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Monitoring Anesthesia Care Delivery and Perioperative Mortality in Kenya Utilizing a Provider-driven Novel Data Collection Tool

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Abstract

Background—Perioperative mortality rate is regarded as a credible quality and safety indicator of perioperative care, but its documentation in low and middle income countries is poor. We developed and tested an electronic, provider report driven method in an East African country.

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Methods—We deployed a data collection tool in a Kenyan tertiary referral hospital that collects case-specific perioperative data, with asynchronous automatic transmission to central servers. Cases not captured by the tool ('non observed') were collected manually for the last two quarters. We created logistic regression models to analyze the impact of procedure type on mortality.

Results—Between January 2014 and September 2015, 8,419 cases out of 11,875 were captured. Quarterly data capture rates ranged from 423 (26%) to 1,663 (93%) in the last quarter. There were 93 (1.53%) deaths reported at 7 days. Compared to 4 (0.53%) deaths in Cesarean section, general surgery (42; 3.65%, odds ratio [OR] 15.8, 95%CI: 5.20–48.1; $p<0.001$), neurosurgery (19; 2.41%, OR 14.08, 95%CI: 4.12–48.1; $p<0.001$), and emergency surgery (25; 3.63%, OR 4.40, 95%CI: 2.46–7.86; $p<0.001$) carried higher risk of mortality. The 'non observed' group did not differ from electronically captured cases in 7-day mortality (1; 0.23% versus 16; 0.58%, OR 3.95, 95%CI: 0.41–38.2; $p=0.24$).

Conclusions—We created a simple solution for high-volume, prospective electronic collection of perioperative data in a lower middle income setting. We successfully used the tool to collect a large repository of cases from a single center in Kenya, and observed mortality rate differences between surgery types.

Keywords

global surgery; global anesthesiology; surgical outcomes; Kenya; perioperative mortality; postoperative mortality; electronic data collection

Introduction

Non-communicable diseases are an increasing disease burden in many low and middle income countries.^{1–3} Providing basic surgical and anesthesia care in such countries could avert as many as 1.4 million deaths yearly.¹ It is important to assess current outcomes in order to identify and remedy unsafe practices or poor quality care along the way to improving surgery and anesthesia in low resource countries. Perioperative mortality rate (defined as percentage of patients dying during or shortly after surgery) is a credible quality and safety indicator of perioperative care.^{3,4} Perioperative mortality rate (henceforth referred to as 'postoperative mortality') data are crucial to direct capacity-building efforts for safe surgical care in low and middle income countries.

Postoperative mortality is a principal indicator of the safety of surgery and anesthesia care in a country or health region.^{3–5} Risk adjustment for factors such as the American Society of Anesthesiologists physical status (ASA status), age, admission urgency, and type of procedure can refine interpretation of postoperative mortality outcomes.⁵ Postoperative mortality is well-documented in high income countries but rarely used as outcome metrics in low and middle income countries.^{3–5} Postoperative mortality in high income settings is 9-fold lower than in low and middle income countries (0.38 vs. 3.44 per 100 admissions, respectively),⁵ and postoperative mortality has declined more in high income countries than in low and middle income ones over the past 3 to 4 decades.⁶ A systematic review of postoperative mortality reporting in low and middle income countries from 1995–1999 revealed a median in-hospital mortality rate of 1.2% for elective procedures and 10.1% for

emergency procedures.⁷ Studies of postoperative mortality have been limited by several factors, including: a) small sample size, b) hospital-level surveys instead of patient level data, c) focus on a specific surgery, such as Cesarean section or cleft palate repair, and d) data collected retrospectively from surgical case logbooks, which are often incomplete.^{8–14}

We designed and implemented a simple electronic data collection solution to gather information on anesthesia, surgery, and perioperative outcomes in a prospective, near real-time manner. We present the methodology for creating and implementing this postoperative mortality tool in Kenya and demonstrate 21 months of case-by-case postoperative mortality data from a rural tertiary referral hospital.

Materials and Methods

Study Design

The Vanderbilt University Medical Center (Nashville, Tennessee, USA) and the Kijabe Hospital Institutional Review Boards (Kijabe, Kenya) approved the study without requiring written informed consent. AIC Kijabe Hospital is a 285-bed, rural teaching hospital that serves a catchment area of 45 million persons.¹⁵ It was chosen to be the first center for implementation of the data collection tool because of its clinical and educational capacity in surgery and anesthesia. Results of the prototype are intended to support an ongoing project to expand anesthesia and surgery capacity in government and non-government hospitals throughout Kenya.

Questionnaire

A case report form was assembled using two guiding principles. First, we included all data fields believed to be important for understanding baseline characteristics of surgical care and outcomes in low and middle income countries. Second, we limited the number of data fields to make the case report form reasonable to complete by the anesthetist during a typical surgical case. These somewhat competing principles were iteratively applied employing a modified Delphi technique with Vanderbilt University (BS, MDM, JPW, WSS) and Kijabe Hospital (MWN, JK, MM) experts. The result contains five sections of questions, yielding a final case report form with 132 data fields (Appendix 1 and 2).

Data Collection Tool

Kenyan anesthetists performed initial data collection using paper forms while we developed the electronic data collection system. We created the electronic system on the Research Electronic Data Capture (REDCap) platform, a free, customizable web based data collection instrument that typically requires Internet connectivity for functionality.¹⁶ Internet connectivity can be unreliable in rural Kenya, so we created a version of the REDCap tool supporting offline data capture with asynchronous data upload when an Internet connection was available (Appendix 3). During the implementation phase, Kenyan registered nurse anesthetists and student nurse anesthetists received training on principles of quality improvement, real-time data acquisition, data management, and professionalism. We collected data from January 2014 to September 2015, organized into seven 3-month quarters.

Mortality

Data collectors followed patients prospectively from preoperative assessment until 7 days into the postoperative period (Appendix 2e). When patients were discharged prior to the 7th day, a follow up phone call was made to the patient or designated family member. In-patient mortality data were independently verified using existing in-hospital mortality logs. Cases that were missed, meaning not collected using the REDCap tool, were identified using the surgical logbook (henceforth referred to as 'non observed'). Key outcome data for 'non observed' cases were manually collected retrospectively for the last 6 months of the data collection period. This manual collection of data did not employ the REDCap tool.

Statistical Analysis

We described baseline characteristics and demographics using counts and percentages for all categorical data. Ear, nose and throat, endoscopy, gynecology, ophthalmology, oral/maxillofacial, and urology surgeries were grouped together and referred to as 'other procedures' under the classification of procedure type. Demographic and clinical characteristics were compared between 'observed' and 'non observed' cases in the last two quarters using the Fisher exact test or Kruskal-Wallis test for categorical and quantitative factors, respectively.

Two types of missing data were identified: the 'non observed' and, for observed cases, missing mortality status. Both types of missing data can introduce bias in the estimate of postoperative mortality and its association with procedure type and other factors. Missing mortality records and missing records for key covariates were treated using multiple imputation with the chained equations approach.¹⁷ Specifically, this method was used to account for uncertainty due to missing values for emergency and trauma status, time of procedure (day/night/weekend), and mortality status at 24 hours, 48 hours, and 7 days. Records with missing values for other covariates were excluded from analysis. We multiply imputed each of these variables using the remaining variables, including procedure type. One hundred chains were initialized and evaluated for 30 iterations. All subsequent statistical analyses were evaluated using each of the 100 completed data sets. The results of these analyses were combined using Rubin's rules.¹⁸

Inverse probability weighting was used to compute marginal estimates of 24-hour, 48-hour, and 7-day postoperative mortality, accounting for the possibility of bias due to missing cases that were not captured in REDCap. Specifically, in the completed Q2–Q3 2015 case data, the probability of failed capture by the REDCap system was estimated using logistic regression, adjusting for procedure type, emergency, trauma, and pediatric status, and time of procedure. The fitted model was then used to estimate the probability of failed capture for all observed procedure records. The reciprocals of these probabilities were used to weight estimate of 24-hour, 48-hour, and 7-day postoperative mortality. All mortalities are reported cumulatively, meaning deaths in 24-hours were counted in 48-hour and 7-day mortality, and deaths in 48 hours were counted in 7-day mortality.

