Surgical Trainee Supervision During Non-Trauma Emergency Laparotomy in Rwanda and South Africa

A Prospective study

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ABSTRACT

Objective: The primary objective was to describe the level of surgical trainee autonomy during non-trauma emergency laparotomy (NTEL) operations in Rwanda and South Africa. The secondary objective was to identify potential associations between trainee autonomy, and patient mortality and reoperation.

Design, Setting, and Participants: This was a prospective, observational study of NTEL operations at three teaching hospitals in South Africa and Rwanda over a one-year period from September 1, 2017 – August 31, 2018. A total of 543 operations on adults over the age of 18 years who underwent NTEL performed by the acute care and general surgery services were included.

Results: surgical trainees led three quarters of NTEL operations, and of these, 72% were performed autonomously in Rwanda and South Africa. Trainees were less likely to perform the operations autonomously for patients who were: age ≥ 60 years, had ASA classification ≥ III, had cancer or TB. Notably, trainee autonomy was not significantly associated with reoperation or mortality.

Conclusions: trainees were able to gain autonomous surgical experience without impacting mortality or reoperation outcomes, while still providing surgical support in a high-demand setting. More in-depth studies to understand the association of high trainee autonomy with surgical competency and patient safety is needed.

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CONFLICTS OF INTERESTS

There are no disclosures or conflicts to report.

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CHAPTER 1

Introduction and Literature Review

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1.1 The Shortage of Surgeons

Surgical provision can cure or alleviate a third of the global burden of disease. (1) However, there are not enough qualified surgeons worldwide to provide this care. In addition, surgeons are inequitably distributed, with a paucity of fully qualified surgeons in low- and middle- income countries (LMICs), especially in sub-Saharan Africa (SSA). (2) In order to reach universal coverage for safe surgical care globally by 2030, the Lancet Commission for Global Surgery (LCGS) has proposed a minimum surgical workforce density of 20 surgeons, anaesthesiologists, and obstetricians per 100,000 by 2030 in every country. (1) For the global community to reach these goals, improving and expanding surgical education to increase the number of fully qualified surgeons is paramount, particularly in SSA.

General surgeon density in LMIC ranges from 0.5 to 8.4 per 100,000 people. (3) In comparison, high-income countries (HICs) have an average of 56.9 surgical specialists per 100,000 people; well above the LCGS target.(3) SSA has the lowest density of surgeons within LMIC and there is a dire need for effective training programmes and appropriately trained surgeons in SSA. (1, 3)

South Africa and Rwanda are two LMICs in SSA that have a shortage of surgeons and maldistribution of surgical capacity. South Africa, an upper-middle-income country of 55 million people, has vast inequities in health care, including surgical care. Over 50% of specialist surgeons work in the private sector, which provides care to only 15% of the population. (4) The density of general surgeons per 100,000 people is estimated to be 6.6. (3)

Rwanda, a low-income country of 11 million people, has a shortage of suitably trained surgeons and available infrastructure to meet its huge demand of emergency surgery. (5, 6) Post the1994 civil genocide, the medical school of the University of Rwanda was rebuilt in 1996 and in 2012 the Human Resources for Health (HRH) Programme was launched to strengthen the country's health care education system and workforce. (7) There are 0.4 general surgeons per 100,000, the majority of whom practice in the capital city of Kigali, which serves only 10% of the population. (3, 5). There is an estimated total specialised surgical workforce density (surgeons, anaesthesiologists, and obstetricians) of 1.0 per 100,000 in 2016. (8) In other words, Rwanda would need to increase its specialised surgical workforce 20-fold to advance surgical care. (1)

1.2. Surgical Post-graduate Education

Scaling-up surgical post-graduate education is the primary way to increase the number of surgeons in SSA, However, there is a paucity of literature on surgical education in SSA, including South Africa and Rwanda. The evolution of surgical education in North America and Europe are well described in the literature. Prior to

the 20th century, surgery was not a medical field. Instead, barber-surgeons who were tradesmen, like blacksmiths, learned their surgical "trade" through apprenticeship.(9) As the field of surgery transitioned from a trade to a medical profession, surgical education expanded from a trade apprenticeship to a more structured and formalised surgical curricula, leading to the establishment of country and regional post-graduation accreditation bodies. (10)

