World J Surg (2016) 40:2109–2116
DOI 10.1007/s00268-016-3515-0

ORIGINAL SCIENTIFIC REPORT

Non-Obstetric Surgical Care at Three Rural District Hospitals in Rwanda: More Human Capacity and Surgical Equipment May Increase Operative Care

Ernest Muhirwa[1] · Caste Habiyakare[2] · Bethany L. Hedt-Gauthier[1,3] · Jackline Odhiambo[1] · Rebecca Maine[3,4] · Neil Gupta[1,5] · Gabriel Toma[1,3] · Theoneste Nkurunziza[1] · Tharcisse Mpunga[2] · Jeanne Mukankusi[2] · Robert Riviello[3,5,6]

Published online: 20 April 2016

Abstract

Background Most mortality attributable to surgical emergencies occurs in low- and middle-income countries. District hospitals, which serve as the first-level surgical facility in rural sub-Saharan Africa, are often challenged with limited surgical capacity. This study describes the presentation, management, and outcomes of non-obstetric surgical patients at district hospitals in Rwanda.

Methods This study included patients seeking non-obstetric surgical care at three district hospitals in rural Rwanda in 2013. Demographics, surgical conditions, patient care, and outcomes are described; operative and non-operative management were stratified by hospitals and differences assessed using Fisher's exact test.

Results Of the 2660 patients who sought surgical care at the three hospitals, most were males (60.7 %). Many (42.6 %) were injured and 34.7 % of injuries were through road traffic crashes. Of presenting patients, 25.3 % had an operation, with patients presenting to Butaro District Hospital significantly more likely to receive surgery (57.0 %, $p < 0.001$). General practitioners performed nearly all operations at Kirehe and Rwinkwavu District Hospitals (98.0 and 100.0 %, respectively), but surgeons performed 90.6 % of the operations at Butaro District Hospital. For outcomes, 39.5 % of all patients were discharged without an operation, 21.1 % received surgery and were discharged, and 21.1 % were referred to tertiary facilities for surgical care.

Conclusion Significantly more patients in Butaro, the only site with a surgeon on staff and stronger surgical infrastructure, received surgery. Availing more surgeons who can address the most common surgical needs and improving supplies and equipment may improve outcomes at other districts. Surgical task sharing is recommended as a temporary solution.

Introduction

About a quarter of the global burden of diseases can be treated with surgery [1] with injuries (38 %), malignancies (19 %), and congenital abnormalities (9 %) as the leading conditions needing surgical care [2]. Only a third of the world's population, mostly from high-income countries, benefit from three quarters of the 234.2 million major surgical procedures performed worldwide [2]. Approximately three quarters of mortality attributable to surgical emergencies are in low- and middle-income countries (LMICs) [3].

Although conditions needing minor and major surgery are common in LMICs [2, 4], the lack of access to surgical care remains a critical gap in these health systems [5]. In

Ernest Muhirwa and Caste Habiyakare are joint first authors.

✉ Ernest Muhirwa
ernestinoy@gmail.com

1 Partners In Health/Inshuti Mu Buzima, Kigali, Rwanda

2 Ministry of Health, Kigali, Rwanda

3 Department of Global Health and Social Medicine, Harvard Medical School, Boston, MA, USA

4 Department of Surgery, University of California, San Francisco, CA, USA

5 Division of Global Health Equity, Brigham and Women's Hospital, Boston, MA, USA

6 University Teaching Hospital, Kigali, Rwanda

the rural areas of most LMICs, including Rwanda, district hospitals serve as the first-level facility providing surgical care [6]. However, inadequate expertise, equipment, and facilities in the district hospitals limit access, safe, and efficient surgical care [2, 6]. Further, financial barriers such as related opportunity costs and cultural barriers such as fear of experiencing surgery and fear of negative outcomes from anesthesia inhibit patients from seeking care [5].