The adjusted associations between mortality (24-hour, 48-hour, and 7-day) and procedure type, emergency, trauma, and pediatric status, time of procedure, and date (days from the

start of data collection) were assessed using unweighted logistic regression analysis. The effect of procedure date was modelled using a restricted cubic spline with three degrees of freedom and knots spaced evenly along the procedure date quantiles. Probabilities and odds ratios were summarized using Wald-type 95% confidence intervals. All statistical analyses were implemented using the open-source software package “R” (<http://www.r-project.org>) with the add-on package “mice”, for multiple imputation.^{17,19}

Results

From January 2014 to September 2015 data from 8,419 cases were captured with the REDCap tool, representing 71% of the 11,875 cases recorded on the surgical book at Kijabe Hospital during that period. We excluded 553 (6.56%) cases with missing demographics and procedure type data, and entered 7,866 cases into the postoperative mortality analysis (Figure 1). Table 1 gives details of patient, provider, and case demographics. Most patients, 7,444 (94.6%), were healthy, as defined by ASA status equal to 1 or 2. Most cases, 7,635 (97.1%), were performed by Kenyan registered nurse anesthetists as is customary at Kijabe Hospital. Because Kijabe Hospital is a training center, 6,679 (84.9%) of the cases included nurse anesthetist students under the direct supervision of registered nurse anesthetists and anesthesiologists in a task sharing, anesthesia team model.

Pulse oximetry was used in 7,813 (99.3%) of cases, blood pressure measurement at least every 5 minutes in 7,737 (98.4%), and a 3-lead electrocardiogram in 7,517 (95.6%). Only 4,829 (61.4%) cases utilized end tidal CO₂ monitoring, and only 1,319 (16.8%) reported monitoring of patient temperature (Table 1). In 7,822 (99.4%) of the cases, a Safe Surgery Checklist was performed, designed to reduce postoperative mortality.²⁰

Overall, 1,702 (21.6%) cases entered into REDCap were missing 7-day mortality data (Figure 1). After a research assistant was hired at the end of the first quarter of 2015 to focus solely on collection of 7-day mortality data, missing data for this statistical element dropped to 5 (0.32%) in the final quarter (Figure 2).

Concerning postoperative mortality, there were 50 (0.64%) mortalities reported at 24 hours, 66 (0.87%) at 48 hours, and 93 (1.53%) at 7 days after surgery (Table 2). Patients who underwent Cesarean section had the lowest 24-hour (2; 0.23%), 48-hour (3; 0.34%), and 7-day (4; 0.53%) mortality, while patients who underwent general surgery ([20; 1.23%], [29; 1.83%], and [42; 3.65%]) and emergency surgery ([13; 1.53%], [17; 2.04%], and [25; 3.63%]) showed significantly higher 24-hour, 48-hour, and 7-day mortality, respectively (Table 2). Logistic regression analysis for 24-hour mortality showed that as compared to Cesarean section, general surgery (OR 10.68, 95%CI: 2.32–49.13; $p=0.002$), neurosurgery (OR 8.45, 95% CI: 1.56–45.8; $p=0.01$), orthopedic surgery (OR 6.81, 95%CI: 1.31–35.4; $p=0.02$), and emergency surgery (OR 4.30, 95%CI: 1.97–9.41; $p=0.0003$) were associated with higher risk of mortality (Table 3). Trauma, pediatrics, and ‘other surgeries’ were not associated with increased risk of 24-hour mortality. In addition, the number of days following the start of data collection was also significantly associated with 24-hour mortality. Specifically, the odds ratio associated with day 450 vs. day 0 was 0.55 (95% CI: 0.25–1.23; $p=0.15$). The corresponding odds ratio for day 600 vs. day 450 was 0.11 (95%

CI: 0.02–0.71; $p=0.02$) (Figure 3). These associations with mortality were also seen in 48-hour and 7-day mortality (Table 3).

During the study period, 3,456 cases from the surgical log book were not captured by the REDCap tool ('non observed'). The first three months of data collected via paper form showed the lowest capture rate, at 26%, while after implementation of electronic tool the average data capture rate was at 77%, increasing to 93% of all cases in the final quarter (Figure 4). Comparison of observed and 'non observed' data for the last two quarters revealed there were more night and weekend cases (28.9% and 40.3% vs 3.5% and 1.1%, $p<0.001$), emergency cases (52.2% vs 8.6%, $p<0.001$), and trauma cases (15.6% vs 11.1%, $p=0.008$) in the 'non observed' group than in the 'observed' group. Procedure type distribution also differed between groups, with fewer orthopedic and pediatric cases in the 'non observed' group (Table 4).

Regression analysis of the 'non observed' group revealed general surgery, neurosurgery and emergency surgery associated with higher 48-hour and 7-day mortality as compared to Cesarean section, similar to the finding with the observed group (Table 5). Adjusting for procedure, emergency status, trauma status, and time of surgery (day, night, weekend), there was no evidence that being in the 'non observed' group was associated with 48-hour (OR 3.52, 95% CI: 0.34–36.7; $p=0.29$) or 7-day (OR 3.95, 95% CI: 0.41–38.2; $p=0.24$) mortality. Because there were no deaths in 24-hour mortality in the 'non observed' group for these quarters, we were unable to perform regression analysis for 24-hour mortality.

We used the propensity score model associated with the 2015 quarter 2 and 3 data to compute the likelihood of having been observed for each case in the whole study cohort and used inverse probability weighting to estimate 24-hour, 48-hour, and 7-day mortality. This revealed an adjusted 24-hour mortality of 0.71 (95% CI [0.54–0.92]), 48-hour mortality of 0.99 (95% CI [0.78–1.24]), and 7-day mortality of 1.86 (95% CI [1.52–2.27]), as opposed to an unadjusted mortality of 1.58.

Discussion

Kenyan anesthesia providers achieved near real-time, point of care collection of key perioperative anesthesia and surgical data using the electronic data collection tool we developed. Thus, we have enabled near real-time electronic outcomes capture for large surgical populations in a middle income country. Postoperative mortality at a tertiary referral center in Kenya is lower than previous reports from similar centers. Consistent with previous literature, emergency surgery is associated with higher postoperative mortality than elective cases. Lastly, we documented higher postoperative mortality rates in orthopedics, general surgery, and neurosurgical cases, as compared to Cesarean section, the most common procedure in low- and middle-income countries.

Prospective Large Scale Data Collection Possible in Low and Middle Income Countries

Our postoperative mortality data were collected prospectively, in contrast to other reports from hospitals in Africa.^{21,22} We collected perioperative data from 8,419 out of 11,875 cases, providing richer data to interpret observed surgical outcomes. Through continued

education and resource allocation, we were able to reduce 'non observed' cases to 7% of total in the last quarter of data collection. We manually collected postoperative mortality data on a subgroup of the 'non observed' population and were then able to demonstrate that postoperative mortality outcomes of cases captured in the REDCap tool were representative of the whole surgical population. While there is a possibility that there are some cases that were performed but not entered in the surgical logbook, based on our clinical experience at Kijabe Hospital, this happens in very rare circumstances. At this hospital there are personnel dedicated to entering such data daily in the surgical logbook, even on weekends, and the likelihood of selection bias affecting our outcomes analysis is extremely low.

Postoperative Mortality at a Tertiary Referral Center in East Africa

Our overall mortality rate is lower than anticipated. Postoperative mortality in low and middle income countries ranges from 3.44% to 6%.^{5,7,21,22} Consistent use of ASA standard monitors, which have been shown to improve perioperative outcomes,^{23,24} might reduce mortality in our population. Monitors are less available in most other low income institutions. For example, pulse oximetry use rates of 12% (Tanzania) to 46% (Uganda) are typical.²⁵ In addition Kijabe Hospital is an international training center for both anesthesiology and surgery, attracting skilled practitioners and creating an environment of excellence, which probably influences postoperative mortality. Lastly the use of the Safe Surgery Checklist in 99.4% of operative cases could have contributed to a lower mortality rate.²⁰ It is important to note that the quality of the use of the checklist was not assessed in depth in this study, therefore additional analysis is needed to further investigate this association.²⁶

We observed declining mortality late in the study period (Figure 3). While the exact reason is not known, we speculate the following. First, the Kenyan Registered Nurse Anesthetist workflow was changed in early January 2015 to relieve the anesthetist from clinical care after taking a full night of call. Fewer fatigued providers on the day shift may have lowered mortality.^{27,28} Second, during this study we placed significant educational emphasis on the need to monitor patient outcomes and modify clinical practice to improve outcomes. It is possible that emphasis on monitoring and improving outcome metrics engendered increased vigilance and more diligent care during each case.²⁹ Third, it is possible that case mix shifted to healthier patients or lower acuity without being detected in the REDCap tool, independently lowering mortality risk. A future study is needed to prospectively test the possibility that the introduction of an initiative of this type might improve outcomes.

