Morbidity and mortality conferences in general surgery: a narrative systematic review

Nicholas Slater, BSc
Perneet Sekhon, BSc
Nori Bradley, MD MSc(Kin) MSc(HSQ)
Farhana Shariff, MDCM, MSc(HPE)
Julie Bedford, RN, MSN
Heather Wong, RN, MHS
Chieh Jack Chiu, MD
Emilie Joos, MD
Chad G. Ball, MD, MSc
Morad Hameed, MD, MPH

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Correspondence to:
S.M. Hameed
Trauma Services
Vancouver General Hospital
855 West 12 Ave
Vancouver BC V5Z 1M9
morad.hameed@vch.ca

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Background: In medical and surgical departments around the world, morbidity and mortality conferences (MMC) serve dual roles: they are cornerstones of quality-improvement programs and provide timely opportunities for education within the urgent context of clinical care. Despite the widespread adoption of MMCs, adverse events and preventable errors remain high or incompletely characterized, and opportunities to learn from and adjust to these events are frequently lost. This review examines the published literature on strategies to improve surgical MMCs.

Methods: We searched OVID Medline, PubMed, Embase and CENTRAL. We defined our combination of search terms using a PICO (population, intervention, comparison, outcome) model, focusing on the use of MMCs in general surgery.

Results: The MMC literature focused on 5 themes: educational value, error analysis, case selection and representation, attendance and dissemination. Strategies used to increase educational value included limiting case presentation time to 15–20 minutes, mandatory brief literature reviews, increasing audience interaction, and standardizing presentations using a PowerPoint template or SBAR (situation, background, assessment, recommendation) format. Interventions to improve error analysis included focused discussion on causative factors and taxonomic error analysis. Case selection was improved by using an electronic clinical registry, such as the National Surgery Quality Improvement Program, to better capture incidence of morbidity and mortality. Attendance was improved with teleconferencing. Dissemination strategies included MMC newsletters, incorporating MMCs into plan-do-check-act cycles, and surgeon report cards.

Conclusion: Greater standardization of best practices may increase the quality improvement and educational impact of MMCs and provide a baseline to measure the effect of new MMC format innovations on the clinical and educational performance of surgical systems.

Contexte : Dans les services de médecine et de chirurgie du monde entier, les conférences sur la morbidité et la mortalité (CMM) jouent 2 rôles : elles forment la pierre angulaire des programmes d'amélioration de la qualité de soins et fournissent l'occasion de faire de l'enseignement dans le contexte même des soins cliniques immédiats. Malgré la popularité grandissante des CMM, le nombre d'événements indésirables et d'erreurs évitables demeure élevé ou mal caractérisé et on perd beaucoup d'occasions d'apprendre de ces événements et d'apporter les changements qui s'imposent. La présente revue analyse la littérature publiée sur les stratégies d'amélioration des CMM en chirurgie.

Méthodes : Nous avons interrogé OVID Medline, PubMed, Embase et CENTRAL. Nous avons défini nos combinaisons de mots clés à l'aide du modèle PICO (population, intervention, comparaison et résultat [outcome]), en mettant l'accent sur l'utilisation des CMM en chirurgie générale.

Résultats : La littérature sur les CMM se concentrait sur 5 thèmes : valeur didactique, analyse des erreurs, sélection et représentation des cas, participation et dissémination. Les stratégies utilisées pour accroître la valeur didactique incluaient limiter la durée des présentations de cas à 15–20 minutes, présenter de brèves revues de la littérature, favoriser les interactions avec l'auditoire et standardiser les présentations au moyen de modèles PowerPoint ou SBAR (situation, background, assessment, recommendation). Les interventions visant à améliorer l'analyse des erreurs incluaient une discussion sur les facteurs causaux et l'analyse des erreurs taxonomiques. La sélection des cas a été améliorée au moyen d'un registre clinique électronique comme le National Surgery Quality Improvement Program, pour mieux suivre l'incidence de la morbidité et de la mortalité. Les systèmes de téléconférences ont amélioré la participation. Parmi les stratégies de dissémination, mentionnons les bulletins sur les CMM, leur intégration aux cycles planifier/faire/vérifier/agir et les relevés de notes des chirurgiens.

Conclusion : Une meilleure standardisation des pratiques optimales pourrait améliorer davantage la qualité des soins et augmenter l'impact didactique des CMM en plus d'offrir une base de référence pour mesurer l'effet des nouvelles mesures appliquées aux CMM sur le rendement clinique et didactique des systèmes chirurgicaux.

Since the early 1900s, morbidity and mortality conferences (MMCs) have been a refuge for thoughtful reflection and deliberation and a cornerstone of quality improvement efforts.[1–3] Often referred to as the "golden hour" of residency training, MMCs have also played a crucial role in surgical education. With the increasing prominence of safety in medical and surgical culture, it is useful to see quality and education as being inextricably linked; this recognition gives the reassessment, and perhaps reimagination of MMCs, with their long-standing emphasis on both quality and education, unprecedented relevance and urgency.[4]

In general surgery and its subspecialties, adverse events occur in 14% and 30% of scheduled and emergency operations, respectively, thus establishing that high-functioning MMCs may be of particular importance.[5–7] Currently, the format and conduct of surgical MMCs are heterogeneous, and a lack of evidence and consensus limits their generalizability and, perhaps, their effectiveness.[8–10] In a recent systematic review, Xiong and colleagues[8] aimed to describe the current content and process of MMC programs in both medicine and surgery across multiple institutions. Their report summarized the most common features of surgical MMCs: 60% occur weekly, 28% last 1 hour, 60% have residents as presenters, 56% have a faculty member moderator, and most are attended by multidisciplinary health care professionals. Surprisingly, inclusion of a scientific review to contextualize adverse events or support MMC-driven quality improvement was reported as a requirement in only 40% of included studies. Although many studies failed to describe vital components of their MMC process, considerable variability in the structure and content of surgical MMCs was evident.