The nature of surgical procedures performed at district hospitals also vary. In 2009 and 2010, over 80,000 surgical procedures (major and minor) were recorded annually in Rwanda. Surgical registers and annual hospital reports at two referral hospitals in Rwanda showed that 82.5 per cent of major surgical procedures were performed in district hospitals [7]. However, 60 % of these major operations were obstetrics and gynecologic. Little is known about the types and management of non-obstetric surgical conditions in the rural district hospitals. This study describes the management and outcomes of patients needing non-obstetric surgical care at three rural district hospitals in Rwanda. The understanding of the non-obstetrics surgical needs and care provided can stimulate changes in policy and practice guidelines that may improve surgical care and hence patient outcomes.

Materials and methods

Study design and setting

This retrospective cohort study included patients seeking non-obstetric surgical care from January 1 to December 31, 2013 at three rural district hospitals (Kirehe, Butaro and Rwinkwavu District Hospitals (DHs)) in Eastern and Northern Provinces of Rwanda. These hospitals are managed by the Ministry of Health and supported by Partners In Health/Inshuti Mu Buzima (PIH/IMB), a US-based non-governmental organization. Collectively, these hospitals serve a population of 897,117 people and provide surgical care to patients referred from 41 health centers.

In Rwanda, district hospitals provide basic surgical care, primarily minor and obstetric surgeries. These hospitals rely on general practitioners and nurses to provide surgical care, except for Butaro DH which had a general surgeon on staff for most of 2013 and benefited from frequent short-term visiting specialists such as plastic surgeons. In addition, Butaro is a cancer center of excellence, thus more equipped to provide surgical care. Typically, patients who need major surgical interventions at any of the three hospitals are referred to tertiary hospitals.

Study population and data collection

The study included all patients admitted to the DHs for non-obstetric surgical conditions from January 1 to December 31, 2013. Patients who were admitted for obstetric conditions were excluded. We collected data on demographics and surgical conditions at presentation, the operative and non-operative management provided, and patient outcomes. We defined non-operative management as treatment, such as laboratory tests, imaging, narcotic and non-narcotic pain medication, wound care, and the use of antibiotics, that did not involve surgical operation. Data were extracted from patients' charts and from registers in surgery and theater departments. Four data collectors were trained in chart extraction and data entry. A sample of data was reviewed and matched across the admission information, patient charts, and theater logs for completeness and accuracy.

Analysis and statistics

We described the number and percent for demographic variables and surgical conditions. The operative and non-operative management provided was stratified by hospitals, and differences were assessed using Fisher's exact test. We described overall patient outcomes, categorized as patients who were discharged after operative care, non-operative management, referred for tertiary care, absconded, or died. Stata v13 (College Station, TX: StataCorp LP) was used for analysis.

Ethics

The study received technical approval from the PIH/IMB Research Committee and the National Health Research Committee, and received ethical approval from Rwanda National Ethics Committee and the Partner's Human Research Committee in Boston, MA. The study was also approved by the Rwanda Ministry of Health.

Results

Demographics

The 2660 patients needing non-obstetric surgical care were relatively evenly distributed across the hospitals, with 766 (28.8 %) at Butaro DH, 909 (34.2 %) at Rwinkwavu DH and 985 (37.0 %) at Kirehe DH (Table 1). For the 2647 (95.5 %) with gender recorded, most were males ($n = 1607$, 60.7 %), and for the 2573 (96.7 %) with age recorded, 864 (33.6 %) were between 25 and 49 years. Insurance status was recorded for 1611 (60.5 %) of the patients, of which 1382

Table 1 Characteristics and surgical conditions of patients seeking non-obstetric surgical care