We observed increased mortality in patients undergoing emergency surgery, consistent with previous reports,^{4,5,22,30} and postoperative mortality rate was also higher in the general surgery, orthopedics, neurosurgery patient mix compared with Cesarean section patients. Regional referral hospitals naturally attract non-obstetrical patients who have a more guarded prognosis. In addition, delayed presentation for oncologic surgery or fixation of fractures is common in low and middle income countries.^{31,32} In contrast, the obstetrical patient is younger, has fewer co-morbidities, and primarily arrives from a short distance, potentially explaining mortality differences. In the future, it will be important to evaluate

mortality rates within these surgical specialties among national referral hospitals to see if the case mix and outcomes are similar.

A standardized set of validated metrics for postoperative mortality rate in low and middle income countries does not exist.⁴ Weiser et al recommended using “day of surgery death ratio” and “in-hospital death ratio” as two metrics that could be adopted globally.³³ We chose to report 24-hour, 48-hour, and 7-day mortality. We believe that the 24-hour death ratio functionally represents day-of surgery ratio for most patients.⁴ Additionally, we believe that 24-hour mortality may have an advantage in that it takes into account emergency cases that are completed in the evening. For instance, a case that ends at 10PM would only have a 2 hour period to consider “day of surgery” mortality, as opposed to a full 24 hours postoperatively in our metric. We elected to collect 7-day mortality instead of “in-hospital death ratio” because we found it challenging to identify date of hospital discharge reliably within our data collection system and current personnel, in a setting where there is no electronic medical record and poor record keeping in general. Instead, having a specific date of follow up after surgery ensured consistency of reporting. We believe that 7-day mortality will capture majority of in-hospital mortality, as it is our experience that almost all patients in our setting are discharged by this time point. However, we recognize that future research should address which set of metrics is most valid and reliable in low and middle income countries.

Strengths and Limitations

The mechanism by which postoperative mortality was determined in this large cohort was the result of a simple information technology solution coupled with a robust and environment-appropriate data collection education program for the anesthesia providers. Our data collection tool allows for electronic data collection without the need for continuous Internet connectivity. Transmission to a central server makes data analysis and reporting more robust, facilitating data aggregation as other data collection sites come online throughout Kenya. Considering that most postoperative mortality data are derived from review of logbooks or paper data collection, a prospective, electronic solution could be a major step forward.

It would have been ideal to collect data from 100% of cases, but we encountered barriers. Electronic data entry in the perioperative period changes the anesthesia providers’ workflow, particularly in low and middle income countries, where paper anesthesia charts are the primary record. This additional workload is eased by the presence of students in the theater, but students are not always available. We plan to modify the REDCap tool to produce a simple intraoperative record, along with its other features, minimizing duplication of effort. In addition, data collection and intraoperative charting in general can have the potential to detract from vigilance. This is not unique to our data collection system or the low resource setting, but something that comes with anesthesia practice and knowing what to prioritize. Part of the training we provide to the data collectors includes emphasizing the precedence clinical care takes over documentation.

There are several limitations to our study. Kijabe Hospital is a tertiary referral hospital with surgery specialization in pediatrics and neurosurgery and extensive, highly supervised

anesthesia and surgery training programs. As such, generalizations of these observed outcomes to other health facilities and hospitals should not be made without accounting for practice setting differences. Second, given an average capture rate of approximately 75% of all cases, it is possible that our dataset varies from the actual population of cases performed. While we believe we have adequately addressed this issue by collecting a sample of ‘non observed’ data and using inverse propensity weighting to estimate postoperative mortality rate and to account for missing data, it is always possible that the true mortality is different from what we observed. Third, as in all non-automated environments, data entry and accuracy are dependent on the skill and diligence of the data collectors. While in-hospital mortality data are verified by an independent person using hospital mortality logs and phone calls to patients and patient families, data quality is still susceptible to human error and bias. As the tool is further modified, data field restrictions are being implemented to improve data quality. Fourth, in October 2014, Kenya’s economic status was changed from low income to lower middle income according to the World Bank, which could impact the application of this study to a country that is a low income country. Lastly, many patients were discharged before postoperative day 7, reducing our 7-day mortality follow up. We hired a research nurse to collect 7-day follow up data, reducing missing data in REDCap observed cases to 0.32% (Figure 2). This raised costs, but we demonstrated feasibility with only one additional staff member at a high-volume referral center. This need for additional personnel will have cost implications in smaller and under-resourced hospitals. We have found that with adequate training, a health care worker with diploma level training is able to accomplish the task. In addition one worker can cover multiple hospitals, depending on case load, which might alleviate some of the cost burdens.

Future Directions and Conclusions

We plan to expand the scope of this project to include a wide variety of hospitals throughout Kenya, including many government facilities. Additionally, we are keen to engage partners in low and middle income countries who wish to use the tool that we described, both to enter data and to improve its content based on local experience. By expanding this data collection effort nationally and in other low income countries, we seek to provide perioperative outcome metrics in diverse hospital settings as baselines against which to evaluate capacity-building efforts. These data are most useful when shared transparently with healthcare system leadership in the government, non-governmental, and faith-based organization sectors, accompanying an assessment of barriers to providing safe surgery and anesthesia for their representative patient populations. Collection and reporting of perioperative outcome metrics, such as postoperative mortality rate, are vital first steps in the quality improvement cycle so urgently needed for emerging health systems to deliver safe surgery and anesthesia. As a goal in line with the vision of Global Surgery 2030,³ creating a multinational dataset surrounding perioperative outcomes, particularly for bellwether procedures, could help guide the development and deployment of resources in these settings.

We created a simple solution for high-volume, prospective electronic collection of perioperative medical information in an asynchronous, context-sensitive manner. We successfully used the tool to collect a large repository of cases from a single center in East

Africa, demonstrating that 24-hour, 48-hour, and 7-day mortality data can be measured along with perioperative process data.

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Appendix 1: PDF of 132-item case report form

Global Perioperative Outcomes

Please enter your case information below.

TRAINEE INFORMATION

Select highest training level completed:	☐ Physician (MD) ☐ RN ☐ CO
Anesthesia Care Provider	_____ (Initials followed by YOB (Example: MSH1962))
Month of Training	_____
Role	☐ Primary Provider (primary student) ☐ Secondary Provider (assisting student)
Hospital	☐ AIC Kijabe Hospital ☐ University of Nairobi ☐ Other (write name) _____
Please select place of surgical case and write in the name:	☐ Provincial Hospital: (name) _____ ☐ District Hospital: (name) _____ ☐ Sub-District Hospital: (name) _____ ☐ Other: (name) _____
Supervisor (person overseeing you for this case)	_____

PATIENT DEMOGRAPHICS

Medical Record Number	_____
Procedure Date (MM/DD/YYYY)	_____
Country of Patient (write UNK if unknown)	_____
District of Patient (write UNK if unknown)	_____
The patient is from which of the following locations? (select one)	☐ Outpatient ☐ General Ward ☐ ICU ☐ HDU ☐ Burn Unit ☐ Newborn Unit ☐ Casualty ☐ Referral or transfer
Patient Age (select one; if unknown, please estimate)	☐ < 1 mo ☐ ≥1 mo, but < 3 mo ☐ ≥3 mo, but < 3 yrs ☐ ≥3 yrs, but < 12 yrs ☐ ≥12 yrs, but < 18 yrs ☐ ≥18 yrs, but < 65 yrs ☐ ≥65 yrs
Gender	☐ Female ☐ Male