Several studies suggest that MMCs are not meeting their goals in quality improvement and education.[1,2,8,11–14] The vast majority of MMCs lack the fundamental principles necessary to identify the root cause of adverse events and implement systematic preventative change.[8,9,15,16] Bal and colleagues[16] identified shortcomings in explaining causation of adverse events in 91% of MMC cases, with less than 10% employing a structured method of error analysis. Furthermore, morbidity is notoriously underreported in the current format of MMCs. More concerning, MMCs have also been found to underreport mortality.[17,18] Case selection is often nonstandardized, chosen based on interest rather than merit or educational value, and is subject to recall bias.[17,19–21] Finally, presentation style may detract from educational value, as the usual didactic approach of an MMC results in passive learning, despite trends in medical education moving toward more active forms of learning.[22]

We conducted a narrative systematic literature review to identify studies investigating surgical MMC format changes. Currently, several papers present theoretical models for systematic improvement of MMCs, but few actually investigated interventions.[14,15,23] The Ottawa MMC model represents one vetted protocol for systematic change and standardization in MMCs, but it is not specific for surgery.[24–26] Giesbrecht and Au[27] and Benassi and colleagues[28] previously conducted systematic reviews investigating strategies used in medicine and surgery to improve the quality of MMCs. Our goal was to build upon their work by identifying MMC interventions aimed at improving both the quality improvement and educational components of MMCs, particularly for general surgery, where a high degree of acuity and complexity can be associated with a high incidence of preventable adverse events.[7]

Methods

We searched OVID Medline, PubMed, Embase and CENTRAL, and we supplemented our search by reference harvesting from the bibliographies of included studies. We defined our combination of search terms using a PICO (population, intervention, comparison, outcome) model. Population was limited to general surgery and subspecialties with emphasis on emergency general surgery; intervention included all format changes to an existing MMC model; comparison was the prior MMC format of each study; and outcomes included any demonstrated improvement in MMC, such as perceived increase in presentation quality, practice change, or enhanced educational value. We used the following search terms and medical subject headings (MeSH): "morbidity and mortality conference" or "morbidity and mortality rounds" or "morbidity and mortality meeting" and "acute*" or "ACS" or "trauma" or "emergency" or "general surgery" or "surg*." Expanded search terms pertaining to emergency general surgery were included because of the relatively high incidence of adverse events. No limit in the range of publication date was applied.

After applying our search terms to the 4 identified search engines, we removed all duplicates, and 2 independent reviewers (N.S. and P.S.) screened the remaining papers based on title and abstract. Microsoft Excel and manual editing were used to manage papers and remove duplicates. Papers were removed as "clear misses" if they did not apply an intervention to their MMC, did not pertain to general surgery, were not available in English, or were review articles. Next, 2 reviewers (N.S. and P.S.) performed an in-depth investigation of the full text of all remaining papers using predetermined inclusion and exclusion criteria (Box 1). Disagreements were resolved by discussion. Finally, the research design of each study and their limitations were appraised. Narrative data were then extracted from each paper in a standardized method, including details regarding study design, setting, summary, MMC intervention and outcomes. The reviewers collectively analyzed the extracted data for recurrent themes, common interventions and similar outcomes.

Results

Our search captured 279 papers, which included 117 duplicates. Of the remaining 162 papers, 130 were removed as "clear misses," leaving 32 papers chosen for full review. Only 18 of those papers met the predetermined inclusion and exclusion criteria. An additional 3 papers were identified and included through reference harvesting, resulting in 21 papers included for narrative analysis. These results are summarized in Figure 1.

The results of our narrative analysis are included in Table 1. Most of these papers used a single surgical department as their population and were prospective studies. The most frequently used assessment method was self-reported questionnaires, often using a Likert scale. Several studies used a pre- and postintervention questionnaire; unfortunately, some were lacking a preintervention comparison. Narrative analysis of intervention strategies revealed 5 major MMC improvement themes targeted by each intervention strategy: educational value, error analysis, case selection and representation, attendance and dissemination strategies. These results are summarized in Table 2.

Box 1. Inclusion and exclusion criteria applied in a systematic review of interventions to improve surgical morbidity and mortality conferences

Inclusion criteria

- Stated inclusion of a general surgery service including all subspecialties
- Analysis of morbidity and mortality rounds that tested an intervention and included outcomes indicative of quality, such as
  - Enhanced case selection
  - Increased participant engagement or satisfaction
  - Increased effectiveness of dissemination
  - Reduction in morbidity and/or mortality
  - Increased identification of systematic and preventable errors
  - Education of attendees

Exclusion criteria

- Inclusion of specific surgical services other than general surgery
- Inclusion of exclusively or primarily non-surgical specialties or hospital-wide studies
- Descriptive analysis with no intervention to morbidity and mortality protocols
- Language other than English
- Rounds not limited to morbidity and mortality
- Review and opinion articles
- Quality improvement of morbidity and mortality rounds was not a primary objective
- No description of strategy used to improve morbidity and mortality rounds was provided

Discussion

Educational value

Most studies included in this narrative systematic review investigated interventions aimed at improving the educational value of MMCs, with the goal of improving resident education and patient safety outcomes. Results were largely determined by self-reported attendee satisfaction and perceived educational value, with few studies empirically testing knowledge obtained. However, clear themes emerged for improving the educational content of MMCs that are

