementation when planning and educational sessions were held.

Data on patient demographics and medical case types were collected. All adverse events identified were classified into error categories adapted from the Agency for Healthcare Research and Quality's common format (29). Quality improvement interventions were also classified into various domains. Implemented interventions included those that were started, ongoing, or completed by the end of the project period. Intervention-to-event ratios were reported as a measure of the magnitude of response for specific categories of adverse events, calculated by dividing the number of interventions suggested by the number of adverse events identified.

Statistical Analysis

Descriptive data analysis was performed with medians, interquartile ranges, and proportions with corresponding 95% confidence intervals. We compared patient characteristics using the K-sample equality-of-medians test and Fisher's exact test for proportions. We compared MMC characteristics using the Wilcoxon rank-sum test. A p value ≤ 0.05 was considered statistically significant. Statistical analysis was performed using STATA 13.0 (StataCorp, College Station, TX, 2013).

RESULTS

Over a 12-month period (April 2013 to March 2014) encompassing 20 MMCs, there were 33 patients discussed before and 31 after implementation of the systems-oriented MMC. No significant differences in patient demographics or medical case types were noted. There was an increase in the mean number of adverse events identified (3.4 vs. 4.3 per MMC), however this did not reach statistical significance ($p=0.307$). Communication-related errors (31%) and medication errors (16%) were common adverse events overall, however more communication-related errors (27% vs. 35%) while less medication errors (24% vs. 9%) were identified after the systems-oriented MMC was implemented (Table 1).

We observed a significant rise in meeting attendance from a mean of 12 (range 8–17) to 31 (24–39) attendees per MMC ($p<0.001$). Attendance nearly doubled from the time the systems-oriented MMC was implemented and was consistently high until the end of data collection. The diversity of staff attending the MMC also increased. Pre-implementation, more than 90% of attendees were physicians; post-implementation, 51% were physicians,

15% were nurses, and the remaining 34% were comprised of relatively even numbers of pharmacists, respiratory therapists, nurse practitioners, social workers, etc.

There was no significant difference in the mean number of cases suggested and discussed per MMC. However, there was an increase in the proportion of cases discussed using the standard review tool (29% vs. 45% or 0.9 vs. 1.4 per MMC), but this did not reach statistical significance ($p=0.231$). Nevertheless, there was a significant increase in the mean number of quality improvement interventions suggested (2.4 vs. 5.6, $p<0.001$) and implemented (1.7 vs. 4.4, $p<0.001$) per MMC, and also a significant increase in the mean ratio of interventions suggested (0.7 vs. 1.7, $p<0.001$) and implemented (0.5 vs. 1.4, $p<0.001$) per case discussed. After the systems-oriented MMC was instituted, 64% of suggested interventions were from cases discussed using the structured tool. Note however that although the absolute number of interventions implemented increased, the same proportion of interventions were implemented among those suggested (72% vs. 79%) before and after institution of the systems-oriented MMC (Table 2).

All adverse event categories identified had corresponding quality improvement interventions suggested after the systems-oriented MMC was instituted, compared to before (80% vs. 100%). Overall intervention-to-event ratios per category were also higher (mean of 0.6 vs. 1.5) after the systems-oriented MMC was instituted. Medication errors, vascular catheter-related complications and unplanned extubations were the adverse event categories with the greatest increases in intervention-to-event ratios (Table 3).

The majority of suggested quality improvement interventions involved changing communication patterns (32%) and workflow for various care processes (36%). These were also the same categories with a substantial proportion of interventions not started or still ongoing at project's end (22% for communication and 40% for workflow). This was especially evident when change involved other consulting services outside of the PICU or if more than 2 groups were involved. In contrast, most of the interventions suggested involving education, equipment improvement, and changes to health information technology have already been completed at the conclusion of the project (Table 4).

