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REPORTS OF ORIGINAL INVESTIGATIONS

Avoidable perioperative mortality at the University Teaching Hospital, Lusaka, Zambia: a retrospective cohort study

Mortalité périopératoire évitable à l'hôpital universitaire de Lusaka (Zambie): une étude rétrospective de cohorte

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Abstract

Purpose *Perioperative mortality has fallen in both high- and low-income countries over the last 50 years. An evaluation of avoidable perioperative mortality can provide valuable lessons to improve care; however, there is relatively little recent data from the Least Developed Countries in the world. We aimed to compare recent avoidable perioperative mortality in Lusaka, Zambia, with historical data from 1987.*

Methods *We conducted a retrospective cohort study by identifying perioperative deaths within days of surgery and comparing the operating room and mortuary registers for the 2012 calendar year. Multiple independent raters from anesthesiology and surgery/obstetrics gynecology reviewed case notes, when available, to identify avoidable causes of death.*

Results *Of the 18,010 surgical patients in 2012, 114 were identified as having died perioperatively within six days of surgery. Fifty-nine files were available for further analysis (52% of identified perioperative deaths). Eighteen (30%) of these cases were assessed as avoidable, 19 cases (32%) probably avoidable, 14 cases (24%) unavoidable, and eight cases (14%) unclear. Thirty-one (53%) cases had surgical factors contributing to death, 19 (32%) cases had anesthesia factors, and 18 (30%) cases had systems factors. Most of the avoidable deaths were attributed to multiple factors. Key factors leading to the avoidable deaths were delays in surgery, lack of the availability of blood, and poor postoperative care.*

Conclusions *Most deaths were avoidable, suggesting that patient outcomes in low-resource settings can be improved within current resources. The multifactorial*

Author contributions *Edwardina Mary Mae Alexandra Lillie, Christopher John Holmes, John Alexander Kinnear,* and *M. Dylan Bould* were involved in the study design. *Edwardina Mary Mae Alexandra Lillie, Christopher John Holmes, Elizabeth Anne O'Donohoe,* and *Lowri Bowen* were involved in data collection. *Edwardina Mary Mae Alexandra Lillie, Lowri Bowen,* and *M. Dylan Bould* were involved in the data analysis. *Edwardina Mary Mae Alexandra Lillie* wrote the first draft of the manuscript. *Christopher John Holmes, Elizabeth Anne O'Donohoe, Lowri Bowen,* and *John Alexander Kinnear* were involved in critical review of the manuscript. *Chadwick L.T. Ngwisha*, *Yusuf Ahmed,* and *David Michael Snell* were involved in the analysis and critical review of the manuscript. *M. Dylan Bould* was involved in revising the manuscript.

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nature of avoidability implies that an interprofessional approach is required to improve the quality of care.

Résumé

Objectif *La mortalité périopératoire a chuté aussi bien dans les pays développés que dans les pays à faible niveau de vie au cours des 50 dernières années. Une évaluation de la mortalité périopératoire évitable peut fournir de pertinentes leçons pour l'amélioration des soins; toutefois, il existe relativement peu de données récentes concernant les pays les moins développés du monde. Nous avons cherché à comparer la mortalité périopératoire évitable récente à Lusaka (Zambie) à des données historiques de 1987.*

Méthodes *Nous avons mené une étude rétrospective de cohorte en identifiant les décès périopératoires survenus dans les jours suivant une chirurgie et en comparant les registres des salles d'opération et ceux de la morgue pour l'année 2012. Plusieurs évaluateurs indépendants (anesthésiologistes, chirurgiens/obstétriciens-gynécologues) ont analysé les dossiers médicaux quand ils étaient disponibles pour identifier des causes évitables de décès.*