Patient Weight (kg)	☐ < 2 kg ☐ 2-3 kg ☐ 4-10 kg ☐ 10-50 kg ☐ 50-70 kg ☐ 70-100 kg ☐ >100 kg
Physical Status Class	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Patient Contact Information (Phone Number)	_____

CASE INFORMATION

Emergency?	☐ yes ☐ no
Trauma (only count if this is 1st operation after trauma event)	☐ Not a trauma case ☐ MVA (car, truck, etc) ☐ Auto v. Pedestrian ☐ Motorcycle ☐ Penetrating injury (knife, GSW) ☐ Blunt trauma (attack, sports, accidental) ☐ Fall-related injury
Length of time since trauma:	☐ _____ hours ☐ not a trauma
Transportation mode to hospital:	☐ Ambulance ☐ Private vehicle (car, truck, van) ☐ Motorcycle ☐ Bicycle ☐ Walk
Time	☐ Daytime (normal hours M-F) ☐ Night (5p-7a M-F) ☐ Weekend (Sat/Sun)
Time of surgery (HH:MM)	_____

ANESTHETIC INFORMATION

Anesthetic Type	☐ Local Only ☐ MAC/Sedation with or without local ☐ General ☐ Spinal ☐ Epidural ☐ Combined Spinal-Epid ☐ Other Regional Block ☐ Combined Regional/General
-----------------	--

Peripheral Nerve Block Site (if applicable)

- ☐ Ankle
- ☐ Axillary
- ☐ Femoral
- ☐ Infra/supra-clavicular
- ☐ Interscalene
- ☐ Lumbar Plexus
- ☐ Paravertebral
- ☐ Popliteal
- ☐ Saphenous
- ☐ Sciatic
- ☐ Other

Localizing technique used:

- ☐ Nerve stimulator
- ☐ Ultrasound
- ☐ Paresthesia
- ☐ Transarterial
- ☐ Other

Neuraxial Block Site (if applicable)

- ☐ Thoracic
- ☐ Lumbar - L2-3
- ☐ Lumbar - L3-4
- ☐ Lumbar - L4-5
- ☐ Caudal
- ☐ Not applicable

If SPINAL ANESTHESIA was used, what was the size of the needle?

- ☐ 25G
- ☐ 22G
- ☐ 20G
- ☐ 18G
- ☐ spinal not used

If spinal or epidural was used, please record the number of attempts:

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more
- ☐ unsuccessful, converted to GA

Primary Procedure Type (ask Supervisor if uncertain about which choice is appropriate)

- ☐ Neurosurgery - intracranial
- ☐ Neurosurgery - spine
- ☐ Plastic surgery
- ☐ Ear, Nose, or Throat (ENT)
- ☐ Orthopedic - upper extremity
- ☐ Orthopedic - lower extremity
- ☐ Orthopedic - spine
- ☐ Vaginal delivery - normal
- ☐ Vaginal delivery - high-risk
- ☐ C-section - elective
- ☐ C-section - fetal distress
- ☐ C-section - maternal bleeding
- ☐ C-section - pre-eclampsia/eclampsia
- ☐ C-section - other
- ☐ Gynecology (hysterectomy, ruptured ectopic, ovarian mass)
- ☐ Gynecology (tubal ligation)
- ☐ Intra-abdominal - bowel/pancreas/bladder
- ☐ Intra-abdominal - liver/kidney/vascular
- ☐ Cardiac or thoracic surgery
- ☐ Other

Procedure Location

- ☐ OR
- ☐ PACU
- ☐ ICU
- ☐ Other

Induction Technique

- ☐ Mask (inhalational)
- ☐ RSI (IV)
- ☐ non-RSI (IV)

Airway Management Techniques Performed	☐ Room Air Oxygen Only ☐ Supplemental Oxygen Only (cannula, face mask, etc.) ☐ Supraglottic Airway (LMA, etc.) ☐ Direct Laryngoscopy and Intubation ☐ Awake Fiberoptic ☐ Asleep Fiberoptic ☐ Cricothyroidotomy ☐ Other (please describe) _____
Airway Device Used	☐ None ☐ Nasal Cannula or Face Mask ☐ LMA ☐ Oral ETT ☐ Nasal ETT ☐ Double Lumen ETT
Airway Management	☐ 1 attempt ☐ 2 attempts ☐ ≥ 3 attempts, secured by trainee (unanticipated DA) ☐ ≥ 3 attempts, secured by supervisor (unanticipated DA) ☐ Airway aborted, patient awakened ☐ Emergency surgical airway
Please select all complications that occurred during the intubation during the induction of anesthesia:	☐ Dental injury ☐ Laceration to lip, tongue, or mouth
Peripheral IV Lines	☐ 1 ☐ 2 ☐ 3 ☐ >3
Was Foley Catheter placed?	☐ Yes ☐ No
Invasive Techniques Performed	☐ Arterial Catheter (landmark) ☐ Arterial Catheter (U/S guided) ☐ Central Venous Catheter (landmark) ☐ Central Venous Catheter (U/S-guided) ☐ None
Invasive Procedure Complication	☐ Hematoma ☐ Pneumothorax ☐ Other ☐ None
Total IV Fluid Given (all types except transfusion; CC)	_____
Types of fluid given (select all that apply)	☐ Normal Saline ☐ Lactated Ringer's ☐ Colloid (albumin, starch) ☐ Blood
Volume Transfused (CC) - Whole Blood	_____
Estimated Blood Loss (CC)	_____
Length of surgery (incision to close; HH:MM)	_____
Length of anesthesia (induction to emergence; HH:MM)	_____

Vital Signs Information

Preop HR (bpm) _____

Preop_BP (Sys/Dias) _____

LOWEST Intraop HR (bpm) _____

HIGHEST Intraop HR (bpm) _____

LOWEST Intraop BP (Sys/Dias) _____

HIGHEST Intraop BP (Sys/Dias) _____

FOLLOW-UP & COMPLICATIONS

Postoperative oxygen requirement (within 48 hours of surgery):

- ☐ No oxygen requirement
- ☐ Nasal cannulae
- ☐ Face mask
- ☐ Intubation and spontaneous ventilation
- ☐ Intubation and controlled ventilation (ventilator)

Surgical or Anesthesia Procedure Complications?

- ☐ Yes
- ☐ No

Outcomes - please select all outcomes that occurred for the patient during the hospitalization after surgery. Next to each one selected, please write which postoperative day (e.g. POD2 for post-operative day 2).

- ☐ No complications
- ☐ Intraoperative Death
- ☐ Postoperative Death (< 24 hours)
- ☐ Nervous system: Stroke
- ☐ Nervous system: Seizure
- ☐ Nervous system: Postoperative Delirium
- ☐ Nervous system: Peripheral Nerve Injury
- ☐ CV: Cardiac Arrest
- ☐ CV: Myocardial Ischemia/Infarction
- ☐ CV: Congestive Heart Failure
- ☐ CV: Cardiac Dysrhythmia
- ☐ CV: Severe Hypotension (SBP < 70)
- ☐ Resp: Unplanned Respiratory Arrest
- ☐ Resp: Aspiration
- ☐ Resp: Pulmonary Edema
- ☐ Resp: Bronchospasm
- ☐ Resp: Pneumothorax
- ☐ Airway: Laryngospasm
- ☐ Airway: Difficult Mask Ventilation
- ☐ Airway: Difficult Laryngoscopy/Intubation
- ☐ Airway: Esophageal Intubation
- ☐ Airway: Unplanned Reintubation
- ☐ Airway: Unplanned Tracheotomy
- ☐ Airway: Airway/Dental Injury
- ☐ Misc: Vascular Injury
- ☐ Misc: Wrong Site Surgery
- ☐ Misc: Drug Error
- ☐ Misc: Equipment Problem/Failure
- ☐ Misc: Allergic Reaction
- ☐ Misc: OTHER

Event Comments

Was the patient alive on the day after surgery?

- ☐ Yes
- ☐ No

Was the patient alive 2 days after surgery?

- ☐ Yes
- ☐ No

Was the patient alive 1 week (7 days) after surgery?

