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Development of an acute care surgery service in Rwanda

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ABSTRACT

Background Acute care surgery (ACS) encompasses trauma, critical care, and emergency general surgery. Due to high volumes of emergency surgery, an ACS service was developed at a referral hospital in Rwanda. The aim of this study was to evaluate the epidemiology of ACS and understand the impact of an ACS service on patient outcomes.

Methods This is a retrospective observational study of ACS patients before and after introduction of an ACS service. χ^2 test and Wilcoxon rank-sum test were used to describe the epidemiology and compare outcomes before (pre-ACS)) and after (post-ACS) implementation of the ACS service.

Results Data were available for 120 patients before ACS and 102 patients after ACS. Diagnoses included: intestinal obstruction (n=80, 36%), trauma (n=38, 17%), appendicitis (n=31, 14%), and soft tissue infection (n=17, 8%) with no difference between groups. The most common operation was midline laparotomy (n=138, 62%) with no difference between groups (p=0.910). High American Society of Anesthesiologists (ASA) score (ASA ≥3) (11% vs. 40%, p<0.001) was more common after ACS. There was no difference in intensive care unit admission (8% vs. 8%, p=0.894), unplanned reoperation (22% vs. 13%, p=0.082), or mortality (10% vs. 11%, p=0.848). The median length of hospital stay was longer (11 days vs. 7 days, p<0.001) before ACS.

Conclusions An ACS service can be implemented in a low-resource setting. In Rwanda, ACS patients are young with few comorbidities, but high rates of mortality and morbidity. In spite of more patients who are critically ill in the post-ACS period, implementation of an ACS service resulted in decreased length of hospital stay with no difference in morbidity and mortality.

Level of evidence Prognostic and epidemiologic study type, level III.

INTRODUCTION

In most US hospitals, trauma surgery and emergency surgery account for a small percentage of surgical procedures. In contrast, in low/middle-income countries (LMIC), elective surgery is relatively uncommon compared with emergency surgery.[1–3] In low-resource settings, emergency procedures can account for more than 50% of all procedures.[4 5] The majority (57%) of operations in sub-Saharan Africa are urgent or emergent.[6] Given the high burden of emergency general surgery conditions in LMICs and sub-Saharan Africa, strengthening and development of acute care surgery (ACS) has been advocated in these regions.[7]

Rwanda is a country in East Africa with a population of 12 million persons.[8] An estimated 40% of the population has an operative condition during their lifetime.[9] In 2012, there were 50 full-time practicing surgeons, with most concentrated in urban areas.[10] In response to a shortage of trained healthcare workers, the Rwanda Human Resources for Health Program was developed to increase health education training and capacity building.[11] Since 2012, there has been an increase in numbers of surgical faculty and residents with more than double the number of residents.[12] There has also been an increase in the number and types of surgical specialties available within the country.

The University Teaching Hospital of Kigali (Centre Hopitalier Universitaire de Kigali, CHUK) is a tertiary referral hospital in Kigali, Rwanda. There are 565 hospital beds and six main operating rooms (OR). An operative database was implemented at CHUK beginning in 2012.[4 5] There are approximately 2800 operations performed by surgery residents with 50% of those cases being general surgery.[4] More than half of general surgery operations are performed for emergent conditions.[4 13] Other surgical services at CHUK include orthopedics, neurosurgery, and urology. In 2013, a pediatric surgery service was developed and in 2015 a plastic surgery service was developed.

Given the high burden of emergent conditions, an ACS service was developed at CHUK with the aim of providing better patient care and improving the educational experience of surgical residents and medical students. The aim of this study was to describe the structure of the ACS service at CHUK and compare time to operation, unplanned reoperation rate, length of hospital stay, and mortality before and after ACS service implementation. We hypothesized that the introduction of an ACS service at CHUK resulted in decreased time to operation, reoperation rate, length of hospital stay and mortality.

METHODS

We describe the formation of an ACS service at a tertiary referral hospital in Rwanda, detailing the patients, staff, space, and systems involved.