	n	%
Total number of patients	2660	100.0
Hospital		
Butaro	766	28.8
Rwinkwavu	909	34.2
Kirehe	985	37.0
Gender	$N = 2647$ (95.5 %)	
Male	1607	60.7
Female	1040	39.3
Age (years)	$N = 2573$ (96.7 %)	
≤15 years	748	29.1
>15 and ≤24 years	383	14.9
>24 and ≤49 years	864	33.6
>49 years	578	22.5
Health insurance	$N = 1611$(60.5 %)	
Uninsured	131	8.1
National insurance	1382	85.8
Other	98	6.1
Occupation		
Farmer	788	29.6
Business/employed	54	2.0
Student/child	684	25.7
Other	85	3.2
Unknown	1049	39.4
Home district		
Within hospital catchment areas	2229	83.8
Outside of hospital catchment areas	431	16.2
Type of diagnosis	$N = 2405$ (90.4)	
Trauma	1024	42.6
Infection	540	22.5
Surgically resectable cancers	252	10.5
General surgery[a]	508	21.1
Congenital defect	32	1.3
Urology	49	2.0
Types of trauma	$N = 939$ (91.7 %)	
Road traffic injuries	355	37.8
Fall	202	21.5
Assault (blunt force/fight/stab/cut)	219	23.3
Burns	65	6.9
Other	98	10.4

[a] We define general surgery as a surgical specialty that focuses on the abdominal area including esophagus, stomach, small bowel, colon, liver, pancreas, gallbladder and bile ducts, and the thyroid gland (depending on local reference patterns). It also deals with diseases involving the skin, breast, soft tissue, and hernias. These are cases not already included in trauma, infection, or surgically resectable cancers

(85.8 %) had national insurance and 131 (8.1 %) were not insured. For the 2405 (90.4 %) with a final diagnosis, the largest cohort ($n = 1024$, 42.6 %) was trauma patients. For the 939 (91.7 %) of trauma patients with details on mechanism of injury recorded, a third ($n = 355$, 37.8 %) were caused by road traffic injuries.

Operative care

For the 2576 (96.8 %) with information recorded, 649 (25.3 %) had a surgical procedure completed at the district hospital, with patients at Butaro DH significantly more likely to have surgery ($n = 436$ out of 765, 57.0 %, $p < 0.001$) (Table 2). Of the operations performed, 36 (6.7 %) were emergency surgeries with the remaining elective, with the percent of emergency operations in Rwinkwavu DH being significantly higher (17.4 %, $p = 0.019$). Most operations ($n = 373$, 81.6 %) were on patients in ASA Class I.

The most common operative procedures were excision of cysts, lipomas, keloids, and masses ($n = 152$, 34.9 %) at Butaro DH; abscess incision and drainage ($n = 22$, 24.2 %) at Rwinkwavu DH; and hernia/hydrocele repair ($n = 76$, 62.3 %) at Kirehe DH. Most patients received antibiotics post-operatively in Rwinkwavu ($n = 63$, 90.0 %) and Kirehe ($n = 67$, 77.9 %) and peri-operatively in Butaro ($n = 267$, 79.2 %, $p < 0.001$). The use of general anesthesia was more common at Rwinkwavu DH ($n = 52$, 74.3 %), followed by Kirehe DH ($n = 52$, 53.6 %). However, local anesthesia was more often used at Butaro DH ($n = 111$, 26.6 %) compared to the other sites.

The majority of procedures were performed by general practitioners at Kirehe ($n = 118$, 100 %) and Rwinkwavu DHs ($n = 81$, 98.8 %), where provider type was recorded. In contrast, at Butaro DH, 184 (42.6 %) of the surgical procedures were performed by the on-staff surgeon and 182 (42.1 %) were performed by visiting plastic surgeons. Most surgical procedures with duration reported were completed in less than thirty minutes ($n = 143$, 47.4 %; $n = 15$, 51.7 %; and $n = 46$, 69.7 % for Butaro, Rwinkwavu and Kirehe DHs, respectively). Surgical complications were rarely recorded in over 85 % of cases at each site.

Non-operative management—evaluation and treatment

For the 2660 patients, 1583 (59.5 %) had at least one laboratory test recorded and 1197 (45.0 %) patients had at least one imaging completed (Table 3). The use of laboratory evaluation differed between sites ($p < 0.001$). Butaro DH patients were most likely to have at least one laboratory test ($n = 649$, 84.7 %). The most common laboratory tests were full blood count ($n = 1447$, 54.4 %) and HIV tests ($n = 913$, 34.3 %). Imaging also differed significantly among the hospitals ($p < 0.001$) with Kirehe DH patients most likely to have at least one imaging