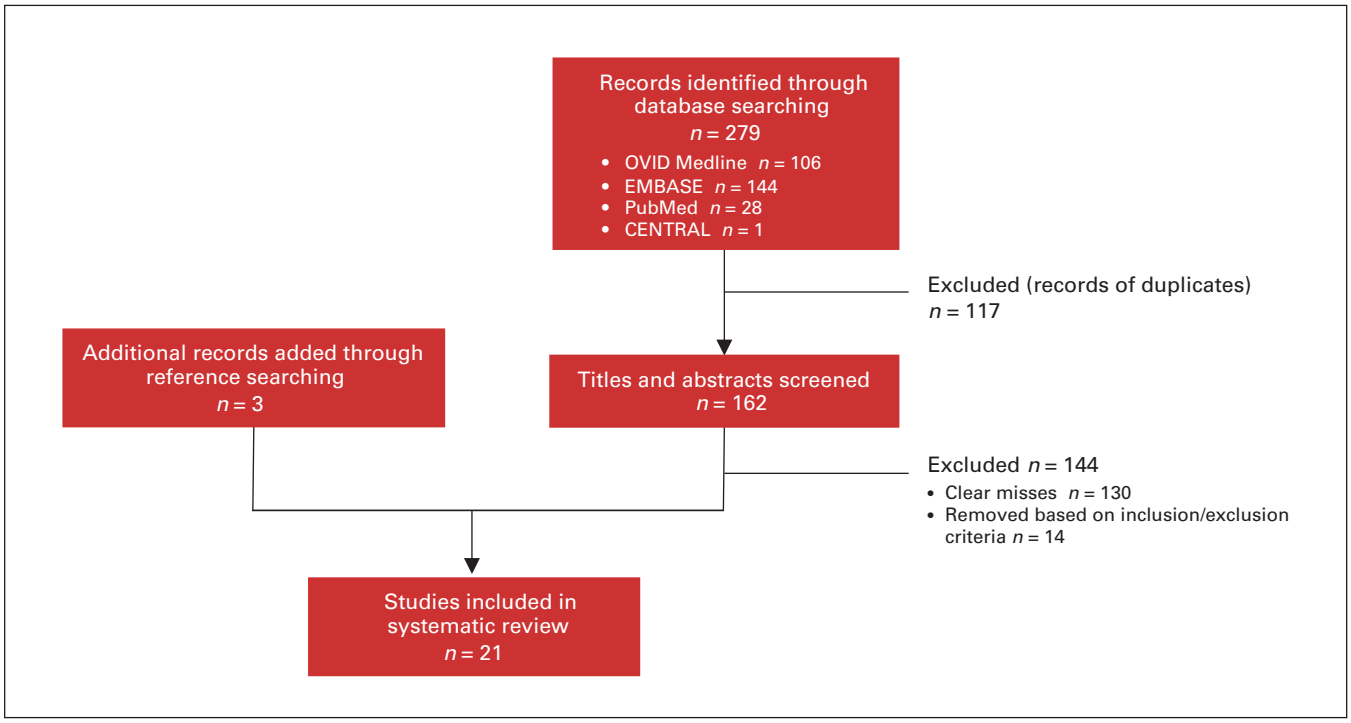

Fig.1. Selection of studies included in the systematic review.

Table 1. Summary of results from a narrative systematic review of studies to improve morbidity and mortality conferences (MMC) in general surgery and subspecialties (part 1 of 3)

Study	Summary	MMC intervention(s)	Outcome(s)	Comment(s)
Abu-Zidan and Premadasa[11]	Single surgical department identified perception of MMC, implemented changes, and used a postintervention 5-point questionnaire	• Notification of cases to present 2 days before MMC • Presentation limited to 15 minutes • Mandatory literature summary	• Increased presentation quality and communication clarity • Increased satisfaction • Increased identification of remediation strategies	• Very small sample size • Small absolute difference on postintervention questionnaire
Antonacci et al.[41]	Three hospitals and 1 ambulatory care facility implemented an error analysis methodology and provided report cards to individual surgeons	• Standardized case critique (what, who, why, when) • Analysis of adverse events for quality-dependent factors • Potential quality issues were identified via consensus and graded • Adverse events caused by quality issues were sent to surgeons and chairperson as a report card	• Reduction in age-adjusted mortality • Privileges restricted or removed for surgeons (3%) • Pushback from surgeons • Three times greater identification of quality issues	• Implementation of error analysis may be difficult at community hospitals • Lacks cost–benefit analysis and analysis among institutions • Lacks preintervention comparison
Auspitz et al.[19]	Single surgical department retrospectively reviewed all cases submitted to MMC and compared results to local NSQIP registry	• NSQIP database (used for a 30-day follow-up period) was compared with MMCs	• Similar reporting in portion of major and minor complications between NSQIP and MMC • NSQIP identified a higher proportion of wound site infection and readmissions • NSQIP identified 30-day postoperatiove outcomes • MMC captured nonoperative cases	• Retrospective review
Bhalla et al.[32]	Single academic centre's department of surgery compared traditional MMC format to the matrix format and assessed improvement with pre- and postintervention questionnaires	• PGY 1–3 assigned weekly readings and PGY 4–5 assigned evidence-based literature reviews • Presentations assigned 2–5 days in advance • Audience response system • Post-MMC matrix newsletter • Standardized case selection by MMC moderator	• Residents spent less time preparing and reported learning more • Enhanced learning reported from other presentations • Matrix format was significantly more preferred • Faculty and resident perceived greater presentation quality	• Small sample size with drop-off in responses • Potential for Hawthorne effect • Increased MMC presentation may be because of enhanced MMC appreciation not format change
Clarke et al.[35]	Single hospital retrospectively reviewed MMC format change and analysis using error taxonomy	• MMC was run by a dedicated moderator • Standardized PowerPoint template • Taxonomic analysis (domain, impact, type, cause and prevention) of adverse events for human-related error	• Enhanced identification of the contribution of error to adverse events	• Descriptive results that lack a preintervention comparison • Small sample size • Limited generalizability
Cromeens et al.[20]	Single pediatric surgical service retrospectively compared NSQIP-P to morbidity and mortality identified by MMCs	• Increased MMC frequency from bimonthly to weekly • Reported straightforward complications • Retrospective use of NSQIP-P to identify complications	• No difference in mortality identified between MMCs and NSQIP-P • Increased MMC reporting of morbidity with format changes • Increased reporting of morbidity by NSQIP-P as compared with MMCs	• Generalizability may be limited to pediatric surgery • NSQIP-P has exclusion criteria that did not capture all morbidity and mortality identified by MMC
Cromeens et al.[42]	Single pediatric surgical service implemented a taxonomic error analysis strategy and standardized MMC structure	• Consistent and multidisciplinary MMC • Established documentation system using taxonomic error analysis	• Taxonomic system enabled identification of errors into categories beyond surgical and patient diseases	• Case selection may not have been comprehensive • Small sample size • Lacks pre-intervention comparison
Falcone and Watson[38]	Multiple campuses at a single medical centre used teleconferencing to improve MMC attendance and provided a cost–benefit analysis	• Implemented a teleconferencing system	• Increased faculty attendance • Travel time reduction resulted in positive net cost–benefit analysis	• Retrospective study reliant onself-reports • Generalizability may be limited to centres with multiple campuses and long commute times