Description of the ACS service

In 2012, two general surgical services were on duty every other day and all emergency patients were assigned to the service on call. The daily and

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nightly influx of patients requiring emergency surgical attention disrupted the elective surgery schedules, creating frustration for both patients and doctors.

In 2013, an ACS team was started at CHUK. All patients who present through the emergency room with a condition considered to be an acute surgical problem are admitted to the ACS service. The ACS team takes care of both trauma and non-trauma general surgery emergencies including patients with thoracic injuries. It coordinates the management of polytrauma patients managed by multiple teams. Patients with isolated fractures, head injuries and urological emergencies are managed by those respective specialties. A separate surgical service performs elective surgery. The ACS service manages all obstetrics and gynecology consults whereas internal medicine consults are managed by the elective surgery service. Pediatric surgery consults, both elective and emergent, are managed by a separate pediatric surgery team.

Faculty surgeons, residents (PGY 1–4), and medical students are assigned to both elective surgical and ACS services. Initially, a single faculty member was assigned to oversee the ACS service. Faculty coverage has since increased to two to three faculty to cover the team. On average, there are three junior and one senior residents assigned to the ACS service. Medical students also rotate on the ACS service. Teaching occurs primarily at the bedside. There are weekly morbidity and mortality conferences with all general surgery residents, primarily discussing ACS patients.[14]

Faculty surgeons and residents assigned to both ACS and elective surgical services participate in night-call (approximately 17:00–07:00) and weekend call. During that time frame, the on-call team manages the emergency admissions operatively and non-operatively. During the normal working hours (approximately 07:00–17:00) the ACS team assumes responsibility for those patients. Every weekday morning, the general surgery faculty and residents discuss all operations performed overnight as well as any pending cases. This helps ensure adequate and appropriate sign-out of ACS patients. It is also an opportunity to discuss challenging and interesting cases.

Two ORs are devoted to emergency surgery operations. One OR is primarily for emergency general surgery operations with occasional use by otorhinolaryngology and urology for emergency procedures. The second emergency OR is primarily used by orthopedics with occasional use by neurosurgery for emergency procedures. Elective operations continue per a block schedule in the four other ORs, split between elective general surgery, pediatric surgery, elective orthopedic surgery, neurosurgery, urology, otorhinolaryngology, and plastic surgery.

Due to high bed occupancy, a shortage of ward beds can delay patients transferring out of the recovery room, and therefore out of the OR. To mitigate this problem, beginning in 2013, each surgical service is allocated a dedicated number of hospital ward beds. Patients cannot be brought to the OR if there is not a ward available for them postoperatively. Each surgical service is then responsible for ensuring patient flow with timely and appropriate discharge of patients from the ward. The general surgery ward has 48 beds. Of these, 24 are dedicated for ACS patients. These beds are located in a single ward, allowing for a consistent nursing team that is familiar with ACS practices.

Daily ward rounds with faculty were instituted, including weekends. Each evening, sign-out rounds were completed between the ACS residents and the on-call team. A list was developed to track and monitor ACS patients. After discharge from the hospital, patients are followed in a dedicated ACS clinic for postoperative issues. No new surgical consults are seen in the ACS clinic.

We conducted a retrospective chart review of urgent and emergent general surgery operations before (January to March 2013) and after (January to March 2017) initiation of an ACS service. We compared variables including: time from admission to operation, intensive care unit (ICU) admission, reoperations, length of hospital stay, and in-hospital mortality.

All patients undergoing urgent or emergent general surgery operations at CHUK during the time periods were included in the study. Data were collected from the patient chart, OR and ward logbooks, and operative database. The information collected included demographic and clinical variables, operative details, and clinical outcomes.