Table 2 Operative interventions for patients needing non-obstetric surgical care

	All the hospitals		Butaro		Rwinkwavu		Kirehe		*p* value
	n	%	*n*	%	*n*	%	*n*	%	
Operation performed	$N = 2576$		$N = 765$		$N = 871$		$N = 931$		
Yes	649	25.3	436	57.0	91	10.5	122	13.1	<0.001
No	1918	74.7	329	43.0	780	89.5	809	86.9	
For patients who received a surgical procedure									
Operation urgency	$N = 537$		$N = 401$		$N = 46$		$N = 90$		
Elective	501	93.3	377	94.0	38	82.6	86	95.6	0.019
Emergency	36	6.7	24	6.0	8	17.4	4	4.4	
ASA Class	$N = 457$		$N = 323$		$N = 48$		$N = 86$		
I	373	81.6	259	80.2	35	72.9	79	91.9	0.035
II	72	15.8	54	16.7	12	25.0	6	7.0	
III, IV, V	12	2.6	10	3.1	1	2.1	1	1.1	
Type of surgical procedure[a]									
Abscess incision and drainage	41	6.3	19	4.4	22	24.2	0	0	Unable to report
Closed reduction of fracture	27	4.2	1	0.2	12	13.2	14	11.5	
Laparotomy	31	4.8	27	6.2	3	3.3	1	0.8	
Excision of cysts, lipoma, keloid and mass	169	26.0	152	34.9	9	9.9	8	6.6	
Wound care/skin graft	47	7.2	26	6.0	16	17.6	5	4.1	
Hernia/hydrocele repair	155	23.9	72	16.5	7	7.8	76	62.3	
Biopsy	39	6.0	36	8.3	3	3.3	0	0	
Amputation	18	2.8	11	2.5	4	4.4	3	2.5	
Hemorrhoidectomy	26	4.0	21	4.8	1	1.1	4	3.3	
Mastectomy	29	4.5	27	6.2	2	2.2	0	0	
Other	67	10.3	44	10.1	12	13.2	11	9.0	
Received antibiotics									
	$N = 480$		$N = 377$		$N = 68$		$N = 75$		
Pre-operative	123	25.6	60	17.8	49	72.1	14	18.7	<0.001
	$N = 463$		$N = 377$		$N = 53$		$N = 73$		
Peri-operative	345	74.5	267	79.2	16	30.2	62	84.9	<0.001
	$N = 493$		$N = 377$		$N = 70$		$N = 86$		
Post-operative	338	68.6	208	61.7	63	90.0	67	77.9	<0.001
Type of anesthesia	$N = 585$		$N = 418$		$N = 70$		$N = 97$		
Local	118	20.2	111	26.6	5	7.1	2	2.1	<0.001
Regional	176	30.1	121	28.9	12	17.2	43	44.3	
General	285	48.7	181	43.3	52	74.3	52	53.6	
Sedation Only	5	0.8	4	1.0	1	1.4	0	0	
Other	1	0.2	1	0.2	0	0	0	0	
Surgical provider[a]	$N = 631$		$N = 432$		$N = 81$		$N = 118$		
General practitioner on staff	231	36.6	33	7.6	80	98.8	118	100.0	
General surgeon on staff	184	29.2	184	42.6	0	0	0	0	
Visiting general practitioner	5	0.8	5	1.2	0	0	0	0	
Visiting general surgeon	8	1.3	8	1.9	0	0	0	0	
Visiting plastic surgeon	182	28.8	182	42.1	0	0	0	0	
Visiting orthopedic surgeon	2	0.3	2	0.5	0	0	0	0	
Visiting obstetrician	4	0.6	3	0.7	1	1.2	0	0	
Visiting breast surgeon	15	2.4	15	3.5	0	0	0	0	
Duration of surgical procedure	$N = 493$		$N = 302$		$N = 29$		$N = 66$		