Résultats *Sur les 18 010 patients chirurgicaux de 2012, 114 ont été identifiés comme étant décédés dans la période périopératoire de six jours suivant l'intervention chirurgicale. Cinquante-neuf dossiers étaient disponibles pour une analyse plus poussée (52 % des décès périopératoires identifiés). Dix huit (30 %) de ces cas ont été jugés évitables, 19 cas (32 %) probablement évitables, 14 cas (24 %) inévitables et huit cas (14 %) incertains. Trente et un (53 %) cas présentaient des facteurs chirurgicaux contribuant au décès; 19 (32 %) cas avaient des facteurs contributifs anesthésiques et 18 (30 %) cas avaient des facteurs contributifs systémiques. La plupart des décès évitables ont été attribués à de multiples facteurs. Les principaux facteurs contribuant à des décès évitables étaient les retards dans la chirurgie, le manque de sang disponible et des soins postopératoires insuffisants.*

Conclusions *La majorité des décès était évitable, suggérant que les résultats cliniques des patients vivant dans un milieu aux ressources limitées peuvent être améliorés avec les ressources existantes. Le caractère multifactoriel de l'évitabilité implique qu'une approche interprofessionnelle est requise pour améliorer la qualité des soins.*

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A death is one of the most devastating outcomes of surgery, and it is particularly tragic if that death could have been avoided with improved quality of care. Mortality and avoidable mortality are therefore key indicators of perioperative outcomes. A recent systematic review and meta-analysis revealed that total perioperative mortality has declined over the last 50 years (from 1.06% before the 1970s to 0.45% in the 1970s-1980s and 0.12% in the 1990s-2000s) despite patients' increased comorbidities.[1] The greatest decline in total perioperative mortality has been in developed countries; however, countries with a Human Development Index (HDI) < 0.8 (a measure of development based on per capita income, life expectancy, literacy, and enrolment in higher education)[2] have also experienced a reduction in mortality (from 1.14% before the 1970s to 0.73% in the 1970s-1980s and 0.24% in the 1990s-2000s).[1]

Zambia is a country with an estimated population of 14.5 million[3] and an HDI of 0.56 (ranked 141st out of 187 countries) compared with Canada's HDI of 0.90 (ranked eighth in the world).[4] The United Nations classifies Zambia as one of the Least Developed Countries in the world.[5] Gross national income per capita is US$2,898, and although this places Zambia in the lower middle income category according to the World Bank classification, 74% of the population lives on less than US$1.25 a day.[3] The mortality rate for children under five years is estimated to be 75 per 1,000 live births; the maternal mortality ratio is 398 per 100,000 live births,[6] and HIV prevalence is 12.7%.[4] The University Teaching Hospital (UTH) is the largest hospital in Zambia. It not only serves the Lusaka area population (estimated at 1.7 million)[7] but also functions as a referral centre for the rest of the country. Officially, it has 1,655 beds and 250 baby cots, but as demand far outstrips capacity, floor beds and bed sharing have been reported.[8]

The avoidable perioperative mortality data for UTH was last collected in 1987[9] when Zambia's population was 8 million. Mortality was found to be 0.76% with avoidable mortality 0.33% - i.e., 43% of deaths were considered avoidable at that time. Anesthesia in Zambia has been found to be highly underdeveloped and underresourced[10] with less than one physician anesthesiologist per million population.[11]

Our aim was to conduct a retrospective assessment of avoidable perioperative mortality at UTH for the 2012 calendar year. We aimed to review the circumstances around every perioperative death to identify avoidable mortality and any learning points that could be used to improve the quality of care in the future. A secondary objective was to compare the six-day perioperative mortality rate in 2012 with the previous data from 1987. We hypothesized that the total perioperative mortality rate

at the UTH would not have decreased significantly based on the established global trend in low HDI countries.[1] We also assumed that avoidable perioperative mortality at the UTH in Lusaka had not improved since 1987 and that many perioperative deaths remained avoidable.