Fever was defined as temperature greater than 38.5°C. Tachycardia was defined as heart rate greater than 90 beats per minute. Tachypnea was defined as respiratory rate greater than 22 breaths per minute. Hypotensive was defined as systolic blood pressure less than 90 mm Hg. Hypoxia was defined as oxygen saturation less than 90%. Leukocytosis was defined as white cells greater than 10×10^9/L. Anemia was defined as hemoglobin <100 g/L. Thrombocytopenia was defined as platelets less than 150×10^9/L. Renal failure was defined as creatinine greater than 168 μmol/L. Complications were based on attending physicians' clinical assessment and physician documentation in the patient chart.

Data were entered into an Excel database and analyzed using STATA V.13.0 (College Station, TX). Categorical variables were reported as frequencies and percentages. Continuous variables were reported as medians and IQRs. Analysis of categorical variables was performed using χ^2 or Fisher's exact test. Continuous variables were analyzed using Wilcoxon rank-sum test. The primary outcomes were time from admission to operation and length of hospital stay. Secondary outcomes were number and frequency of patients requiring reoperation and in-hospital mortality.

RESULTS

Characteristics before and after ACS service implementation at CHUK

Data were available from 120 patients before (January to March 2013) and 102 patients after (January to March 2017) introduction of the ACS service (table 1). Most ACS patients were male with a median age of 33 years (IQR: 24, 53.5). Most patients were referred from the emergency department (n=205, 94%). The most common diagnoses were intestinal obstruction (n=80, 36%), trauma (n=38, 17%), and appendicitis (n=31, 14%) with no difference between time periods.

Patient characteristics were similar between the two study periods (table 1). There was a lower rate of community-based health insurance use in the post-ACS time period (100% vs. 86%, p=0.009). Fewer patients were tachycardic (73% vs. 61%, p=0.064) and tachypneic (42% vs. 19%, p<0.001) in the post-ACS time period. There was a trend towards increased hypoxia in the post-ACS time period (2% vs. 6%, p=0.092).

There was a decrease in median time from admission to OR after introduction of the ACS service (1 day vs. 1 day, p=0.010) (table 2). More patients had a high American Society of Anesthesiologists (ASA) score (ASA ≥3) (11% vs. 40%, p<0.001) in the post-ACS time period. Compared with the pre-ACS time period, there were more faculty scrubbed in cases after ACS (21% vs. 49%, p<0.001). There was no difference in the overall number or types of operations performed. There was no statistically significant difference in the number of patients requiring a reoperation (22% vs. 13%, p=0.082).

Table 1 Characteristics of acute care surgery patients before and after introduction of an acute care surgery service at University Teaching Hospital of Kigali

	Total ACS n=222	Pre-ACS n=120	Post-ACS n=102	P value
Age (years)*	33 (24, 53.5)	32 (23, 52)	35 (26, 58)	0.113
Gender				
Male	144 (65)	79 (66)	65 (64)	0.818
Female	77 (35)	41 (34)	36 (36)	
Insurance				
Community-based health insurance	202 (92)	116 (100)	86 (86)	0.002
Private	14 (6)	4 (3)	10 (10)	
None	4 (2)	0	4 (4)	
Province				
Kigali	75 (34)	39 (33)	36 (36)	0.291
East	66 (30)	31 (26)	35 (35)	
North	42 (19)	25 (21)	17 (17)	
West	24 (11)	17 (14)	7 (7)	
South	13 (6)	8 (7)	5 (5)	
Comorbidities				
Gastritis	21 (9)	14 (12)	7 (7)	0.162
Hypertension	4 (2)	2 (2)	2 (2)	0.626
Diabetes mellitus	7 (3)	3 (3)	4 (4)	0.411
HIV	3 (1)	2 (2)	1 (1)	0.561
Tuberculosis	1 (0.5)	1 (1)	0	0.541
Smoking	14 (6)	5 (4)	9 (9)	0.126
Consulting department				
Accident and emergency	205 (94)	111 (93)	94 (95)	0.748
Internal medicine	6 (3)	4 (3)	2 (2)	
Pediatrics	4 (2)	3 (3)	1 (1)	
Obstetrics and gynecology	3 (1)	1 (1)	2 (2)	
Other	1 (0.5)	1 (1)	0	
Vitals†				
Febrile	73 (33)	45 (38)	28 (27)	0.112
Tachycardia	149 (67)	87 (73)	62 (61)	0.064
Tachypnea	69 (31)	50 (42)	19 (19)	<0.001
Hypotensive	4 (2)	2 (2)	2 (2)	0.626
Hypoxia	8 (4)	2 (2)	6 (6)	0.094
Laboratory‡				
Leukocytosis (n=188)	96 (51)	54 (54)	42 (48)	0.391
Anemia (n=211)	30 (14)	16 (14)	14 (14)	0.979
Thrombocytopenia (n=207)	34 (16)	20 (18)	14 (14)	0.431
Renal failure (n=92)	18 (20)	8 (22)	10 (18)	0.606
Diagnosis				
Intestinal obstruction	80 (36)	35 (19)	37 (36)	0.26
Trauma	38 (17)	24 (20)	14 (14)	0.216
Appendicitis	31 (14)	18 (15)	13 (13)	0.629
Skin and soft tissue infection	17 (8)	6 (5)	11 (11)	0.106
Neoplasm	12 (5)	6 (5)	6 (6)	0.5
Peptic ulcer disease perforation	10 (5)	6 (5)	4 (4)	0.479
Typhoid intestinal perforation	9 (4)	6 (5)	3 (3)	0.336