DISCUSSION

This project showed that in our PICU, a structured systems-oriented MMC incorporating elements of medical incident analysis improved the process of reviewing and responding to adverse events. This was illustrated by the significant increase in the absolute number of quality improvement interventions suggested and implemented. We found only two prior studies that quantitatively reported the proportions of interventions implemented due to a systems-oriented MMC, however both did not have baseline data for comparison (7, 12).

Note that there was little change in the proportion of interventions implemented before and after institution of the systems-oriented MMC (79% vs. 72%). This suggests that our PICU was fairly efficient in implementation, which did not change with this initiative. It appears that the main driver increasing interventions implemented was the increase in interventions suggested at the MMC (i.e. we did not get better at implementation - we just had more

ideas). We attribute this mainly to the use of a standard review tool for identification of improvement targets. This finding echoes those of other studies that advocate the use of a structured tool (7, 14, 20). We could have further increased the volume of interventions implemented had we been able to apply the tool better. Although an improvement from before, our inability to consistently use the tool reflects limitations in preparation time and our continued inclusion of all mortalities, most with no identified adverse events (the tool is most useful for cases with clear identified errors) (27).

Aside from the tool, the increase in interventions suggested may have also been due to the significant increase in MMC attendance and attendee diversity, leading to a wider array of perspectives. Early attendance increases may have been due to initial encouragement from the project's planning phase, however attendance remained consistently high throughout the post-implementation period even though we did not vary the MMC schedule or our methods of inviting participants. This is consistent with prior studies, where high attendance rates were seen as a marker of participant engagement (7, 8, 18). The systems-oriented MMC, by increasing engagement and attendance, thus can indirectly increase suggested interventions. A longer period of observation is needed to determine if this will continue to be sustained.

There was no increase in cases suggested and discussed before and after institution of the systems-oriented MMC. This was not surprising since we did not specifically target case discovery and selection given our PICU staff's history of good reporting. However, prior work has demonstrated the utility of having defined criteria for selecting cases (7, 14, 21), and it has been shown that error reporting by staff is dependent on safety climate (31). Therefore, our strategy for case selection may not work well in units with less developed safety culture.

Majority of adverse events identified included communication (31%) and medication errors (16%), which was not surprising, as these are generally among the most common error categories reported in the MMC (7, 26). Post-implementation, more communication errors (27% vs. 35%) and fewer medication errors (24% vs. 9%) were identified. This may be partly explained by the staff's growing recognition of the MMC's utility in discussing complex events such as those involving communication mishaps. Since there are other avenues available to report straightforward medication errors, staff may have been less eager to use scarce MMC discussion time for such.

After institution of the systems-oriented MMC, majority of the suggested interventions involved changing communication patterns (32%) and workflow for various care processes (36%). This is likely because of the high prevalence of errors in these domains with many system factors that contribute to such. At project's end, 59% of all suggested interventions have been completed and 20% were ongoing. The more straightforward interventions such as those involving education, equipment improvement, and changes to health information technology were the easiest to implement as these required little group consensus. This is consistent with a prior study where the same types of interventions were more easily completed (12). On the other hand, any substantial change to communication or workflow was more difficult to implement given that agreement from staff fulfilling various roles were required.

Although we focused on implementing a systems-oriented MMC in the PICU, such an MMC should be feasible to implement in other inpatient settings, as long as several important factors are fulfilled. Preparation for each MMC is key, so that the facts of each case can be clarified beforehand, maximizing limited conference time better spent on identifying and prioritizing interventions. Dissemination of key MMC discussion points and provision of regular updates to staff are important elements that encourage participation and engagement. The structure of the actual conference is less important than ensuring that the MMC process includes the necessary elements of medical incident analysis, foremost of which is the use of a standard review tool. It likely does not matter which tool is used (9, 28) as long as it is used correctly and consistently. The specifics of structure, process and function of the MMC need to be adapted to each particular setting's resources and goals (30). A robust safety culture and pre-existing quality improvement group are desirable to have beforehand, however the absence of such does not preclude successful implementation. The systems-oriented MMC in itself can serve as a starting point to improve safety culture and establish a unit-based quality and safety team.