- ☐ Yes
- ☐ Uncertain - discharged to home alive before 7 days
- ☐ No - died on post-operative day _____

Other Case Comments

Abbreviations: a – am, AIC – African Inland Church, bpm – beats per minute, CC – milliliter, CO – clinical officer, C-Section – Cesarean section, CV – cardiovascular, DA – difficult airway, DD – date, Dias – diastole, ENT – ear, nose, or throat, Epid – epidural, ETT – endotracheal tube, G – gauge (e.g., 25G – 25 gauge needle), GA – general anesthesia, GSW – gunshot wound, HDU – high demand unit, HH:MM – hours and minutes, HR – heart rate, ICU – intensive care unit, IV – intravenous, kg – kilogram, LMA – laryngeal mask airway, MAC – monitored anesthesia care, MD – medical doctor, M-F – Monday to Friday, Misc – miscellaneous, MM – month, MVA – motor vehicle accident, OR – operating room, p – pm, PACU – post anesthesia care unit, POD – postoperative day, REDCap – Research Electronic Data Capture, Resp – respiratory, RN – registered nurse, RSI – rapid

sequence intubation, Sat – Saturday, Sun – Sunday, Sys – systole, U/S – ultrasound, v. – versus, YOB – year of birth, YYYY – year.

Appendix 2

Appendix 2a.

REDCap

Logged in as [username] Log out

My Projects

Project Home

Project Setup

Project status: Production

Data Collection

Manage Survey Participants

Record Status Dashboard

Add / Edit Records

Record ID 20

Select other record

Provider Info and Case Demographics

General Case Information

Anesthetic Information

Vital Signs Info

Follow-up And Complications

Applications

Calendar

Data Exports, Reports, and Stats

Data Import Tool

Data Comparison Tool

Logging

Field Comment Log

File Repository

User Rights and DAGs

Record Locking Customization

E-signature and Locking Mgmt

Data Quality

API and API Playground

REDCap Mobile App

Project Bookmarks

Synchronize My Data

Reports

Edit records

ImPACT Africa Global Perioperative Outcomes Project

VIDEO: Basic data entry

Save Record
Save and Continue
Save and go to Next Form

Actions: Download PDF of instrument(s) Share instrument in the Library

Assign record to a Data Access Group? [select a group] 1

Adding new Record ID 20

Record ID 20

Global Perioperative Patient and Provider Database

Thank you for taking the time to fill out the case log below. The information that is entered will be used to track case logs for students and to track the delivery of care for patients at your hospital. The specific case management information that you enter, include possible complications, will not be part of your evaluation as a student.

ANESTHESIA PROVIDER INFORMATION AND CASE DEMOGRAPHICS

Anesthesia Care Provider

Physician
Registered Nurse
Clinical Officer
Anesthesia Technician

Select highest training level that you have completed:

1-6 months
7-12 months
13-18 months
19-24 months
25-30 months
31-36 months
36+ months
I have graduated from training

Please select the number of months that you have completed in anesthesia training (NOTE: if you have graduated, please select the bottom answer):

Primary in-room provider - STUDENT
Primary in-room provider - GRADUATE (e.g. in practice)
Secondary in-room provider (e.g. assisting student)

Please select your role on this case:

AIC Kijabe Hospital
Kenyaatta National Hospital
Tererak Hospital
Other (Select from list below)

Hospital

Medical Record Number

Procedure Date (DD/MM/YYYY)

Country of Patient

District/County/State of Patient (write UNK if unknown)

Patient Contact Information (Phone Number)

The patient is from which of the following locations? (select one)

Patient Age (select one; if unknown, please estimate)

Patient Age (if unknown, please estimate)

Gender

Patient Weight (kg)

Patient Height (cm)

Physical Status Class

Form Status

Complete?

Lock this record for this form?

Save Record
Save and Continue
Save and go to Next Form
Cancel

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Appendix 2b.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

REDCap™

Logged in as: Log out

My Projects

Project Home

Project Setup

Project status: Production

Data Collection

Manage Survey Participants

Record Status Dashboard

Add / Edit Records

Record ID 20 Select other record

Data Collection Instruments:

Provider Info and Case Demographics

General Case Information

Anesthetic Information

Vital Signs Info

Follow-up And Complications

Applications

Calendar

Data Exports, Reports, and Stats

Data Import Tool

Data Comparison Tool

Logging

Field Comment Log

File Repository

User Rights and DAGs

Record Locking Customization

E-signature and Locking Mgmt

Data Quality

API and API Playground

REDCap Mobile App

Project Bookmarks

Synchronize My Data

Reports

Edit reports

ImPACT Africa Global Perioperative Outcomes Project

VIDEO: Basic data entry

Actions:

Download PDF of instrument(s)

Share instrument in the Library

General Case Information

Assign record to a Data Access Group?

-- select a group --

Adding new Record ID 20

Record ID 20

GENERAL CASE INFORMATION

Emergency?

Yes

No

reset

Is this a trauma case?

Yes

No

reset

Transportation mode to hospital:

Ambulance

Private vehicle (car, truck, van)

Motorcycle

Bicycle

Walk

Public transportation

Unknown

reset

General Time of Surgery

Daytime (7am-5pm Mon-Fri)

Night (5pm-7am M-F)

Weekend (Sat/Sun)

reset

Surgery Start Time (HH:MM) Round to the nearest 5-minutes

Click the button "Now" if you're within the time that the surgery began.

C-section - elective

C-section - fetal distress

C-section - maternal bleeding

C-section - pre-eclampsia/eclampsia

C-section - failure to progress

Gynecology (hysterectomy, ruptured ectopic, ovarian mass)

Gynecology (tubal ligation)

General surgery (intra-abdominal) - bowels/pancreas/bladder

General surgery (intra-abdominal) - liver/kidney/vascular

General surgery (Other)

Orthopedic - upper extremity

Orthopedic - lower extremity

Orthopedic - spine

Urology (bladder, prostate, kidney)

Ear, Nose, or Throat (ENT)

Plastic surgery or burns

Neurosurgery - intracranial/VP shunt

Neurosurgery - spine

Oral/Maxillofacial

Endocrine (thyroid)

Cardiac or thoracic surgery

Endoscopy (upper or lower GI)

Vaginal delivery - labor epidural - low risk

Vaginal delivery - labor epidural - high risk

Ophthalmology

reset

Was there a secondary procedure performed?

Yes

No

reset

Procedure Location

OR

PACU

ICU/HDU

Labor/Delivery

Casualty/Emergency Department

reset

Was a Safe Surgery Checklist-Time-Out done before surgery start?

Yes

No

reset

Form Status

Complete?

Incomplete

Lock this record for this form?

If locked, no user will be able to edit this record on this form until someone with Lock/Unlock privileges unlocks it.

Lock

Save Record

Save and Continue

Save and go to Next Form

Cancel

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Appendix 2c.

REDCap

Log in as [] Log out

My Projects
Project Name
Project Setup
Project Status - Production

Data Collection
Manage Survey Participants
Record Status Dashboard
Add/Edit Records

Report ID 20
Data Collection Information
Provider Info and Case Demographics
General Case Information
Anesthetic Information
Vital Signs Info
Follow-up And Complications

Applications
Calendar
Data Exports, Reports, and Stats
Data Import Tool
Data Comparison Tool
Logging
Fast Comment Log
File Repository
User Rights and Data
Record Locking Customization
E-signature and Locking Mgmt
Data Quality
API and API Playground
REDCap Mobile App

Project Bookmarks
Synchronize My Data

Reports
Edit Record

ImPACT Africa Global Perioperative Outcomes Project

Actions: Download PDF of instrument(s) | Share instrument in the Library | VIDEO: Basic data entry

Assign record to a Data Access Group? | select a group

Anesthetic Information

Adding new Record ID 20

Record ID 20

ANESTHETIC INFORMATION

Anesthetic Type

General
Spinal
Combined Peripheral Nerve Block and General
Peripheral Nerve Block only
Sedation with or without local
Local anesthesia only
Spinal
Combined Spinal and Epidural
Combined Epidural and General
Spinal converted to General
Regional converted to General

Peripheral Nerve Block Site (select all blocks performed)

Arachnoid
Auricular
Facial
Infraorbital/mandibular
Intercostals
Lumbar Plexus
Paravertebral
Pudendal
Radial
Sciatic
Ventral block
Digital block (finger or toe)
Other

Localizing technique used (select all used):

Neural stimulator
Ultrasound
Pneumatics
Transperineal
Other

Induction Technique

Mask (inhalational) induction
IV induction
Rapid Sequence IV Induction

Airway Management Techniques Performed (Please select ALL that apply)

Room Air Oxygen Only
Supplemental Oxygen Only (nasal, face mask, etc.)
Bipap/APAP/Away (ASMA, etc.)
Direct Laryngoscopy and intubation
Awake Fiberoptic
Awake Fiberoptic
Cricothyrotomy
Other

Peripheral IV Lines

1
2
3
>3

Which of the following monitors were used? (Please select ALL that apply)

pulse oximeter
end-tidal CO2
blood pressure cuff (automatic at least q5min)
blood pressure cuff (manual at least q5min)
ECG (telemetry/monitoring)
temperature probe
arthroscope
peripheral nerve stimulator

Was Foley Catheter placed?