Table 1. Summary of results from a narrative systematic review of studies to improve morbidity and mortality conferences (MMC) in general surgery and subspecialties (part 2 of 3)

Study	Summary	MMC intervention(s)	Outcome(s)	Comment(s)
Greco et al.[39]	Single division of general surgery invited a clinical librarian to MMC and assigned research questions to MMC attendees, to be completed with librarian assistance	• Clinical librarian invited to attend MMCs • Residents assigned relevant questions from MMC to be researched and presented at next MMC	• Presentation of assignments increased perceived continuity between MMCs • Speculation that librarian assistance increased resident research skills	• No objective analysis of outcomes • Limited to centres with access to a clinical librarian • Limited postintervention feedback
Gurien et al.[17]	Single department of surgery retrospectively compared NSQIP and MMC registries for commonality	• NSQIP employed to identify incidence of morbidity and mortality	• NSQIP increased reporting comprehensiveness of morbidity and mortality	• Limited generalizability as not all institutes subscribe to NSQIP • NSQIP limited to sampling process that does not capture nonoperative procedures
Hutter et al.[18]	Single general surgery service retrospectively compared data from MMC and NSQIP registry for commonality	• NSQIP used to identify incidence of morbidity and mortality	• NSQIP demonstrated increased incidence of morbidity and mortality compared with MMCs	• NSQIP captures only operative patients, whereas MMC also captures nonoperative • Small sample size limited subgroup analysis • Suggested creation of an NSQIP integrated Web-based reporting for MMC
Kim et al.[29]	Five divisions from 1 department of surgery employed format changes to their MMC and assessed efficacy with a pre- and postintervention questionnaire	• Presenters instructed to provide brief clinical histories and literature reviews • Presentation limited to 15 minutes • Instruction to analyze case presented for underlying cause of complication(s) • Electronic sample presentation template provided	• Presentations lasted 15–20 minutes owing to questions • Increased specificity of the cause of complication • Increased specificity of future practice change(s) • Increased positive response from residents	• Small sample size • Drop-off in participants from pre- to postintervention questionnaires • Prospective study
Kong and Clarke[34]	Single metropolitan trauma service introduced a structured MMC and HEMR to report morbidity and mortality	• HEMR used to capture routine data, generate reports on morbidity and mortality, and compare with MMC data • Introduction of a multidisciplinary MMC	• HEMR increased morbidity, specifically for systemic complications • Increased identification of common clinical scenarios associated with error and morbidity	• Retrospective study • Lacks preintervention comparison
Lewis et al.[37]	Single department of surgery conducted a prospective study in which participants were randomly assigned to attend MMC live or via televideoconference and response was assessed with an anonymous survey	• Implemented televideoconferencing system	• No significant difference in learning among faculty, residents, and students • No significant difference in perceptions • Increased favourable perceptions for televideoconferencing as commuting distance increased	• Potential for decrease in audience interaction with televideoconferencing • Uneven representation in faculty, residents and student participants • Number of questions to detect learning may have been inadequate
McVeigh et al.[21]	Single department of surgery conducted a prospective comparative study over 6-mo period concerning reporting of adverse events comparing MMC and a proforma	• Prospective proforma used to identify incidence of morbidity and mortality	• Increased capture of morbidities with proforma • Increased capture of mortalities with proforma	• Differences may be due to surgeons not reporting all complications • Potential Hawthorne effect

Table 1. Summary of results from a narrative systematic review of studies to improve morbidity and mortality conferences (MMC) in general surgery and subspecialties (part 3 of 3)