Table 2 continued

	All the hospitals		Butaro		Rwinkwavu		Kirehe		*p* value
	n	%	*n*	%	*n*	%	*n*	%	
≤30 min	204	51.4	143	47.4	15	51.7	46	69.7	<0.001
>30 and ≤60 min	102	25.7	75	24.8	9	31.0	18	27.3	
> 1 and ≤2 h	58	14.6	52	17.2	4	13.8	2	3.0	
>2 h	33	8.3	32	10.6	1	3.5	0	0	
Surgical complications									
Surgical site infection	16	2.5	14	3.2	1	1.1	1	0.8	0.131
Unplanned reoperations	3	0.5	3	0.7	0	0	0	0	
Other infections	30	6.0	33	7.6	3	3.3	3	2.5	
None recorded	591	91.0	386	88.5	87	95.6	118	96.7	

min minutes; *h* hours

[a] Stata could not calculate a Fisher's exact *p* value

(52.1 %, $n = 513$). The most common imaging overall was orthopedic related x-ray (26.8 %, $n = 713$). The major non-surgical treatments were the use of both narcotic and non-narcotic pain medication (73.8 %, $n = 1964$), antibiotics (63.5 %, $n = 1689$), and wound care (52.7 %, $n = 1401$), and these differed significantly across the hospitals ($p < 0.001$). The majority of the patients were discharged between 1 and 7 days ($n = 1468$, 58.2 %).

Outcomes

Overall, we found that 562 (21.1 %) patients were operated upon and were discharged, and the additional 562 (21.1 %) were referred to another facility (Table 4). Up to 1051 (39.5 %) patients received non-operative management only and were discharged, 39 (1.5 %) absconded, and 34 (1.3 %) died. Outcomes were not recorded for 412 (15.5 %) patients. Cancer patients ($n = 103$, 40.9 %) and non-cancer general surgery patients ($n = 299$, 58.8 %) were most likely to receive surgery and be discharged. Most trauma patients ($n = 572$, 55.9 %) and those with surgical infections ($n = 312$, 57.8 %) were discharged with non-operative management, and the majority of the patients with congenital conditions ($n = 19$, 59.4 %) were referred to another facility.

Discussion

In this study, we retrospectively investigated medical records of patients needing non-obstetric surgical care in three rural district hospitals in Rwanda. Most patients were males, and injury was the most common diagnosis, mainly resulting from road traffic injuries and assaults. Injury has been recognized as the leading condition requiring surgical care in Rwanda and other LMICs [1, 2, 8]. The prevalence in our cohort is similar to a Kenyan study where 41 % of patients who visited a hospital's emergency department were injured [9]. The Kenyan study also found that most non-obstetric surgical patients were males and most injuries resulted from road traffic injuries (42 %) and assaults (28 %), consistent with our results. Road traffic injuries are a persistent menace in Africa, and preventive strategies at the national level such as improved road traffic safety and community promotion of the safe use of roads are suggested [1].

Supporting laboratory and imaging diagnostics were limited, with only 59.5 % of patients having any laboratory testing and only 45.0 % receiving any imaging. While not all patients presenting for surgical care may need testing or imaging (for example, in Kenya, only 72 % of trauma patients needed x-rays [9], the current level of testing and diagnostics remains low. As observed in other studies, inadequate equipment and materials may contribute to the low levels of laboratory tests and imaging [2]. In addition, the variation noted in diagnostics may be attributed to differences in equipment and availability of specialists at the three district hospitals. Availing the needed equipment and materials can improve laboratory testing and imaging and hence improve diagnosis for better care. These differences may also reflect variation in practice patterns based on the surgical training received by the providers at the different district hospitals. Developing protocols for management of surgical conditions to guide providers at all district hospitals could also improve appropriate resource utilization for surgical patients.