*Continuous variables reported as median (IQR), analysis with Wilcoxon rank-sum test.
†Febrile=temperature greater than 38.5°C; tachycardia=heart rate greater than 90 beats per minute; tachypnea=respiratory rate greater than 22 breaths per minute; hypotensive=systolic blood pressure less than 90 mm Hg; hypoxia=oxygen saturation less than 90%.
‡Leukocytosis=white cells greater than 10 x10^9/L; anemia=hemoglobin <100 g/L; thrombocytopenia=platelet <150 K/μL; renal failure=creatinine >168 μmol/L.
ACS, acute care surgery.

Table 2 Operative details of acute care surgery patients before and after introduction of an acute care surgery service at University Teaching Hospital of Kigali

	Total ACS n=222	Pre-ACS n=120	Post-ACS n=102	
	n (%)	n (%)	n (%)	P value
Admission to operating time (days)* (n=221)	1 (0, 2)	1 (1, 2)	1 (0, 1)	0.01
ASA (n=205)				
I	62 (30)	38 (35)	24 (25)	<0.001
II	92 (45)	58 (54)	34 (35)	
III	44 (21)	11 (10)	33 (34)	
IV	7 (3)	1 (1)	6 (6)	
Operating surgeon level				
PGY 1	17 (8)	16 (13)	1 (1)	<0.001
PGY 2	41 (19)	40 (34)	1 (1)	
PGY 3	27 (12)	9 (8)	18 (18)	
PGY 4	58 (26)	24 (20)	34 (34)	
Faculty	76 (35)	30 (25)	46 (46)	
Faculty				
Scrubbed	81 (37)	32 (27)	49 (49)	0.001
Not scrubbed	140 (63)	88 (73)	52 (51)	
Operative duration (min)* (n=207)	120 (75, 150)	110 (75, 150)	120 (70, 150)	0.847
Operation				
Midline laparotomy	138 (62)	75 (63)	63 (62)	0.91
Bowel resection	58 (26)	29 (24)	29 (28)	0.471
Bowel anastomosis	48 (22)	22 (18)	26 (25)	0.197
Ostomy	21 (9)	12 (10)	9 (9)	0.765
Omental patch	10 (5)	7 (6)	3 (3)	0.241
Splenectomy	10 (5)	4 (3)	6 (6)	0.278
Abscess drainage	20 (9)	11 (9)	9 (9)	0.56
Extremity debridement	10 (5)	5 (4)	5 (5)	0.521
Amputation	12 (5)	7 (6)	5 (5)	0.5
Reoperation	39 (18)	26 (22)	13 (13)	0.082

*Continuous variables reported as median (IQR), analysis with Wilcoxon rank-sum test.
ACS, acute care surgery; ASA, American Society of Anesthesiologists.