Yes
No

Were Invasive Techniques performed?

Yes
No

Invasive Techniques Performed

Arterial Catheter (landmark)
Arterial Catheter (US guided)
Central Venous Catheter (landmark)
Central Venous Catheter (US-guided)

Did patient receive IV Fluids?

Yes
No

Total IV Fluid Given (all types except transfusion; CC)

Enter Number (CC) in right eg. 5000

Types of fluid given (select all that apply)

Normal Saline
Lactated Ringers
Colloid (albumin, starch)

Did the patient receive a blood transfusion?

Yes
No

Blood transfused (cc)

Enter Number (CC) in right eg. 500

Estimated Blood Loss (CC)

Enter Number (CC) in right eg. 500

Length of surgical prep time (from Anesthesia release to incision; minutes)

Enter Number (CC) in right eg. 30

Length of surgery (incision to close; minutes)

Enter Number (CC) in right eg. 120

Length of anesthesia (induction to emergence; minutes)

Enter Number (CC) in right eg. 120

Form Status

Complete? ☒ Incomplete 2

Lock this record for this form?
Prevent, for now, all the data to edit this record on this form, until someone with Contributor privileges unlocks it.

Save Record
Save and Continue
Save and go to Next Form
Cancel

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Appendix 2d.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

REDCap™

Logged in as | Log out

My Projects

Project Home

Project Setup

Project status: **Production**

Data Collection

Manage Survey Participants

Record Status Dashboard

Add / Edit Records

Record ID 20

Select other record

Data Collection Instruments:

Provider Info and Case Demographics

General Case Information

Anesthetic Information

Vital Signs Info

Follow-up And Complications

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Data Quality

API and API Playground

REDCap Mobile App

Project Bookmarks

Synchronize My Data

Reports

Edit reports

ImPACT Africa Global Perioperative Outcomes Project

VIDEO: Basic data entry

Actions:

Download PDF of instrument(s)

Share instrument in the Library

Vital Signs Info

Assign record to a Data Access Group?

-- select a group --

Adding new Record ID 20

Record ID 20

Vital Signs Information

Preop HR (bpm)

Enter number ONLY (leave the units out)

Preop Systolic BP

Enter number ONLY (leave the units out)

Preop Diastolic BP

Enter number ONLY (leave the units out)

LOWEST Intraop HR (bpm)

Enter number ONLY (leave the units out)

LOWEST Intraop Systolic BP

Enter number ONLY (leave the units out)

* must provide value

LOWEST Intraop Diastolic BP

Enter number ONLY (leave the units out)

* must provide value

LOWEST Mean Arterial Blood Pressure

View equation

HIGHEST Intraop HR (bpm)

Enter number ONLY (leave the units out)

* must provide value

HIGHEST Intraop Systolic BP

Enter number ONLY (leave the units out)

* must provide value

HIGHEST Intraop Diastolic BP

Enter number ONLY (leave the units out)

* must provide value

10 Point Surgical Outcome

View equation

Form Status

Complete?

Incomplete

Lock this record for this form?

Lock

Save Record

Save and Continue

Save and go to Next Form

Cancel

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Appendix 2e.

REDCap

ImPACT Africa Global Perioperative Outcomes Project

Actions: [Download PDF of instrument\(s\)](#) [Share instrument in the Library](#) VIDEO: Basic data entry

Follow-up And Complications Assign record to a Data Access Group? [-- select a group --](#)

Adding new Record ID 20

Record ID 20

FOLLOW-UP & COMPLICATIONS

Did you have your STANDARD resources available for the care of the patient? (This information will help us in requesting and directing resources in the future.)

☐ Yes ☒ No

* must provide value

Which of the following STANDARD RESOURCES were not available to you? (select all that apply)

☐ medication ☐ monitors ☐ fluid ☐ blood ☐ equipment

Please describe your resource limitations (which medicine, monitor, etc?)

Expanded

Did the patient require postoperative oxygen (within 48 hours of surgery)?

☐ Yes ☒ No

Surgeal or Anaesthesia Procedure Complications?

☐ Yes ☒ No

* must provide value

☐ Intraoperative Death ☐ Postoperative Death (< 24 hours) ☐ Nervous system: Stroke ☐ Nervous system: Seizure ☐ Nervous system: Postoperative Delirium ☐ Nervous system: Peripheral Nerve Injury ☐ CV: Cardiac Arrest ☐ CV: Myocardial Ischemia/Infarction ☐ CV: Congestive Heart Failure ☐ CV: Cardiac Dysrhythmia ☐ CV: Severe Hypotension (SBP < 70) ☐ Resp: Re-intubation ☐ Resp: Unknown cause of Resp Insufficiency ☐ Resp: Aspiration ☐ Resp: Pulmonary Edema ☐ Resp: Bronchospasm ☐ Resp: Pneumothorax ☐ Airway: Laryngospasm ☐ Airway: Difficult Mask Ventilation ☐ Airway: Difficult Laryngoscopy/Intubation ☐ Airway: Esophageal Intubation ☐ Airway: Unplanned Reintubation ☐ Airway: Unplanned Tracheostomy ☐ Airway: Airway/Dental Injury ☐ Misc: Vascular Injury ☐ Misc: Wring Site Surgery ☐ Misc: Drug Error ☐ Misc: Equipment Problem/Failure ☐ Misc: Allergic Reaction ☐ Misc: Central Venous Line Infection ☐ Misc: OTHER

Complications - please select all outcomes that occurred for the patient during the hospitalization after surgery and anesthesia.

Please describe the complication that happened:

Expanded

Was the patient alive on the day after surgery?

☐ Yes ☒ No

Was the patient alive 2 days after surgery?

☐ Yes ☒ No

Was the patient alive 1 week (7 days) after surgery?

☐ Yes ☐ Uncertain - discharged to home alive before 7 days ☒ No

* must provide value

Other Case Comments:

Please enter any comments, thoughts, or concerns that you have regarding this case that are not captured above.

Expanded

Form Status

Complete? ☐ Incomplete ☒

Lock this record for this form?

☐ Lock

If locked, no user will be able to edit this record on this form until someone with Lock/Release privileges unlocks it.

[Save Record](#) [Save and Continue](#) [Cancel](#)

Appendix 2a–e. REDCap data collection tool

Abbreviations: a – am, AIC – African Inland Church, bpm – beats per minute, CC – milliliter, CO – clinical officer, C-Section – Cesarean section, CV – cardiovascular, DA – difficult airway, DD – date, Dias – diastole, ENT – ear, nose, or throat, Epid – epidural, ETT – endotracheal tube, G – gauge (e.g., 25G – 25 gauge needle), GA – general anesthesia, GSW – gunshot wound, HDU – high demand unit, HH:MM – hours and minutes, HR – heart rate, ICU – intensive care unit, IV – intravenous, kg – kilogram, LMA – laryngeal mask airway, MAC – monitored anesthesia care, MD – medical doctor, M-F – Monday to Friday, Misc – miscellaneous, MM – month, MVA – motor vehicle accident, OR – operating room, p – pm, PACU – post anesthesia care unit, POD – postoperative day, REDCap – Research Electronic Data Capture, Resp – respiratory, RN – registered nurse, RSI – rapid sequence intubation, Sat – Saturday, Sun – Sunday, Sys – systole, U/S – ultrasound, v. – versus, YOB – year of birth, YYYY – year.