Study	Summary	MMC intervention(s)	Outcome(s)	Comment(s)
Mitchell et al.[12]	Single department of surgery conducted prospective study concerning standardization format for MMC using pre- and postintervention questionnaires and a multiple-choice questionnaire (MCQ) to assess knowledge	• Standardized SBAR presentation format • Mandatory resident and faculty attendance • Decreased defensiveness and blame • Mandatory use of PowerPoint • Radiographic images encouraged • Focused analysis of error • Integration of evidence-based literature • Facilitated audience participation • Facilitation of the conference by a moderator	• SBAR was positively regarded by presenters and reported as easy to implement • Modified MMC format did not add to preparation time • Presentation quality improved significantly in background, assessment, and recommend-ation • Improved MCQ scores from all learners	• Large sample size • Potential Hawthorne effect • Assessor bias • Absolute increases reported on Likert scale were small but significant
Mitchell et al.[33]	Single department of surgery conducted a prospective observational study testing a modified MMC presentation format	• Implementing SBAR MMC tool at weekly departmental MMC	• Increased presentation quality • Increased communication clarity • Increased attendee satisfaction • Increased identification of remediation strategies	• All assessors were familiar with residents so there was potential bias
Murayama et al.[30]	University medical school conducted a prospective observational test using a 23-item survey before and after implementation of a modified MMC format	• Quicker summary of pertinent aspects of cases (5–10 min) • Limited literature review (5–10 min) • Discussion stimulated by moderator • Moved from 6 pm to 7 am • Residents encouraged to discuss case with attending prior	• Increased faculty and resident attendance • Increased faculty contribution and analytical thinking • Residents preferred modified formats • Attending surgeons disliked shorter literature review	• Small sample size • Single centre • Drop-off in survey response between pre- and post • Greater resident response, skewed to juniors • Possible Hawthorne effect
Prince et al.[36]	Single department of surgery at a tertiary academic medical centre implemented an interactive MMC format and analyzed the effectiveness using a questionnaire	• Directed questions to audience • Provided explanations during session • Asked questions to attending faculty members • Included illustrative slides and videos • Moderator stimulated and facilitated discussion	• Increased perceived educational value • Increased clinical confidence related to MMC cases	• Incomplete or missing data • Hawthorne effect and practice effect may have been confounding • Prospective longitudinal analysis • Lacks preinterven-tion comparison
Risucci et al.[31]	Single department of surgery conducted a prospective study in which a modified MMC was investigated using pre- and postintervention questionnaires	• Conference lengthened from 60–90 min with 3 cases presented • Mandatory PowerPoint use that followed a uniform format concerning timing of diagnostic inquires, consultations, and procedures • Mandatory brief literature review • Increased multi-disciplinary attendance • Error discussion is focused on timeliness and appropriateness of diagnosis and treatments	• Consensus was reached more often • Complications were perceived as more often avoidable • Strategies for prevention were more likely to be identified • Increased percentage of complications attributed to errors in judgment • Speculation that modified MMC facilitates more detailed description and analysis of a patient's entire clinical course	• Small sample size • Prospective study • Small number of nonsurgical personnel included in survey, which may limit generalizability • No faculty surveyed
Vogel et al.[40]	Single department of surgery conducted a prospective study which incorporated MMC findings into a PDCA cycle	• Conducted MMC within a PDCA cycle format	• Significant reduction in anastomotic leak rate	• Authors report potential for random errors at each step in the PDCA cycle • May not be generalizable beyond colorectal surgery

HEMR = hybrid electronic medical registry; MMC = morbidity and mortality conference; NSQIP = National Surgical Quality Improvement Program; NSQIP-P= National Surgical Quality Improvement Program-Pediatrics; PDCA = plan-do-check-act; PGY = postgraduate year; SBAR= situation, background, assessment, recommendation.

consistent with current literature.[27,28] Morbidity and mortality conferences should use a standardized presentation format that is succinct, limiting both clinical history and literature review to only pertinent details to ensure ample time for discussion and analysis of the root cause of the adverse event presented. Outcomes associated with this style of MMC included increased presentation quality, increased satisfaction with the MMC, and increased likelihood of identification of remediation strategies. The most commonly used strategies to improve presentation standardization were enforcing a time limit of 15–20 minutes[11,29,30] and mandatory brief literature reviews.[11,12,29–32] Abu-Zidan and Premadase[11] suggest that a 15-minute time restriction focuses debate, deters inappropriate speculation, reduces emotional stress, and maintains audience alertness. Furthermore, Murayama and colleagues[30] proposed that shorter presentations allow for greater breadth of complications to be presented, which appeals to a wider audience of surgical residents and faculty.

Other strategies used to standardize presentation format included providing a PowerPoint template[29,31] and conforming presentations to an SBAR (situation, background, assessment, recommendation) design[12,33] or matrix format.[32,43] Mitchell and colleagues[12] found that implementing SBAR not only enhanced presentation quality, but also increased performance on multiple-choice questionnaires based on MMC content. The SBAR format is also relatively easy to implement and requires minimal training. Furthermore, SBAR can be used to quantitatively assess residents' MMC presentations to facilitate systematic assessment and to provide constructive criticism for teaching residents how to deliver informative MMC presentations.[33] Bhalla and colleagues[32] found that matrix format increased learning, enhanced presentation quality and was significantly preferred to the traditional MMC format by attendees.[23,43] Matrix format involves a skilled moderator who selects cases, assists residents with their presentation preparation, facilitates discussion at the MMC, and

Table 2. Stratification of literature review results into themes, goals, specific interventions and supporting studies