For patients seeking non-obstetric surgical care at the district hospitals, nearly a quarter received some type of operation at the district hospital. Although other studies report over 80 % of major surgeries happening at the district hospitals in Rwanda (CHUK Report 2010), most of these are obstetric cases [6, 7]. Although obstetrics care

Table 3 Non-operative management—evaluation and treatment

	All the hospitals $N = 2660$		Butaro $N = 766$		Rwinkwavu $N = 910$		Kirehe $N = 984$		p value
	n	%	n	%	n	%	n	%	
Received at least one laboratory test[a]	1583	59.5	649	84.7	437	48.2	497	50.5	<0.001
Full blood count	1447	54.4	618	80.7	394	43.3	435	44.2	<0.001
Bleeding time	474	17.8	360	47.0	33	3.6	81	8.2	<0.001
Clotting time	457	17.2	356	46.5	37	4.1	64	6.5	<0.001
HIV	913	34.3	527	68.8	190	20.9	196	19.9	<0.001
Type and cross	527	19.8	377	49.2	68	7.5	82	8.3	<0.001
At least one imaging test[a]	1197	45.0	266	34.7	418	45.9	513	52.1	<0.001
Abdomen x-ray	77	2.9	35	4.6	17	1.9	25	2.5	0.004
Orthopedic x-ray[b]	713	26.8	168	21.9	238	26.2	308	31.3	<0.001
Chest x-ray	247	9.3	67	8.8	105	11.5	75	7.6	0.012
Head x-ray	249	9.4	30	3.9	90	9.9	129	13.1	<0.001
Ultrasound	166	6.2	47	6.1	87	9.6	32	3.3	<0.001
Non-operative treatments[a]									
Antibiotics	1689	63.5	560	73.2	532	60.5	597	63.2	<0.001
Non-OR wound care	1401	52.7	371	48..5	419	46.1	611	62.1	<0.001
Pain medication (narcotic + non-narcotic)	1964	73.8	638	83.3	546	60.0	780	79.3	<0.001
Traction for fracture	25	0.9	21	2.7	1	0.1	3	0.3	<0.001
Casting/immobilization	282	10.6	44	5.7	79	8.7	159	16.2	<0.001
Blood transfusion	52	1.9	18	2.4	22	2.4	12	1.2	0.095
Admission ward of patient	$N = 2639$		$N = 762$		$N = 895$		$N = 973$		
Surgery ward	2163	82.0	685	89.9	605	67.6	873	89.7	<0.001
Other wards	467	18.0	77	10.1	290	32.4	100	10.3	
Duration in the hospital[c]	$N = 2525$		$N = 752$		$N = 856$		$N = 917$		
Discharged same day	314	12.4	33	4.4	221	25.8	60	6.5	Unable to report
1–7 days	1468	58.2	444	59.0	433	50.6	591	64.5	
8–14 days	328	13.0	122	16.2	93	10.9	113	12.3	
15–30 days	245	9.7	99	13.2	58	6.8	88	9.6	
More than 30 days	170	6.7	54	7.2	51	6.0	65	7.1	

We defined non-operative management as treatment, such as laboratory tests, imaging, narcotic and non-narcotic pain medication, wound care, and the use of antibiotics, that did not involve surgical operation

[a] Each test and treatment is a binary variable and only reporting the frequencies for those who received an intervention

[b] Includes extremity, and pelvic and spine x-rays

[c] Stata could not calculate a Fisher's exact p value

may affect non-obstetrics care at the district hospital level [10], due to separate obstetrics theaters and providers in our study hospitals, we suspect minimal impact and advise further study to assess this relationship. There was significant variation in types of non-obstetric surgery completed across the three district hospitals, and similar variations at district hospitals have been observed in other sub-Saharan countries [6]. Kirehe and Rwinkwavu DH had higher incidences of orthopedic trauma (56 and 49 % of all non-obstetric conditions, respectively) compared to Butaro (18 %). This pattern remained even with the exclusion of operations performed by visiting plastic surgeons which might skew the surgical presentations (Kirehe (56 %), Rwinkwavu (49 %), and Butaro (23 %)). Butaro is more rural and difficult to reach than Kirehe and Rwinkwavu which are closer to tarmac roads, and hence higher road traffic and more likely to experience road traffic injuries. The differing surgical practice patterns at district hospitals reflect differences in both surgical capacity and epidemiologic needs at each hospital, indicating that decision makers will need to tailor some decisions based on the needs at the hospital level.