Appendix 3. Close-up of REDCap Data Collection tool

REDCap™

Logged in as **sileshb** | Log out

My Projects
Project Home
Project Setup
Project status: **Production**

Data Collection

Manage Survey Participants
Record Status Dashboard
Add / Edit Records

Record ID 20 [Select other record](#)

Data Collection Instruments:

- Provider Info and Case Demographics**
- General Case Information
- Anesthetic Information
- Vital Signs Info
- Follow-up And Complications

Applications

- Calendar
- Data Exports, Reports, and Stats
- Data Import Tool
- Data Comparison Tool
- Logging
- Field Comment Log
- File Repository

ImPACT Africa Global Perioperative Outcomes Project

Actions: [Download PDF of instrument\(s\)](#) [Share instrument](#)

Provider Info and Case Demographics

Assign record to a Data Access Group? [-- select a group --](#)

Adding new Record ID 20

Record ID 20

Global Perioperative Patient and Provider Database

Thank you for taking the time to fill out the case log below. The information that is entered will be used to track case logs for students and to track the delivery of care for patients at your hospital. The specific case management information that you enter, include possible complications, will not be part of your evaluation as a student.

ANESTHESIA PROVIDER INFORMATION AND CASE DEMOGRAPHICS

Anesthesia Care Provider

* must provide value

Initials followed by YOB (Example: MSH1962)

Select highest training level that you have completed:

Physician
Registered Nurse
Clinical Officer
Anaesthesia Technician

Please select the number of months that you have completed in anaesthesia training (NOTE: if you have graduated, please select the bottom answer):

1-6 months
7-12 months
13-18 months
19-24 months
25-30 months
31-36 months

* must provide value

Appendix 3b

REDCap™

Logged in as **sileshb** | Log out

My Projects
Project Home
Project Setup
Project status: **Production**

Data Collection

Manage Survey Participants
Record Status Dashboard
Add / Edit Records

Data Collection Instruments:

- Provider Info and Case Demographics
- General Case Information
- Anesthetic Information
- Vital Signs Info
- Follow-up And Complications

Applications

- Calendar
- Data Exports, Reports, and Stats
- Data Import Tool
- Data Comparison Tool
- Logging
- Field Comment Log

ImPACT Africa Global Perioperative Outcomes Project

Record Status Dashboard (all records)

Displayed below is a table listing all existing records/responses and their status for every data collection instrument (and if longitudinal, for every event). You may click any of the colored buttons in the table to open a new tab/window in your browser to view that record on that particular data collection instrument. Please note that if your form-level user privileges are restricted for certain data collection instruments, you will only be able to view those instruments, and if you belong to a Data Access Group, you will only be able to view records that belong to your group.

Legend for status icons:

- Incomplete
- Incomplete (no data saved)
- Unverified
- Partial Survey Response
- Complete
- Completed Survey Response

Displaying Data Access Group: [-- ALL --](#)

Displaying record: "999_683" through "999_732" of 13,040 records

Displaying: Instrument status only | [Lock status only](#) | [All status types](#)

Record ID	Provider Info and Case Demographics	General Case Information	Anesthetic Information	Vital Signs Info	Follow-up And Complications
999_727 - 714253 - 2014-07-16 - 09:25	Complete	Complete	Complete	Complete	Complete
999_728 - 562417 - 2014-11-14 - 10:15	Complete	Complete	Complete	Complete	Complete
999_729 - 785664 - 2015-06-02 - 10:16	Complete	Complete	Incomplete	Unverified	Incomplete
999_730 - 754852 - 2015-06-03 - 15:56	Complete	Complete	Complete	Complete	Complete
999_731 - 1234567 - 2015-06-04 - 15:33	Complete	Complete	Complete	Complete	Incomplete
999_732	Complete	Incomplete	Incomplete	Incomplete	Incomplete
999_699 - 720175 - 2014-10-27 - 13:50	Complete	Complete	Complete	Complete	Complete

Appendix 3c

Appendix 3a–c. Close-up of REDCap data collection tool

Appendix 3a. REDCap tool allows the data collector to enter records offline. Record ID number is displayed in the left column, and the user can see which of the five data collection instruments he/she is entering (highlighted in blue with red outlined box). In the right column, mandatory data points are highlighted with red text (*must provide value). Data entry points include free text, radio buttons, check boxes, and calculated data fields. Free text data entry fields are limited in number to provide the most usable structure to the overall dataset.

Appendix 3b. Under the Record Status Dashboard, a data collector is able to see, by identification number, all the records entered. The record identification (Record ID) number includes the date and time of surgery for ease of identifying a particular record (red box). Whether all data fields within a form are complete is indicated by the circles in the table, with the key being shown in the upper right of the page (blue box).

Appendix 3c. The REDCap software was modified so that in the absence of Internet connection (which is a common occurrence in low- and middle-income countries), the laptop will serve as the server and store patient data. Whenever an Internet connection is available, the user can press the upload data button indicated in the red box in the left column, at which point data are uploaded to the main server. If successful, the confirmation message “Data is uploaded successfully” is displayed.

Abbreviations: FAQ – frequently asked questions, ID – identification, MB – megabyte, REDCap – Research Electronic Data Capture, YOB – year of birth.

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Figure 1.

Figure 1 lists number of cases with missing data. 7,866 cases were used for evaluating patient demographics, while mortality analyses for 24 hours, 48 hours, and 7 days were performed on 7,820, 7,686, and 6,164 cases, respectively.

Abbreviations: n – number of cases, SAS – surgical apgar score.

Figure 2.

Non observed and 7-day mortality missing data. Figure 2 shows percentage alive, dead, and missing data for 7-day mortality per quarter. Black dotted line between quarters 1 and 2 in 2014 represents transition from paper form of REDCap to electronic, while red dotted line between quarters 1 and 2 in 2015 indicates the period when a research assistant dedicated to the collection of 7-day mortality data was hired.

Abbreviations: n – number of patients, Q – quarter, REDCap – Research Electronic Data Capture.

Figure 3.

The effect of date of surgery on the odds of mortality. This figure illustrates the effect of date on the log odds of postoperative mortality rate, relative to the earliest time period point (January 2014). There does not appear to be much effect until roughly March of 2015 (with exception of 48 hours), where there is a sharp decline in postoperative mortality rate, adjusting for the effects of all other factors in the multiple regression. The postoperative mortality odds ratio associated with day 450 versus day zero (January 1, 2014) is 0.55 (95% CI [0.25, 1.23], p-value: 0.15, 0.43 (95% CI [0.24, 0.76], p-value: 0.003), and 0.58 (95% CI [0.38, 0.88], p-value: 0.01), for 24-hour, 48-hour, and 7-day mortality, respectively. The corresponding odds ratio for day 600 versus day 450 is 0.11 (95% CI [0.02, 0.71], p-value: 0.02), 0.09 (95% CI [0.03, 0.33], p-value: <0.001), and 0.13 (95% CI [0.05, 0.35], p-value: <0.001), for 24-hour, 48-hour, and 7-day mortality, respectively.

Figure 4.

Figure 4 shows the number of cases collected with REDCap tool compared to surgical logbook ('non observed'). Black dotted line between quarters 1 and 2 in 2014 represents transition from paper form of REDCap to electronic, while red dotted line between quarters 1 and 2 in 2015 indicates the period when a research assistant dedicated to the collection of 7-day mortality data was hired.

Abbreviations: Q – quarter, REDCap – Research Electronic Data Capture.