We do emphasize that implementing a systems-oriented MMC entails a substantial investment in time and effort, and should be strongly supported by unit leadership. The most significant challenge we had was the need for intensive preparation and follow-up requiring many person-hours of work. We addressed this by requesting protected time for preparation, coupling project work with graduate schoolwork for some, and sharing the work among many. We also had the benefit of a research assistant, although this was the only additional resource we had. Another significant challenge was the need to consistently identify change champions who will lead improvement projects. To fulfill this, we consistently brought MMC suggestions to the PICU Safety and Quality group meetings where improvement projects were planned, and inevitably champions for specific projects step up. Challenges such as these will need to be addressed proactively if the project is to be sustainable long-term. Although difficult to assess with certainty, any group undertaking such a project must evaluate if the desired outcomes are worth the effort. For our group, we do believe that our efforts given our results have been worthwhile.

Our work has several limitations. This is a single center quality improvement project with a time series design and no separate control group. The sample size of MMCs was small, there was no washout period, and participants were already aware of the project at most 6 weeks prior to implementation. All of these may partly explain our limited ability to detect some differences before and after implementation. There were no set criteria for case selection; we relied mostly on clinician reporting which may have been susceptible to recall and outcome bias. The structured review tool was not locally tested for its ability to identify contributing factors to adverse events, however prior work in our institution has demonstrated that its benefits may be worth the effort required to use it (20). We were also unable to apply the structured review tool to all cases discussed due to time and resource constraints, plus the continued inclusion of all mortalities, most of which had no adverse events. We may not have captured all quality improvement interventions completed given the finite project period. Although numerous interventions were implemented that could have conceivably improved patient outcomes, measurement of direct patient impact was beyond the scope of

the study. Thus, we have no data regarding impact of interventions on adverse events. Long-term follow-up is pending to determine sustainability.

Despite these limitations, our findings have important implications for promoting quality and safety in the PICU. We know of only few studies quantifying the effectiveness of the MMC in increasing the implementation of quality improvement interventions (7, 12), and most only reported qualitative examples.

CONCLUSIONS

A structured systems-oriented PICU MMC incorporating elements of medical incident analysis improves the process of reviewing and responding to adverse events, significantly increasing quality improvement interventions suggested and implemented. This process requires substantial investment in time and effort by a dedicated MMC team with strong leadership support to be successful. Future work would involve implementing and testing locally adapted versions of the systems-oriented MMC in multiple inpatient settings.

Acknowledgments

Funding: Funding for this project was received from the American Academy of Pediatrics Section on Critical Care Small Grants Program.

Partial support for statistical analysis (through the Johns Hopkins Institute for Clinical and Translational Research) was received from the National Center for Research Resources and the National Center for Advancing Translational Sciences of the National Institutes of Health through Grant Number 1UL1TR001079.

We are grateful for funding received from the American Academy of Pediatrics Section on Critical Care Small Grants Program. We thank Sarah Jabour from the Johns Hopkins School of Public Health for her assistance in data collection. We also thank Carol Thompson, MS from the Johns Hopkins School of Public Health Biostatistics Center and Erik Westlund, MSc from the Johns Hopkins Department of Sociology for their contributions to statistical analysis. Ms. Thompson's assistance was supported by the National Center for Research Resources and the National Center for Advancing Translational Sciences (NCATS) of the National Institutes of Health through Grant Number 1UL1TR001079. Most of all, we are grateful for and continually inspired by the tireless efforts of the Johns Hopkins PICU staff in providing the best care they can to our patients and their families.