Methods

We undertook a retrospective review of case notes involving inpatient perioperative six-day mortality, i.e., deaths that occurred between induction of anesthesia and postoperative day 5 (operation day being day 0) at the UTH, Zambia. The University of Zambia Biomedical Research Ethics Committee approved this study in November 2012 (UNZAREC reference number 014-11-12).

A flow chart (Fig. 1) shows how the files were identified. All patients who died while an inpatient at the UTH from January 1, 2012 to December 31, 2012 were identified from the mortuary registers. These registers (filled in by mortuary technicians) are paper ledgers that document patient name, gender, date of death, and the location in the hospital from which the patient was transferred. The patient's age, date of birth, and hospital identification number were sometimes recorded but without consistency.

Individual patients who underwent surgery during the study period were identified from operating theatre registers filled in by theatre or recovery staff. In order to identify patients suspected of death within six days of surgery, the patient lists from the mortuary and theatre registers were entered into an Excel spreadsheet (Microsoft, Redmond, WA, USA) and compared line by line for name, age, date of surgery, and date of death,. We also alerted ward clerks on the surgical wards to advise us of any perioperative deaths and asked the Department of Obstetrics and Gynaecology to inform us of any maternal mortality that may have involved an operative intervention.

Each case file was reviewed by two assessors, an anesthesiologist (L.B.) and an obstetrician (Y.A.) or a general surgeon (C.N.), depending on whether the case was an obstetric or other surgical specialty. Each investigator independently filled in a data collection form for each patient and the forms were then compared. The goal of this review was to identify whether the death was avoidable and whether surgical care, anesthesia care, or systems issues had contributed to the avoidable death. Any disagreement regarding the categorization of cases was resolved through discussion and, if necessary, additional raters (E.M.M.A.L., M.D.B.) until they reached consensus. Consensus was eventually reached in all cases. An "avoidable death" was defined as a case where the patient would most likely have survived if the quality of care was improved within current resources. A "probable avoidable death" was defined as a case where it was likely but not certain that the patient would have survived if the quality of care was improved within current resources. An "unavoidable death" was defined as a case where the patient would have died regardless of the quality of care within available resources. A categorization of "unclear" was used if the notes did not provide sufficient detail to comment on avoidability of death. An anesthetic or surgical contribution to avoidable death was defined as a case where improved care by either the anesthesia or surgical team could have prevented death. A system of care contribution to avoidable death was designated when avoidability fell outside of the immediate remit of these teams and included organizational issues and nursing care.