There was no difference in ICU admission (8% vs. 8%, p=0.894) or mortality (10% vs. 11%, p=0.848) between the time periods. There was no difference in complications between the time periods (table 3). There was a trend to decreased rates of prolonged ventilation in the post-ACS time period though not statistically significant (6% vs. 1%, p=0.053). The median length of hospital stay decreased after introduction of the ACS service (11 days vs. 7 days, p<0.001).

DISCUSSION

ACS can be implemented in a low-resource setting with good clinical outcomes and teaching opportunities for trainees. Workforce (faculty, residents and nurses) was allocated, the space (OR and wards) was secured, and systems were put in place to care for and monitor patients. Similarly, an Acute Care and General Surgery Unit was created at Groote Schuur Hospital in South Africa to provide care to patients who were previously managed on an ad hoc basis by subspecialists.[15] The ACS program was shown to improve patients' outcome by providing a dedicated team to care for patients with emergency surgical conditions. Studies have shown that an ACS service provides an opportunity for other units to concentrate on elective care, allows optimal use of resources, and provides a career opportunity for trainees.[15]

The ACS unit at CHUK has been a teaching opportunity for trainees as through ACS rotations, they learn emergency general surgery and trauma resuscitation. Through morning report discussions and weekly mortality and morbidity meetings, residents received feedback on their performance and the way they can improve patients' safety and outcome.[14]

Patients with emergency general surgery conditions most commonly are admitted to CHUK through the emergency department. As CHUK is a national referral hospital, most of the patients come from provincial and district hospitals, where they receive variable initial management. In spite of this, the patients' characteristics (demography and diagnosis) were similar in both pre-ACS and post-ACS services. These findings illustrate that the causes of emergency surgical conditions in 2013 and in 2017 are similar. This is consistent with prior reports of emergency general surgery conditions reported at this hospital.[4 5 13] One difference, however, was the higher ASA scores in the post-ACS period which suggests that these patients may have been sicker. From 2013 to 2017, the number of surgeons and anesthesiologists graduating from the University of Rwanda has increased

Table 3 Postoperative course of acute care surgery patients before and after introduction of an acute care surgery service at University Teaching Hospital of Kigali

	Total ACS n=222	Pre-ACS* n=120	Post-ACS n=102	
	n (%)	n (%)	n (%)	P value
Intensive care unit admission	18 (8)	10 (8)	8 (8)	0.894
Intensive care unit length of stay (days)*	2.5 (2, 6)	2 (2, 6)	3.5 (1.5, 6)	0.928
Complications				
Surgical site infection	17 (8)	12 (10)	5 (5)	0.155
Abscess	11 (5)	8 (7)	3 (3)	0.202
Fascial dehiscence	3 (1)	1 (1)	2 (2)	0.468
Urinary tract infection	2 (1)	2 (2)	0	0.190
Prolonged ventilator	8 (4)	7 (6)	1 (1)	0.053
Cardiac arrest	21 (9)	11 (9)	10 (10)	0.872
Mortality	23 (10)	12 (10)	11 (11)	0.848
Disposition				
Home	155 (72)	86 (75)	69 (70)	0.608
District hospital	18 (8)	10 (9)	8 (8)	
Death	23 (10)	12 (10)	11 (11)	
Other	18 (8)	7 (6)	11 (11)	
Length of hospital stay (days)*	8 (5, 15)	11 (6, 17.5)	7 (4, 11)	<0.001

*Continuous variables reported as median (IQR), analysis with Wilcoxon rank-sum test.
ACS, acute care surgery.

which has led to staffing of specialists at provincial and some district hospitals. Non-complicated emergency general surgery patients could be managed at the district and provincial hospitals, whereas those patients with critical conditions requiring ICU management would still require referral to CHUK. This is one potential explanation why more patients with high ASA scores were managed after ACS service development. In addition, more trained anesthesiologists at CHUK could have resulted in more accurate classification of ASA scores in the post-ACS time period.