References

1. Kohn, Linda T.; Corrigan, Janet M.; Donaldson, Molla S., editors. Committee on Quality of Health Care in America, Institute of Medicine: To Err Is Human: Building a Safer Health System. Washington, D.C: The National Academies Press; 2000.
2. Landrigan CP, Parry GJ, Bones CB, et al. Temporal trends in rates of patient harm resulting from medical care. *N Engl J Med*. 2010; 363:2124–2134. [PubMed: 21105794]
3. Classen DC, Resar R, Griffin F, et al. “Global trigger tool” shows that adverse events in hospitals may be ten times greater than previously measured. *Health Aff Proj Hope*. 2011; 30:581–589.
4. Matlow AG, Baker GR, Flintoft V, et al. Adverse events among children in Canadian hospitals: the Canadian Paediatric Adverse Events Study. *CMAJ*. 2012; 184:E709–718. [PubMed: 22847964]
5. Larsen GY, Donaldson AE, Parker HB, et al. Preventable harm occurring to critically ill children. *Pediatr Crit Care Med*. 2007; 8:331–336. [PubMed: 17417126]
6. Agarwal S, Classen D, Larsen G, et al. Prevalence of adverse events in pediatric intensive care units in the United States. *Pediatr Crit Care Med*. 2010; 11:568–578. [PubMed: 20308932]
7. Deis, JN.; Smith, KM.; Warren, MD., et al. Transforming the Morbidity and Mortality Conference into an Instrument for Systemwide Improvement. In: Henriksen, K.; Battles, JB.; Keyes, MA., et al., editors. *Advances in Patient Safety: New Directions and Alternative Approaches (Vol. 2: Culture and Redesign)*. Rockville (MD): Agency for Healthcare Research and Quality (US); 2008.

8. McDonnell C, Laxer RM, Roy WL. Redesigning a morbidity and mortality program in a university-affiliated pediatric anesthesia department. *Jt Comm J Qual Patient Saf.* 2010; 36:117–125. [PubMed: 20235413]
9. Szostek JH, Wieland ML, Loertscher LL, et al. A systems approach to morbidity and mortality conference. *Am J Med.* 2010; 123:663–668. [PubMed: 20609691]
10. Szekendi MK, Barnard C, Creamer J, et al. Using patient safety morbidity and mortality conferences to promote transparency and a culture of safety. *Jt Comm J Qual Patient Saf.* 2010; 36:3–9. [PubMed: 20112658]
11. Rabizadeh S, Gower WA, Payton K, et al. Restructuring the morbidity and mortality conference in a Department of Pediatrics to serve as a vehicle for system changes. *Clin Pediatr.* 2012; 51:1079–1086.
12. Bechtold ML, Scott S, Nelson K, et al. Educational quality improvement report: outcomes from a revised morbidity and mortality format that emphasised patient safety. *Qual Saf Health Care.* 2007; 16:422–427. [PubMed: 18055885]
13. Gonzalo JD, Bump GM, Huang GC, et al. Implementation and evaluation of a multidisciplinary systems-focused internal medicine morbidity and mortality conference. *J Grad Med Educ.* 2014; 6:139–146. [PubMed: 24701325]
14. Gerstein WH, Ledford J, Cooper J, et al. Interdisciplinary quality improvement conference: Using a revised morbidity and mortality format to focus on systems-based patient safety issues in a VA hospital: Design and outcomes. *Am J Med Qual Off J Am Coll Med Qual.* 2014 (Epub ahead of print).
15. Batthish M, Tse SML, Feldman BM, et al. Trying to improve care: the morbidity and mortality conference in a division of rheumatology. *J Rheumatol.* 2014; 41:2452–2458. [PubMed: 25362651]
16. Sellier E, David-Tchouda S, Bal G, et al. Morbidity and mortality conferences: their place in quality assessments. *Int J Health Care Qual Assur.* 2012; 25:189–196. [PubMed: 22755474]
17. Orlander JD, Barber TW, Fincke BG. The morbidity and mortality conference: the delicate nature of learning from error. *Acad Med.* 2002; 77:1001–1006. [PubMed: 12377674]
18. Gonzalo JD, Yang JJ, Huang GC. Systems-based content in medical morbidity and mortality conferences: A decade of change. *J Grad Med Educ.* 2012; 4:438–444. [PubMed: 24294419]
19. Aboumatar HJ, Blackledge CG Jr, Dickson C, et al. A descriptive study of morbidity and mortality conferences and their conformity to medical incident analysis models: results of the morbidity and mortality conference improvement study, phase 1. *Am J Med Qual.* 2007; 22:232–238. [PubMed: 17656727]
20. Berenholtz SM, Hartsell TL, Pronovost PJ. Learning from defects to enhance morbidity and mortality conferences. *Am J Med Qual.* 2009; 24:192–195. [PubMed: 19258468]
21. Ksouri H, Balanant P-Y, Tadié J-M, et al. Impact of morbidity and mortality conferences on analysis of mortality and critical events in intensive care practice. *Am J Crit Care.* 2010; 19:135–145. [PubMed: 20194610]
22. Kirschenbaum L, Kurtz S, Astiz M. Improved clinical outcomes combining house staff self-assessment with an audit-based quality improvement program. *J Gen Intern Med.* 2010; 25:1078–1082. [PubMed: 20556534]
23. Fassier T, Favre H, Piriou V. How to assess the impact of morbidity and mortality conferences on healthcare quality and safety in ICU ? *Ann Fr Anesthésie Réanimation.* 2012; 31:609–616.
24. Pagano LA, Lookinland S. Nursing morbidity and mortality conferences: promoting clinical excellence. *Am J Crit Care.* 2006; 15:78–85. [PubMed: 16391317]
25. Cifra CL, Bembea MM, Fackler JC, et al. The morbidity and mortality conference in PICUs in the United States: a national survey*. *Crit Care Med.* 2014; 42:2252–2257. [PubMed: 25014066]
26. Cifra CL, Jones KL, Ascenzi J, et al. The morbidity and mortality conference as an adverse event surveillance tool in a paediatric intensive care unit. *BMJ Qual Saf.* 2014; 23:930–938.
27. Pronovost PJ, Holzmüller CG, Martinez E, et al. A practical tool to learn from defects in patient care. *Jt Comm J Qual Patient Saf.* 2006; 32:102–108. [PubMed: 16568924]