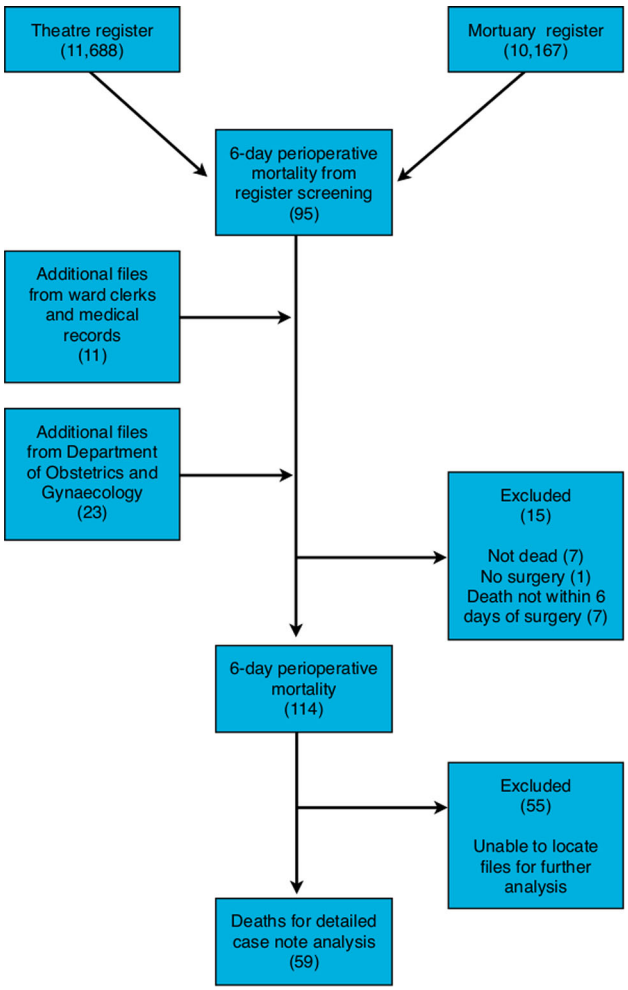

Fig. 1 Flow chart for a study on perioperative mortality at the University Teaching Hospital, Lusaka

Statistical analysis

Descriptive statistics were used to report patient characteristics, postoperative day of death, avoidability of

death, and contributory causes. A two-tailed Chi square test was used to compare avoidable mortality and overall mortality with historical data from 1987.[9] All reported *P* values are two sided. SPSS® version 19 (IBM, Armonk, NY, USA) software was used for analysis.

Our study sample size estimate was calculated in order to identify a drop in mortality from 0.7% to 0.5%. Using a conservative estimate based on global trends,[1] assuming an alpha of 0.05, we needed a denominator of 1,231 operative cases for a power of 80% using G*Power version 3.1.2 (University of Düsseldorf).[12] We elected to collect data for a full calendar year in order to have a number of cases comparable with the historical study and to maximize the opportunity to learn from avoidable causes of mortality.

Results

During 2012, 18,010 operations were conducted throughout the UTH as noted from prospectively collected official hospital statistics. In spite of this, some theatre registers were lost entirely, and some had multiple pages missing or damaged. Patient details of only 11,688 cases were available from these registers. Ninety-five patients matched the mortuary list and therefore were suspected of death within six days of surgery. In addition, ward clerks and the medical records department, whom we had alerted to our goal of capturing all perioperative mortality for 2012, identified another 11 patients who died perioperatively. The Department of Obstetrics and Gynecology, where maternal mortality is independently tracked, identified 26 additional patients as perioperative deaths. Only three of these additional cases had been previously identified from the search of the theatre and mortuary registers, resulting in 23 additional cases. Fifteen of the 129 patients identified in this manner were excluded on further examination of the case notes which revealed that the patients had not died, did not have surgery, or the death was not within the first six days of surgery. This left an estimated six-day perioperative mortality of 114 cases (0.98% of patients included on the theatre registers). Fifty-five patients were excluded from further analysis as their case notes could not be found, which left 59 case files that were available and analyzed for the study.

Patient characteristics are shown in Table 1. Of importance, only 25% of cases involved a consultant surgeon/obstetrician (i.e., "consultant" was defined as a senior doctor who completed a locally or internationally recognized specialty training program), and only 34% of cases involved a consultant anesthesiologist. Forty-one deaths (69%) involved patients less than 40 yr old.

Table 1 Patient characteristics relating to cases with perioperative mortality

Gender	
• Male	16 (27%)
• Female	43 (73%)
Age	
• 0-9	5 (8%)
• 10-19	9 (15%)
• 20-29	12 (21%)
• 30-39	16 (27%)
• 40-49	7 (12%)
• 50-59	3 (5%)
• 60-69	2 (3%)
• 70-79	3 (5%)
• Over 80	1 (2%)
• Not documented	1 (2%)
Urgency of surgery	
• Elective	16 (27%)
• Emergency	43 (73%)
Type of surgery	
• Minor	16 (27%)
• Major	43 (73%)
Surgical specialty	
• General surgery	18 (31%)
• Obstetrics	16 (27%)
• Gynecology	11 (19%)
• Pediatric general surgery	6 (10%)
• Orthopedic	3 (5%)
• Urology	2 (3%)
• Neurology	2 (3%)
• Cardiac	1 (2%)
ASA	
• I	6 (10%)
• II	13 (22%)
• III	15 (26%)
• IV	25 (42%)
• V	0 (0%)
Most senior anesthetist present	
• Consultant (completed specialist training)	20 (34%)
• Registrar (postgraduate trainee)	8 (14%)
• Clinical officer (non-physician)	24 (40%)
• None	1 (2%)
• Not documented	6 (10%)
Most senior surgeon present	
• Consultant	15 (25%)
• Registrar (postgraduate trainee)	27 (46%)
• Senior house officer (postgraduate trainee)	6 (10%)
• Clinical officer (non-physician)	8 (14%)
• Not documented	3 (5%)