Theme	Goal	Intervention	Supporting studies
Educational value	Standardized presentations	Time limit < 15–20 min	Abu-Zidan and Premadasa,[11] Kim et al.,[29] Murayama et al.[30]
		Mandatory brief literature review	Abu-Zidan and Premadasa,[11] Kim et al.,[29] Mitchell et al.,[12] Murayama et al.,[30] Risucci et al.,[31] Bhalla et al.[32]
		PowerPoint template	Kim et al.,[29] Risucci et al.[31]
		SBAR format	Mitchell et al.,[12] Mitchell et al.[33]
		Advanced notification of selection to present*	Abu-Zidan and Premadasa,[11] Bhalla et al.[32]
		Matrix format†	Bhalla et al.[32]
	Increased audience interaction	Audience response system	Bhalla et al.[32]
		Moderator facilitation of discussion	Clarke et al.,[35] Murayama et al.,[30] Mitchell et al.,[12] Prince et al.[36]
		Targeted questions to specific audience members	Prince et al.[36]
	Enhanced morbidity and mortality continuity	Assigned research for all unanswered questions to be reported at the next MMC	Bhalla et al.,[32] Greco et al.[39]
Error analysis	Improved error analysis	Focused analysis on underlying cause of complication	Antonacci et al.,[41] Kim et al.,[29] Mitchell et al.[12]
		Taxonomic error analysis‡	Clarke et al.,[35] Cromeens et al.[42]
Case selection and representation	Comprehensive case selection	Electronic database used to identify cases	Auspitz et al.,[19] Cromeens et al,[20] Gurien et al.,[17] Hutter et al.,[18] Kong and Clarke[34]
		Moderator selects cases	Bhalla et al.[32]
		Prospective proforma	McVeigh et al.[21]
Attendance	Improved faculty and resident attendance	Teleconferencing	Falcone and Watson,[38] Lewis et al.[37]
		Morning meeting time	Murayama et al.[30]
Dissemination	Established systematic dissemination strategy	Post-MMC newsletter	Bhalla et al.[32]
		PDCA cycle	Vogel et al.[40]
		Surgeon report cards	Antonacci et al.[41]

MMC = morbidity and mortality conference; PDCA = plan-do-check-act; SBAR = situation, background, assessment, recommendation.

*Advanced notice of selection to present ranged from 2 days[11] to 2–5 weeks[32] and included dissemination of the cases to be presented to prospective MMC attendees to allow time for background research.

†Matrix format is a cyclical MMC that involves a designated moderator selecting cases, helping residents with presentations, facilitating discussion, and testing the residents quarterly to create a learning environment that constantly reinforces MMC learning points.[43]

‡Taxonomic error analysis involves categorizing errors to facilitate more specific reporting and analysis of the root cause. Examples of taxonomic categories include domain, impact, type/process, cause, and prevention[35] or more complex determination templates.[42]

implements quarterly examinations pertaining to the cases presented. While this strategy is effective, it appears labour intensive and requires a talented and dedicated moderator.

Other interventions used to improve MMC educational value aimed to increase audience interaction and enhance continuity. Consistent with the current emphasis on reducing didactic learning in medical education, we found that strategies aimed at increasing audience interaction resulted in increased perceived educational value, improved clinical confidence related to MMC content and enhanced identification of errors.[12,30,32,35,36] Methods used to increase audience interaction included MMC moderator–stimulated discussion,[12,30,35,36] use of an audience response system[32] and questions directed to specific audience members.[36] Prince and colleagues[36] suggest that direct examination of a presenter is beneficial only if facilitated by a moderator who actively engages the audience and explicitly states the implications of the question(s) being asked. More broadly, the creation of a safe MMC environment by facilitators helps encourage participants to ask questions and to collectively advance their understandings of the clinical problems at hand.[44] Consistent with literature on collaborative adult learning, a focus on discussion also capitalizes on the unique opportunity MMCs present for novices and experts to engage together to teach and learn from each other in the moment.[2,44] Furthermore, collaboration and small group–based discussion may also improve error analysis.[45] In regards to MMC continuity, assigning research questions or evidence-based literature reviews[32,39] to residents in order to clarify questions arising from previous MMCs increased perceived continuity. Greco and colleagues[39] investigated a pilot intervention that incorporated a clinical librarian in their MMCs. The role of the librarian was to help residents make better use of evidence-based medicine by assisting them with researching unanswered questions arising from MMCs for presentation at the following MMC. Alternatively, Bhalla and colleagues[32] assigned residents weekly readings or literature reviews pertaining to the pathophysiology, treatment and complications presented at the MMC.

While research linking the effectiveness of MMCs at improving patient outcomes is limited,[46] we can theorize that by enhancing the educational value of MMCs, we are not only establishing better trainee education, but also contributing to quality improvement. It is reasonable to believe that if residents or staff physicians are well educated on patient safety issues, they will be less likely to encounter similar issues in their future careers. It is thus prudent to recognize that discussion regarding strategies to improve MMC educational value, such as standardizing presentation format, increasing audience interaction, and enhancing continuity, also represent strategies to address quality improvement and patient safety issues. Standardizing case presentation has previously been found to be associated with increased perception of MMC effectiveness as a quality-improvement tool.[46] Most studies identified in this narrative systematic review used interventions to improve the educational content and value of MMCs, which may be attributable to the dual role of the educational value of MMCs in resident education and quality improvement.

Error analysis

In order to identify patient safety issues and act as an effective quality-improvement tool, all MMCs should include discussion or analysis focused on the root cause of a complication.[44] Berenholtz and colleagues[15] suggested that 3 elements are necessary to learn from adverse events: individuals involved in the case must be involved in the error analysis, a structured framework should guide identification of contributing factors, and implementation of future preventative strategies must be assigned as a responsibility to an individual or team. Unfortunately, current analysis is largely retrospective and relies on practitioner experience or insight, with few programs using a structured approach.[28] We identified 2 strategies for improving error analysis: focused discussion on causative factors[12,29,41] and taxonomic error analysis.[35,42] These strategies involve using systematic analysis such that a complication is first identified as being caused by a potential quality issue and then analyzed for the root cause. Cromeens and colleagues[42] use a template in their MMCs that includes patient identifiers, event summary, preventability and failure mode categories, discussion points and action items with implementation timelines. They further incorporated a rating of preventability based on MMC discussion with management and achieved through consensus. Similarly, Clarke and colleagues[35] suggest categorizing error into taxonomies such as domain, impact, type, cause and prevention. Both systematic strategies improve MMC error analysis by defining causative factors other than human error and surgical disease to affect patient safety outcomes.