28. Deshpande JK, Throop PG, Slayton JM. Standardization of case reviews (morbidity and mortality rounds) promotes patient safety. *Pediatr Clin North Am*. 2012; 59:1307–1315. [PubMed: 23116527]
29. AHRQ. [Accessed February 8, 2015] AHRQ Common Formats [Internet]. Available at: <http://www.pso.ahrq.gov/formats/commonfmt.htm>
30. Snijders C, Kollen BJ, van Lingen RA, et al. Which aspects of safety culture predict incident reporting behavior in neonatal intensive care units? A multilevel analysis. *Crit Care Med*. 2009; 37:61–67. [PubMed: 19050606]
31. Argent AC. Safety and quality as a “way of life” in the PICU: where does the morbidity and mortality conference fit in? *Crit Care Med*. 2014; 42:2306–2308. [PubMed: 25226129]

Figure 1. Morbidity and Mortality Conference Conceptual Framework

A structured systems-oriented process of reviewing and responding to adverse events incorporating elements of medical incident analysis can potentially improve patient outcomes by 1) eliciting input from all staff involved in an incident, 2) using a structured framework to investigate underlying contributing factors to adverse events, and 3) prioritizing and assigning responsibility for implementation and follow-up on improvements planned and made. PICU, pediatric intensive care unit

Figure 2. Morbidity and Mortality Conference Case Example

This illustrates a case with an adverse event analyzed through a standard case review tool, Learning from Defects.