ASA= American Society of Anesthesiologists

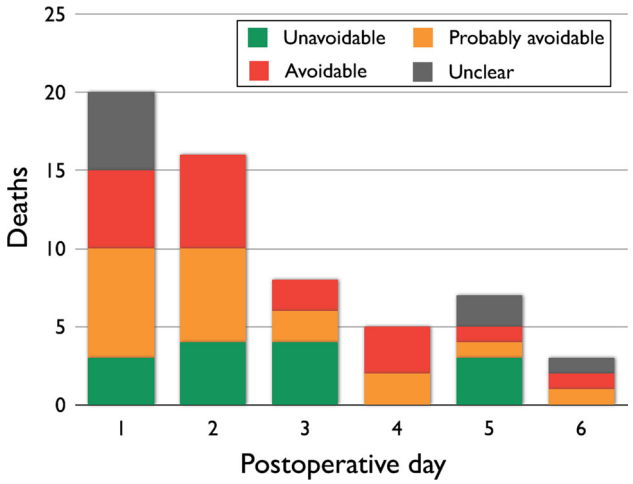

Fig. 2 Avoidability of perioperative death by postoperative day. Green refers to unavoidable deaths, orange to probably avoidable deaths, red to avoidable deaths, and grey when it was unclear whether the death was avoidable. Day 0 refers to the day of surgery

In terms of determining the avoidability of deaths, two independent reviewers were in agreement in 28 cases (47%). There was discrepancy in 31cases (53%) so the initial two reviewers plus two secondary reviewers discussed these folders and reached consensus for every case. Eighteen cases (30%) were thought to be avoidable, 19 cases (32%) probably avoidable, 14 cases (24%) unavoidable, and eight cases (14%) unclear. The deaths by postoperative day are shown in Fig. 2. Thirty-seven (63%) of the 59 cases available for review were classified as either avoidable or probably avoidable. Table 2 includes the factors contributing to avoidable deaths, and Table 3 includes de-identified examples of avoidable deaths. Fig. 3 illustrates the contributions of anesthesia, surgery, and systems of care to the avoidable deaths. Of the avoidable and probably avoidable deaths, 13 (35%) had one contributing factor (either surgery or systems issues), 17 (46%) had two factors, and seven (19%) had all three contributing factors. If the avoidable and probably avoidable cases are combined (37 cases), this value is not statistically significantly different from the previously described avoidable mortality rate in 1987 (avoidable mortality rate, 0.21% in 1987 *vs* 0.33% in 2012; Chi square = 3.65; df = 1; $P = 0.06$). Nevertheless, this is most likely an underestimate as an analysis of avoidability was not available for 55 of our 114 cases (48.2%).

Based on the annual hospital statistics for 2012, the actual number of surgical cases was 18,010: 12,954 under general anesthesia, 1,817 under spinal anesthesia, 3,229 under local anesthesia, and ten under sedation. Nevertheless, theatre registers were available for only 11,688 (64%) of these cases. If we calculate a "best possible case" mortality rate - i.e., assuming that there were no deaths in the patients whose details were missing - 114 deaths from 18,010 procedures represents a six-day perioperative mortality of 0.63%. There is no statistically significant difference between this "best possible case" estimate and the actual six-day mortality found in the 1987 report (total mortality, 0.76%; Chi square = 1.29; df = 1; $P = 0.26$).