While not addressed by the studies included in this narrative systematic review, another limitation of MMC error analysis is that MMCs commonly have a strict focus on systematic issues, such as medication administration, communication and handover, while omitting discussion regarding cognitive psychology, or the biases that contributed to error via flawed clinical reasoning.[47] Such omissions mean that our capacity to solve patient safety and quality-improvement problems is limited, as MMC error analysis does not fully address human error in identification and discussion of the root cause of an adverse event. The inclusion of metacognition, or "thinking about thinking," may further enrich error analysis discussion by addressing this commonly negated facet of error. Katz and Detsky[47] recommend that, with considerable internal analysis and self-reflection, experienced clinicians could share personal stories in MMCs that highlight how cognitive bias leads to error, thus normalizing cognitive biases

and acknowledging that even the most experienced clinicians are not impervious to them. Identification of both cognitive misstep and system problems is essential in the complete discussion of potential patient safety concerns in order to identify remediation strategies. Typically, MMCs are well-focused on education; however, it is their function in quality improvement that often falls short.[48] Hopefully, with inclusion of metacognition in MMC error analysis as well as system problems, using tools such as focused discussion on causative factors and taxonomic error analysis, MMCs can better serve as the cornerstone of quality improvement in surgical departments around the world.

Case selection and representation

Case selection and representation remains an essential part of the MMC. Appropriate representation should identify common and recurrent adverse outcomes that occur in a specific hospital setting. This necessitates the need for accurate data recording. The traditional MMC method of tracking adverse outcomes has been criticized, as it is often performed without standard definition of complications and is largely heterogeneous among institutions.[8] Several studies have shown that MMCs tend to underreport morbidity and mortality.[17–21] Hutter and colleagues[18] provide several explanations for this phenomenon, such as not reporting patients with primarily nonsurgical problems, lack of patient ownership as patients are transferred among physicians, and not reporting adverse outcomes for fear of punishment.

The National Surgical Quality Improvement Program (NSQIP) has been identified as an alternative to the traditional MMC method of data collection.[17–20] It uses 30-day prospective data collection and categorizes complications with standard definitions. Several studies comparing NSQIP and traditional MMC data collection methods found that morbidity was consistently underreported by MMCs not using NSQIP, and in most cases, mortality was also underreported. For example, a study performed at Massachusetts General Hospital revealed that mortality and morbidity rates as reported by MMCs were 0.9% and 6.4%, respectively, whereas, NSQIP reported 1.9% mortality and 28.9% morbidity. Proportions of morbidity categories were also underreported in MMCs compared with NSQIP.[18] However, limitations with NSQIP have been identified. Adverse outcomes in patients who are admitted to the general surgery unit but do not undergo surgery are not captured by NSQIP.[19] Barriers to implementing NSQIP have also been reported, including preconceived notions of inability for NSQIP data to lead to change, feelings that NSQIP is not relevant to a surgeon's individual practice, and the financial cost of implementing and maintaining NSQIP.[17]

Data collection systems other than NSQIP have also been reviewed. A recent retrospective study found morbidity reporting increased by using data collected with a hybrid electronic medical registry (HEMR) compared with traditional MMC methods.[34] A paper-based proforma following the NSQIP platform was developed by McVeigh and colleagues,[21] which also increased capture of morbidity and mortality. The proforma included patient identifiers as well as check boxes to document complications and was inserted into the patient's chart. The use of a predefined framework for case selection and standardized data collection methods can help optimize case representation at MMCs and improve capture of local morbidity and mortality; however, the local culture of adverse event reporting will also influence the accuracy of data collection.

Attendance

A combination of retrospective and prospective studies evaluated interventions to increase MMC attendance. Teleconferencing led to increased attendance in settings where multiple medical centres existed in geographic separation and with increased commuting distance.[37,38] In addition, a net cost–benefit analysis was positive owing to the significant reduction in travel time with teleconferencing.[38] Despite the potential for decreased audience interaction, no difference in learning or perception among faculty, residents and students was demonstrated after implementation of a teleconferencing system.[37] Murayama and colleagues[30] conducted a prospective study in which they modified the time of their MMC from 6 pm after grand rounds to 7 am before the operating day. The schedule change resulted in increased faculty and resident attendance. Possible explanations include increased energy in the morning, fewer scheduling conflicts, and a new indication of departmental priority. Despite few studies in this area, it appears that improving attendance requires interventions targeted at locally identified challenges.

Dissemination

Dissemination of the MMC content allows for continued learning, continuity and, ultimately, translation of knowledge into quality-improvement initiatives. Three strategies identified to disseminate information from MMCs were post-MMC newsletters,[32] incorporating MMC findings into a plan-do-check-act (PDCA) cycle,[40] and surgeon report cards.[41] Post-MMC newsletters were created by the MMC moderator and reiterated teaching points, clinical pearls and answers to questions asked at the MMC. Bhalla and colleagues[32] reported that most residents found newsletters useful and that faculty used portions of the newsletter for their continued education. A PDCA cycle is a decision-making tool designed to facilitate the translation of scientific hypothesis into a management strategy for implementing proposed plans.[49] Vogel and colleagues[40] incorporated their MMC into the plan,

do, and check steps and found a significant decrease in the rate of anastomotic failure in colorectal surgery; however, it remains to be seen whether these results are generalizable. Creation of surgeon report cards that were sent to individual surgeons and department chairs to highlight quality-dependent factors leading to adverse events has also been reported. While a decrease in age-adjusted mortality was demonstrated, the authors experienced pushback from surgeons regarding the report cards, and the study lacked a preintervention comparison.[41] A universal strategy to optimize dissemination of results from MMCs has not clearly been identified and is an area requiring additional research.