Table 1

Characteristics of Cases Discussed at the Morbidity and Mortality Conference

Characteristic % (95% Confidence Interval)	Before Systems-Oriented MMC 10 MMCs	After Systems-Oriented MMC 10 MMCs	<i>p</i> value ^a
Patient Characteristics	n = 33 % (95% CI)	n = 31 % (95% CI)	
Age, years, median (IQR)	4 (0.75–11)	1 (0.42–11)	0.617
Male	58 (40–74)	61 (42–77)	0.803
Medical type			0.288
Medical	48 (31–66)	61 (42–77)	
Surgical	27 (14–46)	29 (15–48)	
Trauma	24 (12–43)	10 (3–27)	
Adverse Events Identified	n = 34 n (%)	n = 43 n (%)	
Blood product-related events	0	1 (2.3)	NA
Device-related events			
Unplanned extubations	2 (5.9)	4 (9.3)	
Vascular catheter complications ^b	2 (5.9)	1 (2.3)	
Mechanical ventilator-related complications	1 (2.9)	0	
ECMO-related events	0	1 (2.3)	
Health information technology-related events	2 (5.9)	0	
Other device-related events	0	3 (7)	
Hospital-acquired infections	0	1 (2.3)	
Medication-related errors	8 (23.5)	4 (9.3)	
Complications of surgery/anesthesia	1 (2.9)	2 (4.7)	
Sedation and pain control events	0	2 (4.7)	
Diagnostic errors	1 (2.9)	3 (7)	
Communication-related errors	9 (26.5)	15 (34.9)	
Workflow/process-related errors	2 (5.9)	0	
Other	6 (17.7)	6 (14)	

MMC, morbidity and mortality conference; CI, confidence interval; IQR, inter-quartile range; ECMO, extracorporeal membrane oxygenation

^a Medians were compared using the K-sample equality-of-medians test and proportions were compared using Fisher's exact test. NA - statistical tests to compare groups not applied due to small numbers.^b Does not include catheter-related infections.

Table 2
Morbidity and Mortality Conference Attendance, Cases, and Quality Improvement Interventions Before and After Implementation of the Systems-Oriented Conference

MMC Characteristics	Before Systems-Oriented MMC 10 MMCs	After Systems-Oriented MMC 10 MMCs	p value ^a
Meeting attendance, mean (SD)	12 (3.4)	31 (5.1)	<0.001
Cases			
Total cases suggested for discussion	42	46	
Cases suggested per meeting, mean (SD)	4.2 (1)	4.6 (1)	0.444
Total cases discussed, n (%)	33/42 (78.6)	31/46 (67.3)	
Cases discussed per meeting, mean (SD)	3.3 (0.8)	3.1 (0.6)	0.624
Cases discussed using a standard review tool, n (%)	9/33 (27.3)	14/31 (45.2)	
Cases discussed using a standard review tool per meeting, mean (SD)	0.9 (0.9)	1.4 (0.8)	0.231
Adverse events^b			
Total adverse events identified	34	43	
Adverse events identified per meeting, mean (SD)	3.4 (1.1)	4.3 (2)	0.307
Quality Improvement Interventions^c			
Total interventions suggested	24	56	
Interventions suggested per meeting, mean (SD)	2.4 (1)	5.6 (2)	<0.001
Interventions suggested per case discussed, mean (SD)	0.7 (0.2)	1.7 (0.7)	<0.001
Interventions implemented ^d , n (%)	17/24 (71.8)	44/56 (78.6)	
Interventions implemented per meeting, mean (SD)	1.7 (1.2)	4.4 (1.7)	<0.001
Interventions implemented per case discussed, mean (SD)	0.5 (0.3)	1.4 (0.6)	<0.001

MMC, morbidity and mortality conference; SD, standard deviation

^a Groups were compared using the Wilcoxon rank-sum test.

^b An adverse event is an unintended injury that resulted in prolongation of hospital stay, temporary/permanent disability, or death, caused by healthcare management rather than the patient's disease.

^c Quality improvement interventions (i.e. "interventions") include any action intended to prevent future adverse events. This can include changes in education, the physical environment, health information technology, communication, or workflow.