Discussion

Our aim was to review the circumstances around every perioperative death to identify avoidable mortality and any learning points that could be used to improve the quality of care in the future. Unfortunately, this was simply not possible. Nevertheless, based on the review of available case notes, almost two-thirds of cases were classified as avoidable (37 cases, 62.7%). Although only 59 case notes out of the 114 identified perioperative deaths were available, we found no indicators of systemic bias in the non-availability of the missing notes. Even if none of the outstanding 55 missing cases were classified as unavoidable, this category still contributes to almost a third of perioperative deaths (37 cases per 114 deaths, 32.5%). Avoidability due to surgical factors was similar to that noted in 1987. The most common surgical factors were related to preoperative care, in particular, failure to book the operating room with the appropriate urgency and poor preoperative preparation of the patient. Failure to consult with a senior colleague was common, and in light of the scaled up anesthesia training since 2012, it seems likely that more anesthesia input into preoperative optimization could potentially improve outcomes.

The most common anesthesia factors related to postoperative care included failure to recognize and treat patient deterioration and failure of intensive care management when needed. This contrasted with the data from 1987 when poor airway management was the most common anesthesia contributor to death. It is not clear why this is the case, but we suggest that it may be due to better availability of oximetry, although this is speculative and we do not have data to confirm this view. The frequency of suboptimal care in the postoperative period is a major concern and should be a particular focus for the anesthesia training program at the UTH.[11] Anecdotally, there was little improvement in intensive care resources at UTH from 1987 to 2012, e.g., only ten intensive care beds for over 1,600 hospital beds, lack of basic equipment such as syringe pumps, an open unit with no dedicated intensive care physicians, and inadequate nursing education and staffing. Lack of availability of intensive care beds and poor postoperative nursing care were the most common systems factors after lack of blood availability, and it

Table 2 Factors contributing to avoidable or probably avoidable mortality in 1987 and 2012

	1987	2012
Cases where surgery contributed to avoidable mortality	**Not reported**	**31 cases, 53%***
Delay in surgery	11 (31.4%)*	18 (30.5%)* • Failure to book operating theatre with appropriate urgency (12) • Delay in diagnosis (3) • Incorrect diagnosis (3) • Failure to review patient by surgical team
Inadequate preparation for surgery/preoperative care	9 (25%)	10 (16.9%) • Failure to correct anemia/hypovolemia (4) • Nonsteroidal given inappropriately (2) • Failure to investigate appropriately (2) • Failure to recognize unfit for surgery • Poor preoperative medical care/failure to refer
Poor intraoperative care	-	7 (11.8%) • Poor judgement - should have chosen more conservative surgical approach (3) • Unable to achieve hemostasis (2) • Perforated bowel during Cesarean delivery (unrecognized) • Failure to give uterotonics (2)
Failure to call senior surgeon	-	5 (8.4%)
Poor postoperative care of critically ill surgical patient	7 (20%)	4 (6.7%)
Inadequate or no surgical documentation	-	3 (5%)
Cases where anesthesia contributed to avoidable mortality	**Not reported**	**19 cases, 32%**
Poor preoperative preparation/care	2 (5.7%)	5 (8.4%) • Failure to investigate appropriately (3) • Failure to act on investigations (2) • Delay in getting to theatre
Poor airway management	5 (14.2%)	-
Poor intraoperative care	1 (2.9%)	2 (3.3%) • Failure to administer uterotonics • Failure to adequately treat hemorrhage
Poor postoperative care	2 (5.7%)	12 (20.3%) • Failure to transfer to a high-dependency area (7) • Failure to resuscitate when deteriorating post-op (3) • Inappropriate discharge from intensive care • Inappropriate analgesic regimen
No anesthesia documentation	-	3 (5%)
Cases where systems of care contributed to avoidable mortality	**Not reported**	**18 cases, 30%**
Lack of availability of blood	10 (28.5%)	8 (13.6%)
Poor recovery facilities	4 (11.4%)	-
Poor communications	2 (5.7%)	-
Lack of availability of intensive care bed	-	2 (3.3%)
Inadequate nursing staffing/care	-	2 (3.3%)
Lack of availability of equipment/equipment failure	2 (5.7%)	2 (3.3%) • No functional sigmoidoscope • No apnea monitoring