In the post-ACS period, the time from admission to the time of surgery has decreased and the difference was statistically significant. This may be due to earlier recognition and planning for surgical emergencies. As faculty are consistently on rounds, this may lead to earlier decision-making on complex cases. Another possibility is that with a dedicated emergency OR, and increased organization and patient flow, it is easier to get patients into the OR in a timely manner.

During this period more faculty were present in the OR compared with pre-ACS period. More senior residents operated on the patients in the post-ACS period compared with the pre-ACS period where more junior residents were the primary surgeons. This is due to the fact that the ACS has more faculty and more senior residents. Over the years, the overall number of residents has increased, as well as the overall number and percentage of senior residents.[12] Though the number of procedures that were performed by faculty increased with ACS service introduction, the majority of procedures were performed by trainees. This is similar to other ACS services in Africa where the majority of surgical procedures are performed by trainees.[15] There was no difference in the type of procedures performed in both pre-ACS and post-ACS periods with the most commonly performed procedures being laparotomy (including bowel resection, bowel anastomosis, omental patch repair, appendicectomy), extremity debridement and amputations.

The perioperative mortality rate in our study was similar in both periods (10% and 11%, respectively), but was higher compared with the perioperative mortality rate recorded in other LMICs (6%).[6] However, it was similar with other studies that were conducted at CHUK prior to ACS service introduction.[5] The most common adverse outcomes in both pre-ACS and post-ACS periods were surgical site infections, fascial dehiscence, intra-abdominal abscesses and cardiac arrest. In a large multicenter study in Africa evaluating emergency and elective operations, perioperative complications occurred in 18.2% of patients, and 2.1% of patients died.[6] The differences in morbidity and mortality between different sites are likely due to differences in patient groups. The patients in this study all underwent emergent operations, which is a known risk factor for increased morbidity and mortality. In addition, many patients present in a delayed fashion which increases the risk of advanced, complex disease. Studies have shown that the greatest delay is in the prehospital time period which is not addressed by implementation of the ACS service.[16]

The rate of adverse outcomes was not different in both pre-ACS and post-ACS periods, however patients had a shorter length of hospital stay in the post-ACS period. The decreased length of hospital stay noted in this study is likely due to increased organization, improving flow in the hospital. In addition, daily rounding with faculty members helps progress care for patients who need complex decision-making. Faculty members promote early enteral feeding and walking which contributes to earlier discharge.

This study was limited by the fact that it was a retrospective chart review. We only included patients who made it to the OR. We did not include patients managed non-operatively, declining surgery, too sick for surgery, or those who died prior to OR. There may have been differences in patient selection over time. However, patient characteristics are consistent with prior studies in this hospital.[4 5 17 18] As patients in the later time period were more sick (based on ASA scores), this does not account for overall differences. Time from admission to the time of operation was measured in days, whereas time in hours would have been more precise measure of this parameter. We were unable to compare cancellations of elective operations before and after ACS service implementation. We propose future studies focusing on how the introduction of ACS services impacted the elective surgical care delivery including cancellation rates and operative volume.

Though there are positive changes with ACS introduction, we cannot attribute all the changes to implementation of the ACS service. During the same period, the number of faculty and residents increased.[12] This could influence the quality and quantity of surgical care received. In addition, more district and provincial hospitals were staffed with surgeons, which may have impacted referral patterns due to more operations performed at the district hospitals. An emergency medicine residency program was started at CHUK in 2013, which likely resulted in improved patient care and better emergency department organization.

CONCLUSIONS

An ACS service can be implemented in a low-resource setting. Systems changes resulted in decreased length of hospital stay with no changes in morbidity and mortality. Further studies are needed to explore hospital-wide impact, including the impact on the elective case burden.

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