^d Interventions implemented include those that were started, ongoing or completed at the end of the project period.

Table 3
Adverse Events Identified and Quality Improvement Interventions Suggested After Implementation of the Systems-Oriented Morbidity and Mortality Conference

Adverse Event ^a Category	Before Systems-Oriented MMC				After Systems-Oriented MMC			
	Adverse Event ^a Identified n = 34 n (%)	Interventions ^b Suggested n = 24 n (%)	Intervention-to- Event Ratio ^c	Adverse Event ^a Identified n = 43 n (%)	Interventions ^b Suggested n = 56 n (%)	Intervention-to- Event Ratio ^c		
Blood product-related events	0	-	-	1 (2.3)	2 (3.6)	2		
Device-related events								
Unplanned extubations	2 (5.9)	1 (4.2)	0.5	4 (9.3)	6 (10.7)	1.5		
Vascular catheter complications ^d	2 (5.9)	0	0	1 (2.3)	1 (1.8)	1		
Mechanical ventilator-related complications	1 (2.9)	0	0	0	-	-		
ECMO-related events	0	-	-	1 (2.3)	2 (3.6)	2		
Health information technology-related events	2 (5.9)	2 (8.3)	1	0	-	-		
Other device-related events	0	-	-	3 (7)	5 (8.9)	1.7		
Hospital-acquired infections	0	-	-	1 (2.3)	1 (1.8)	1		
Medication-related errors	8 (23.5)	7 (29.2)	0.9	4 (9.3)	8 (14.3)	2		
Complications of surgery/anesthesia	1 (2.9)	1 (4.2)	1	2 (4.7)	2 (3.6)	1		
Sedation and pain control events	0	-	-	2 (4.7)	4 (7.1)	2		
Diagnostic errors	1 (2.9)	1 (4.2)	1	3 (7)	5 (8.9)	1.7		
Communication-related errors	9 (26.5)	9 (37.4)	1	15 (34.9)	17 (30.4)	1.1		
Workflow/process-related errors	2 (5.9)	1 (4.2)	0.5	0	-	-		
Other	6 (17.7)	2 (8.3)	0.3	6 (14)	3 (5.4)	0.5		

MMC, morbidity and mortality conference; ECMO, extracorporeal membrane oxygenation

^a An adverse event is an unintended injury that resulted in prolongation of hospital stay, temporary/permanent disability, or death, caused by healthcare management rather than the patient's disease.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

^b Quality improvement interventions (i.e., "interventions") include any action intended to prevent future adverse events. This can include changes in education, the physical environment, health information technology, communication, or workflow.

^c Intervention-to-event ratios were calculated by dividing the number of interventions suggested by the number of adverse events identified.

^d Does not include catheter-related infections.

Table 4

Quality Improvement Interventions After Implementation of the Systems-Oriented Morbidity and Mortality Conference

Quality Improvement Intervention ^a Category	Interventions Suggested n = 56 n (%)	Interventions Ongoing n = 11 n (%)	Interventions Completed n = 33 n (%)
Education / Training	11 (19.6)	0	11 (33.3)
Equipment Improvement			
New supplies or equipment to order	2 (3.6)	0	2 (6.1)
Repair, revise or remove existing supplies or equipment	2 (3.6)	0	2 (6.1)
Changes related to health information technology	3 (5.4)	1 (9.1)	2 (6.1)
Changes in communication patterns or standards			
Communication within the PICU	9 (16.1)	1 (9.1)	7 (21.2)
Communication between the PICU and other services	9 (16.1)	2 (18.2)	4 (12.1)
Changes in guidelines and workflow for care processes			
Activities involving 2 groups	8 (14.3)	2 (18.2)	4 (12.1)
Activities involving 3 groups	12 (21.4)	5 (45.4)	1 (3)

PICU, pediatric intensive care unit

^aQuality improvement interventions (i.e. “interventions”) include any action intended to prevent future adverse events.