Table 2 continued

	1987	2012
Operating theatre not available in timely manner	-	1 (1.7%)
Lack of availability of investigations (ultrasound scan)	-	1 (1.7%)
Wrong blood given	-	1 (1.7%)
Oxygen failure in theatre	-	1 (1.7%)

* Percentages do not add up to 100% as many cases had multiple contributing causes, including multiple subcategories within surgery, anesthesia, and systems of care

Table 3 De-identified examples of avoidable mortality

Avoidable mortality attributed to surgery (and systems of care).
A young male (ASA III), admitted with an unrelated problem, died after a suspected gastrointestinal bleed whilst an inpatient. Surgery had reviewed the patient and noted the hemoglobin to be 28 $g{\cdot}L^{-1}$, but no effort was made to investigate or treat the cause of the bleed.
Avoidable mortality attributed to anesthesia (and systems of care).
An ASA I female in her 20 s who had a Cesarean delivery died on the ward of respiratory failure. Her trachea was extubated at the end of the procedure despite low intraoperative oxygen saturations and having been given aminophylline. Her trachea was re-intubated *in extremis* in recovery, but as no intensive care beds were available, her trachea was extubated and she was sent to the ward.
Avoidable mortality attributed to systems of care.
An ASA II female in her 30 s who had a Cesarean delivery followed by hemorrhage died of pulmonary edema and shock. There had been more than a three-hour delay in getting blood when her hemoglobin was 35 $g{\cdot}L^{-1}$; incompatible blood was delivered.

ASA = American Society of Anesthesiologists

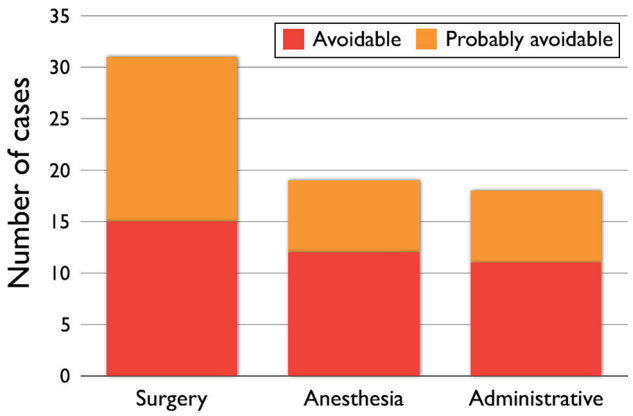

Fig. 3 The contributions of surgery, anesthesia, and administrative issues to avoidable mortality. Red refers to avoidable deaths and orange to probably avoidable deaths

seems likely that the anesthesia care team will need to work together with nursing teams and hospital administration in order to ensure adequate nurse education, staffing, and intensive care resources to care for critically ill surgical patients.

The most common systems of care failures were related to the timely availability of correctly cross-matched blood products (eight of 37 cases, 22%), a problem often due to organizational issues and communication breakdown rather than an absolute scarcity of blood products. The most common "administrative" factor contributing to mortality in 1987 was "insufficient or no blood" (ten of 35 cases, 29%). This has also been found to be the most common systems factor in other developing countries and was implicated in ten of 30 perioperative deaths in Togo in 2005.[13] Inability to manage severe hemorrhage was the most common avoidable factor in perioperative deaths in a study in Zimbabwe in 1995,[14] and inadequate blood bank services was a key factor in a Nigerian tertiary teaching centre in 2007.[15] This was the only "administrative" cause of avoidable death in a study in Malawi in 2000, although that study described the situation at that time as having no blood bank and all blood was donated by relatives.[16] This is very different from the situation in Zambia where the Lusaka-based Zambia National Blood Transfusion Service is 100% dependent on volunteer donations. Our data and the existing literature urgently warrant further collaborative research and quality improvement by anesthesia, surgical specialties, and transfusion medicine on how best to manage, process, and distribute this scarce resource in a low-income context.