A significantly higher proportion of patients in Butaro DH received surgery, likely attributable to the presence of

Table 4 Immediate administrative outcomes of patients needing non-obstetric surgical care

	All surgical patients		Diagnosis													
			Trauma		Infection		Cancer		General surgery		Congenital		Urology		Unknown	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Outcomes																
Received operation and discharged	562	21.1	41	4.0	67	12.4	103	40.9	299	58.8	7	21.9	11	22.5	34	13.3
Received non-operative management only and discharged	1051	39.5	572	55.9	312	57.8	35	13.9	40	7.9	2	6.3	14	28.6	76	29.8
Referred to another facility	562	21.1	206	20.1	80	14.8	78	31.0	90	17.7	19	59.4	8	16.3	81	31.8
Absconded	39	1.5	29	2.8	4	0.7	1	0.4	2	0.4	0	0	1	2.0	2	0.8
Died	34	1.3	7	0.7	10	1.9	6	2.4	1	0.2	0	0	2	4.1	8	3.1
Unknown	412	15.5	169	16.5	67	12.4	29	11.5	76	15.0	4	12.5	13	26.5	54	21.2

a general surgeon on staff in Butaro in addition to frequent specialist surgeons' visits who provided non-routine surgical care in this setting during 2013. In most countries in sub-Saharan Africa, hospitals rely on non-surgeons to provide surgical care in rural facilities. A study of eight district hospitals in Mozambique, Tanzania, and Uganda found no specialist surgeons or anesthetists, with general practitioners and nurses providing most of the operative services [4]. While not all patients presenting with a surgical condition need an operative procedure, the very low volume of operative procedures, especially in Rwinkwavu and Kirehe, indicates a gap in meeting the district-level surgical need. The increased number of operations at Butaro DH emphasizes recommendations that more operative care could be provided at the district hospital level if additional surgical staff were available and proper surgical equipment availed [1]. In Butaro, visiting plastic surgeons performed 40 % of all surgeries in 2013. However, the exclusion of the 182 surgeries performed by the visiting surgeons still left Butaro with the highest volume of operations, more than twice the operations performed in Rwinkwavu or Kirehe, suggesting that the visits met local needs rather than skew presentation and interventions. The 2015 Lancet Commission on Global Surgery also recommends surgical task sharing through increasing the number of non-physician surgeons as a temporary solution [1]. Not only would this reduce the number of patients discharged without receiving a needed procedure, but it would also reduce the number of patients referred to tertiary facilities, which are heavily burdened by the number of surgical referrals. However, there is need to ensuring that the additional trained surgical staff are comfortable with handling the most common surgical needs. Although trauma was the major clinical diagnosis overall, the majority of the trauma cases were referred. Currently, orthopedic care in Rwanda is available at referral hospitals. A general surgeon, without additional training and equipment, would not be able to handle the majority of orthopedic cases, depending on complexity.

Several limitations should be considered in the interpretation of these results. As our study used routinely collected data from patients' charts, we were not able to report for all variables on all patients. We performed data quality checks to reduce inaccuracies; however, missing data were often due to data not being recorded in the clinical charts. We believe that these data are missing at random, due to the heavy clinical load at the hospitals. However, we recommend revising the clinical charts and implementing routine audits to improve these data in the future. Finally, even though our study was limited to three rural district hospitals and that Butaro DH was relatively different from Rwinkwavu and Kirehe DHs due to the presence of a surgeon on staff and other visiting surgical specialists, the general infrastructure and human resources available at Rwinkwavu and Kirehe DHs are similar to other district hospitals in Rwanda. Therefore, we believe our results are informative of the needs of other rural district hospitals in Rwanda and beyond.

Conclusion

We found variation in the operative and non-operative surgical care that was provided at each district hospital potentially reflecting the variation in the surgical capacity of each district hospital in terms of human resources as well as equipment. As shown by our results, the percentage of patients receiving operative care was higher in Butaro than in Rwinkwavu and Kirehe. We attribute this to the presence of a general surgeon on staff and more surgical equipment. In the absence of trained surgeons particularly in low-resource settings, surgical task sharing is an

alternative option [1, 11]. However, robust comparative analysis, assessing the relationship between the presence of surgeons and surgical equipment with surgical volume, interventions, and outcomes, is recommended.