Limitations

Our study has several limitations that pertain to the nature of narrative systematic reviews, including the potential for unintentional omission of studies addressing the research question and exclusion of non-English literature.[50] Unlike systematic reviews, narrative reviews do not involve quantitative analysis and rely on subjective analysis, which can be subject to bias. Furthermore, analysis was focused on descriptive outcomes with no numerical weighting applied to each intervention. The nature of the studies surveyed also created challenges for this narrative review. Many studies lacked comprehensive description of their MMCs or described heterogeneous MMC protocols, which limits comparison and generalizability of this study. Furthermore, outcomes were mostly self-reported perception of learning or satisfaction, with few quantitative measures. Several studies also lacked a preintervention comparison, generating more speculative results. Finally, in our analysis we highlight specific strategies for improving MMCs; however, several studies often incorporated multiple changes to their MMC format, thus confounding the efficacy of each individual intervention.

Creating learning health systems

Our analysis revealed that surgical MMC format changes targeted improvement in at least 1 of the following themes in order to better serve a dual purpose in education and quality improvement: educational value, error analysis, case selection and representation, attendance, and dissemination. These interventions are detailed in a problem and recommendation format in Table 3. Educational value was maximized with standardized presentation

Table 3. MMC problems and recommended interventions

Problem	Recommendation
How to improve education value of MMC	• Enforce a time limit < 15–20 min • Standardize presentations with a PowerPoint template or SBAR format • Dedicated moderator to facilitate discussion • Target discussion questions to specific audience members or use an audience response system • Assign all unanswered questions as a research question to learners to be reported at the next MMC
How to improve error analysis	• Focused discussion on causative factors • Taxonomic error analysis
How to better represent morbidity and mortality with case selection	• Use an electronic database (e.g., NSQIP) to identify cases for presentation • Dedicated moderator to select cases for presentation
How to improve MMC attendance	• Teleconferencing for geographically separated centres • Plan MMCs in the morning before operating hours
How to improve continuity and dissemination of MMC content	• Create and circulate newsletters that highlight salient points of each MMC • Distribute surgeon report cards that detail quality-dependent factors that may have contributed to adverse events

MMC = morbidity and mortality conference; NSQIP = National Surgical Quality Improvement Program; SBAR = situation, background, assessment, recommendation.

Table 4. Foundational elements of high reliability organizations

Element	Description
Sensitivity to operations	Continuously work to identify variations and errors in complex processes.
Reluctance to simplify	Avoid overly simplified explanations of failure. Embrace and address complexity in analyses.
Preoccupation with failure	Work to predict and avoid catastrophes. Place high importance on near misses.
Deference to expertise	Teams and leaders defer to those with the most front-line knowledge, rather than to those with the most seniority, in analyzing processes and solving problems.
Resilience	Systems are designed to limit and contain errors before they escalate and to promote resourceful problem solving and improvization in order to maintain function even in the face of setbacks.
Collective mindfulness	Individuals at all levels and teams operate mindfully to make critical adjustments promptly. There is a culture of continuous evaluation and learning that enables continuous refinement of process and identification of potential problems.

formats using PowerPoint templates or SBAR format, restricting presentations to 15–20 minutes, mandatory brief literature reviews, and increasing audience interactions. Focused discussion on causative factors leading to adverse events and taxonomic error analysis were interventions used to improve MMC error analysis. Case selection was improved by using an electronic clinical data registry, such as NSQIP, moderator-selected cases, and use of a prospective proforma. Attendance was increased with teleconferencing and by scheduling consistent MMCs that occur before the operating day. Finally, dissemination strategies included post-MMC newsletters, incorporating MMCs into PDCA cycles, and surgeon report cards. New strategies such as a safety learning system,[51] not yet widely adopted in surgery, have begun to standardize presentation formats, incorporate informatics approaches, embrace the perspectives of all members of modern multidisciplinary teams, and create avenues for action.

As surgical care becomes more complex and more multidisciplinary, these ideals must be applied more rigorously and on a larger scale to systems of surgical care. The next great opportunity in surgical quality and patient safety may be the creation of learning health systems, "in which surgical science, information technology, and surgical culture are aligned for continuous improvement and innovation, with best practices seamlessly embedded in the delivery process, and new knowledge captured as an integral by-product of the delivery experience."[52] Part of this effort may involve embracing principles of high-reliability organizations:[53] sensitivity to operations, reluctance to simplify, preoccupation with failure, deference to expertise, resilience and collective mindfulness (Table 4). These new perspectives will undoubtedly build on a rich legacy of thought and action on how surgeons reflect on and learn from their mistakes, and how they use new knowledge to constantly improve the care of surgical patients.

Conclusion

Better MMCs, learning health systems and high reliability principles, embedded in inclusive surgical cultures that value and nurture the contributions of all of their members while blurring traditional boundaries between quality and education, have the unprecedented potential to bridge the gap between knowledge and transformative action in surgical care and systems development.

Affiliations: From the Department of Surgery, University of British Columbia, Vancouver, BC (Slater, Sekhon, Shariff, Chiu, Joos, Hameed); the Department of Surgery, University of Alberta, Edmonton, Alta. (Bradley); Quality and Patient Safety, Vancouver Coastal Health, Vancouver, BC (Bedford); Trauma Services, Kelowna General Hospital, Kelowna, BC (Wong); and the Department of Surgery, University of Calgary, Calgary, Alta. (Ball).

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