Categorization of cause of death into surgical, anesthesia, or systems issues is subjective. Nevertheless, consensus was eventually achieved in all cases. The key point here is the fact that most avoidable deaths involved a combination of factors, suggesting that improved interprofessional and interspecialty collaboration (e.g., joint mortality and morbidity meetings, a combined audit, and jointly developed clinical and logistic protocols) is likely necessary to achieve a significant reduction in avoidable mortality. The high total perioperative mortality

and avoidable mortality are significant concerns and, in light of other data showing underresourced anesthesia services across Zambia,[10] they signify a mandate for greater investment in perioperative care.

Our secondary objective was to identify the six-day perioperative mortality rate. Disappointingly, deficiencies in the completeness of the data available for review precluded an accurate estimate of perioperative mortality at the UTH in Zambia. The failure to identify many perioperative deaths is likely due to our inability to compare the mortuary register with the 5,636 cases missing from the theatre registers. As we are relatively confident in our denominator, it is almost certain that our "best possible case" mortality rate is an underestimate. Therefore, despite a global trend towards reducing perioperative mortality, it is extremely unlikely that there was a decrease in perioperative mortality at the UTH since the 1980s - in fact, it is possible that it has actually increased. It is difficult to determine from our data why this would be the case, but we point out that, as one of the United Nation's designated Least Developed Countries, Zambia lacks the infrastructure and strong healthcare systems necessary for safe timely surgical care. Bainbridge noted key factors that may have led to improvements in perioperative mortality since the 1970s, including advancements in training in anesthesia and surgery, improved selection of patients, advances in aseptic technique and sterilization, increased use of antibiotics, improved postoperative care, improved monitoring, fluid and blood administration, and improvements in team work. [1] Anecdotally, there has been little improvement in these factors at UTH since 1987, and these would be ideal areas to focus attention for the future.

In common with historical data from the UTH but in contrast with data from the developed world,[17] perioperative deaths were most common in young patients (younger than 40 yr),[9] which also has significant economic implications for the families of the deceased.

Improved audits and reporting appear to be essential first steps in improving perioperative care; otherwise, it is difficult to advocate to governments and funding organizations for the necessary investment to improve outcomes. We would suggest that the World Health Organization include perioperative statistics in its Global Health Observatory data bank. This would encourage institutions to upgrade their recordkeeping and provide ongoing robust data for measurement.

Although any audit of perioperative mortality must be retrospective, we were further limited by having to identify the deaths retrospectively, whereas the deaths in the previous study at the UTH were identified prospectively. This may have contributed to the significant amount of missing data. Ideally, the perioperative mortality rate should include all deaths up to 30 days postoperatively in order to capture important late deaths; however, in our study, we chose six-day mortality to allow a comparison with historical data. Future research should endeavour to determine the 30-day mortality rate, or at least all deaths before discharge, as post-discharge follow-up is often unfeasible in low- and middle-income countries.

In conclusion, we were unable to show a decrease in the total perioperative mortality rate at the UTH during 1987 to 2012. This was due in part to an inability to review over half of the files of perioperative deaths in 2012. Nevertheless, considering even a "best case scenario", it is extremely unlikely that mortality has improved over this period of time. In the files reviewed, the factors leading to avoidable deaths were delays in surgery, lack of availability of blood products, and poor postoperative care. We recommend a multiprofessional approach to the review of morbidity and mortality and a collaborative approach to quality improvement and patient safety. These initiatives are likely necessary to reduce avoidable perioperative deaths.

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Conflicts of interest None declared.

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