Table 1

Patient demographics

Category	Number (percentage)
Total Number of Patients	7,866
In-room Providers	
KRNA	7,635 (97.1%)
Anesthesia student	6,679 (84.9%)
Clinical officer	140 (1.8%)
ASA Classification	
ASA 1	3,370 (42.8%)
ASA 2	4,074(51.8%)
ASA 3	388 (4.9%)
ASA 4	25 (0.32%)
ASA 5	9 (0.11%)
Male	3,948 (50.2%)
Age *	
< 1 months	355 (4.5%)
< 3 months	555 (7.1%)
< 3 years	1,250 (15.9%)
< 12 years	2,075 (26.4%)
< 18 years	2,442 (31.0%)
18–65 years	4,621(58.7%)
> 65 years	803 (10.2%)
Anesthesia Type	
General	4,491 (57.1%)
Regional / spinal	2,895 (36.8%)
MAC	480 (6.1%)
Monitors Used	
Pulse oximetry	7,813 (99.3%)
Blood pressure	7,737 (98.4%)
3-lead ECG	7,517 (95.6%)
End tidal CO ₂	4,829 (61.4%)
Temperature probe	1,319 (16.8%)
Peripheral nerve stimulator	147 (1.9%)
Safe Surgery Checklist	7,822 (99.4%)

* For patients <18 years old, the age categories reported contain all patients less than the age listed in each line; thus, the summated percentages will be >100%. Categories for ages <18 years, 18–65 years, and >65 years equal 100%.

Abbreviations: ASA classification – American Society of Anesthesiologists physical status classification, ECG – electrocardiogram, KRNA – Kenyan registered nurse anesthetist, MAC – monitored anesthesia care.

Table 2
Absolute numbers for 24-hour, 48-hour, and 7-day mortality by procedure type and other categories

Surgery Type	24 hour			48 hour			7 day		
	Mortality (%) [*]	Alive	Missing	Mortality (%)	Alive	Missing	Mortality (%)	Alive	Missing
All surgeries	50 (0.64)	7,770	46	66 (0.87)	7,620	180	93 (1.53)	6,071	1,702
By Procedure Type									
C-sections	2 (0.23)	876	5	3 (0.34)	870	10	4 (0.53)	758	121
General surgery	20 (1.23)	1,622	4	29 (1.83)	1,586	31	42 (3.65)	1,151	453
Neurosurgery	9 (0.88)	1,025	6	11 (1.08)	1,014	15	19 (2.41)	789	232
Orthopedics	11 (0.73)	1,499	14	12 (0.83)	1,447	65	14 (1.20)	1,162	348
Other surgeries [†]	8 (0.29)	2,748	17	11 (0.41)	2,703	59	14 (0.63)	2,211	548
By Other Categories									
Emergency surgery	13 (1.53)	847	5	17 (2.04)	832	16	25 (3.63)	689	151
Pediatrics (age <18 y)	18 (0.75)	2,408	16	24 (1.01)	2,375	42	31 (1.66)	1,863	547
Trauma	6 (0.84)	716	7	8 (1.15)	693	28	9 (1.66)	543	178

^{*} Denominator used for calculation of percent mortality is the number of patients alive, without taking missing data into account.

[†] Other surgeries include: ear nose and throat, endoscopy, gynecology, ophthalmology, oral/maxillofacial, and urology surgeries.

Abbreviations: C-sections – Cesarean sections, y – years.

Table 3

Logistic regression analysis: Odds ratio of mortality at 24 hours, 48 hours, and 7 days as compared to C-section for entire study period

Variable	24 hours				48 hours				7 days			
	Odds Ratio	95%CI	P-value		Odds Ratio	95%CI	P-value		Odds Ratio	95%CI	P-value	
C-section	REF	REF	REF		REF	REF	REF		REF	REF	REF	
Procedure Type												
General surgery	10.68	[2.32, 49.13]	0.002		10.09	[2.86, 35.6]	0.0003		15.8	[5.20, 48.1]	<0.0001	
Orthopedics	6.81	[1.31, 35.4]	0.02		4.45	[1.09, 18.1]	0.04		5.79	[1.69, 19.9]	0.005	
Neurosurgery	8.45	[1.56, 45.8]	0.01		6.45	[1.56, 26.6]	0.01		14.08	[4.12, 48.1]	<0.0001	
Other surgeries	3.09	[0.60, 15.9]	0.18		2.67	[0.69, 10.4]	0.16		3.53	[1.07, 11.7]	0.04	
Emergency	4.30	[1.97, 9.41]	0.0003		3.95	[1.97, 7.91]	0.0001		4.40	[2.46, 7.86]	<0.0001	
Pediatrics	1.02	[0.52, 2.03]	0.95		1.05	[0.59, 1.89]	0.86		0.76	[0.45, 1.28]	0.30	
Trauma	0.90	[0.32, 2.53]	0.84		1.11	[0.44, 2.77]	0.83		0.79	[0.35, 1.77]	0.57	
Date of Surgery												
Day 450 vs Day 0	0.55	[0.25, 1.23]	0.15		0.43	[0.24, 0.76]	0.003		0.58	[0.38, 0.88]	0.01	
Day 600 vs Day 450	0.11	[0.02, 0.71]	0.02		0.09	[0.03, 0.33]	<0.001		0.13	[0.05, 0.35]	<0.001	
Time of Surgery (N/W) *	1.02	[0.38, 2.76]	0.97		1.13	[0.47, 2.74]	0.86		1.18	[0.57, 2.43]	0.66	

* N/W – night or weekend case.

C-section was used as the reference variable, as it is the most commonly performed surgical procedure in low and middle income countries. P-values <0.05 are indicated in bold. Abbreviations: 95%CI – 95% confidence interval, C-section – Cesarean section, REF – reference value.

Table 4

Data summary for observed versus non-observed quarters 2 and 3 of 2015

Variable	Observed (N=2,740)	Non Observed (n=429)	P-value
Procedure Type			<0.001
C-section	259 (9.5%)	154 (35.9%)	
General surgery	428 (15.6%)	50 (11.7%)	
Neurosurgery	297 (10.8%)	19 (4.4%)	
Orthopedics	548 (20.0%)	60 (14.0%)	
Other Surgery	1,208 (44.1%)	146 (34.0%)	
Pediatrics	807 (29.5%)	47 (11.0%)	<0.001
Emergency	237 (8.6%)	224 (52.2%)	<0.001
Trauma	303 (11.1%)	67 (15.6%)	0.008
Surgery Time			<0.001
Day	2,495 (91.1%)	132 (30.8%)	
Night	96 (3.5%)	124 (28.9%)	
Weekend	30 (1.1%)	173 (40.3%)	
24-hour mortality	9 (0.33%)	0 (0%)	0.24
48-hour mortality	12 (0.44%)	1 (0.23%)	0.54
7-day mortality	16 (0.58%)	1 (0.23%)	0.35

Data presented as absolute number with percent (%) of total cases in parentheses.

Table 5

Odds ratio of 48-hour and 7-day mortality for observed and non observed cases for quarters 2 and 3 in 2015

Variable	48 hour			7 day		
	Odds Ratio	95%CI	P-value	Odds Ratio	95%CI	P-value
C-section	REF	REF	REF	REF	REF	REF
Procedure Type						
General surgery	25.5	[3.07, 211.2]	0.003	33.7	[4.13, 274.4]	0.001
Orthopedics	3.58	[0.27, 46.7]	0.33	8.27	[0.74, 92.7]	0.09
Neurosurgery	15.4	[1.36, 173]	0.03	34.8	[3.42, 353.6]	0.002
Other						
Emergency	4.99	[1.08, 23.02]	0.04	6.45	[1.72, 24.2]	0.006
Pediatrics	1.97	[0.54, 7.14]	0.30	1.19	[0.36, 3.98]	0.78
Trauma	3.83	[0.79, 18.64]	0.10	2.17	[0.51, 9.23]	0.29
Time of Surgery (N/W) *	1.46	[0.23, 9.29]	0.69	1.07	[0.20, 5.82]	0.94
Observed	3.52	[0.34, 36.7]	0.29	3.95	[0.41, 38.2]	0.24

To assess if being 'non observed' affected mortality, we performed a regression analysis only on Q2 and Q3 data in 2015, the same time period manual data were collected for the 'non observed' group. C-section was used as the reference variable, as it is the most commonly performed surgical procedure in low and middle income countries. Because there was no mortality reported at 24 hours in the 'non observed' group, we were unable to perform this analysis for 24-hour mortality. P-values <0.05 are indicated in bold.

* N/W – night or weekend case.

Abbreviations: 95% CI – 95% confidence interval, C-section – Cesarean section, REF – reference value.