Rwanda's Ministry of Health is implementing a Human Resources for Health program to increase the number of specialist throughout the country, including surgical providers, in addition to improving rural district hospital's infrastructure [12, 13]. While these initiatives should go far in improving surgical care in the rural districts over time, assessing local needs and providing training to meet those needs could address the site-specific issues immediately at hand. Countries responding to the Lancet Commission call to create national surgical plans can learn from the care provided and the existing gaps identified in this study to appropriately address their surgical needs.

Acknowledgments We acknowledge Partners In Health/Inshuti Mu Buzima and the IMB Innovation Grants for the support of this work. This study was developed under the Partners In Health/Inshuti Mu Buzima Intermediate Operational Research Training Program, developed and facilitated by Bethany Hedt-Gauthier and Neil Gupta. We are thankful to all three PIH/IMB-supported District Hospitals staff for their contribution. We also appreciate the Association of Academic Surgeons and the Harvard Kennedy Traveling Fellowship for their financial support of the data collection for this project.

Author contributions EM and CH led the study design, data cleaning and analysis, results interpretation, and manuscript preparation. RR, BHG, JO, RM, and NG provided inputs in study design, data analysis, and results interpretation and critically reviewed the manuscript. BHG, RM, and JO supported data cleaning, and RR, BHG, and NG also provided mentorship. GT, TN, TM, and JN supported study design, results interpretation, and manuscript preparation.

Compliance with ethical standards

Conflict of interest The authors affirm that they have no competing interests.

References

1. Meara JG, Leather AJM, Hagander L et al (2015) Global surgery 2030: evidence and solutions for achieving health, welfare, and economic development. The Lancet 386(9993):569–624
2. Grimes CE, Bowman KG, Dodgion CM et al (2011) Systematic review of barriers to surgical care in low-income and middle-income countries. World J Surg 35:941–950
3. Stewart B, Khanduri P, McCord C et al (2014) Global disease burden of conditions requiring emergency surgery. Br J Surg 101:e9–e22
4. Kruk ME, Wladis A, Mbembati N et al (2010) Human resource and funding constraints for essential surgery in district hospitals in Africa: a retrospective cross-sectional survey. PLoS Med 7(3):e1000242
5. Hsia RY, Mbembati NA, Macfarlane S et al (2011) Access to emergency and surgical care in sub-Saharan Africa: the infrastructure gap. Health Policy Plan 27:234–244
6. Galukande M, Von Schreeb J, Wladis A et al (2010) Essential surgery at the district hospital: a retrospective descriptive analysis in three African countries. PLoS Med 7(3):e1000243
7. Petroze RT, Nzayisenga A, Rusanganwa V et al (2012) Comprehensive national analysis of emergency and essential surgical capacity in Rwanda. Br J Surg 99:436–443
8. Linden AF, Maine RG, Hedt-Gauthier BL et al (2016) Validation of a community-based survey assessing nonobstetric surgical conditions in Burera District, Rwanda. Surgery 159(4):1217–1226
9. Ogendi JOK, Ayisi JG (2011) Causes of injuries resulting in a visit to the emergency department of a Provincial General Hospital, Nyanza, western Kenya. Afr Health Sci 11(2):255–261
10. Petroze RT, Mehtsun W, Nzayisenga A, Ntakiyiruta G, Sawyer RG, Calland JF (2010) Ratio of cesarean sections to total procedures as a marker of district hospital trauma capacity. World J Surg 36(9):2074–2079
11. Chu K, Rosseel P, Gielis P et al (2009) Surgical task shifting in sub-Saharan Africa. PLoS Med 6(5):e1000078
12. Binagwaho A, Kyamanywa P, Farmer PE et al (2013) The human resources for health program in rwanda—a new partnership. N Engl J Med 369(21):2054–2059
13. Higashi H, Barendregt JJ, Kassebaum NJ et al (2014) Burden of injuries avertable by a basic surgical package in in low-and middle-income regions: a systematic analysis from the Global Burden of Disease 2010 study. World J Surg 39:1–9