Modern surgical training involves acquiring theoretical knowledge as well as technical skills. Surgical education programmes worldwide cover these two requirements using diverse pedagogy. First, most surgical education programmes are four- or five-year in length and have specific pedagogy to master theoretical content. Typically, they have a structured theoretical curriculum, which includes formal written and oral assessments required to progress in training and are regulated by certifying bodies, for example The American Board of Surgery (USA), the Royal Colleges of Surgeons (UK). (10, 11) Second, technical skills are learned through a combination of videos and simulation, and observation, supervision, and autonomy in the operating theatre. (10-12)

William Halstead has been credited as the father of modern surgical education, particularly in the United States (US), based on an apprentice model of graduated supervision. (10) In graduated supervision, trainees are allowed incremental levels of independence or autonomy in the operating theatre. Trainees acquire surgical skills through instruction and observation of qualified and experienced surgeons in an operating theatre. Trainees then practice their acquired skills while being supervised by a qualified surgeon. Supervision allows trainees to practice their skills in a live

operating environment with a qualified specialist present who is able to guide and instruct a trainee or take over the operation should the need arise to safeguard patient safety. (13-16)

After having acquired sufficient practical surgical skills, trainees are permitted to practice autonomously without supervision. (13-16) Autonomy provides opportunities for trainees to gain confidence, develop patient management skills, improve problem-solving skills, encourage self-learning, and increase responsibility patients and outcomes while reducing the workload of hospitals. (13, 17-19)

1.3. Surgical Training Programmes

Healthcare is ever-evolving and thus requires surgical education to be responsive to changes in the field. Furthermore, the globalisation of healthcare has necessitated the standardization of education and training programmes. However, depending on the accreditation body and country, there is large variability in the training requirements between surgical post-graduate education programmes.

Most programmes worldwide use a variation of graduated supervision. However, when and how trainees progress to operative autonomy, as well as the measure of surgical competence is not always well-outlined. Secondly, the minimum surgical volumes requirements and examinations to test theoretical, clinical, and technical assessments are not standardised between programmes. (15, 20)

Many HICs have formally integrated graduated supervision into their surgical

postgraduate programmes, as well as defined the requirements to progress through graduated supervision, including formal measures of competency. For example, the US surgical education programmes are certified by the Accreditation Council for Graduate Medical Education (ACGME) which requires general surgery trainees to perform 850 operations, 250 of which as primary surgeon or first assistant. (21) In many US surgical training programmes, the graduated supervision model is usually employed, where a trainee is given more autonomy based on the level of demonstrated experience and observed competency through Objective Structured Clinical Examination (OSCE) as they progress through a set programme. (22-24)

In the United Kingdom, trainees must complete a minimum of 1600 specified operations in order to graduate, although there are no requirements on operative autonomy. Surgical skills competence of trainees is assessed by consultant surgeons through procedure-based assessments (PBA) and observation of practical skills (OPS), as part of formative and summative assessments. (25) However, these are not uniformly applied by the various training hospitals nationally. (25-27)

In Australia and New Zealand, surgical training follows a formal graduated supervision model with well-defined supervision and trainee outcomes. Surgical trainees are to complete 100 operations per six-month rotation including the minimum supervision and autonomy requirements for key operations. (28, 29) In Canada, graduated supervision is also formally employed as a training methodology. However, there are no minimum number of operations for trainees but a list of operations that a general surgical trainee should be able to perform autonomously upon graduation. (30)

In comparison, graduated supervision is less defined in SSA countries, including South Africa and Rwanda. (2, 30, 31) Surgical curricula often cover a broad spectrum of techniques to prepare trainees to operate in resource-constrained settings. (13-16) SSA surgical programmes, including those in South Africa and Rwanda, are three to five years in length and include a form of graduated supervision with written and oral final examinations. Training is done at either academic or non-academic hospitals and accreditation is completed through national or regional accreditation bodies. (2, 31-34) Many LMICs including SSA countries utilise, low cost, low fidelity simulation including simulations on cadavers, live animals and animal parts. While high fidelity surgical simulation is not commonly used in comparison with HIC training programmes, it is gaining traction in some SSA surgical programmes. (35-37)

In South Africa, surgical postgraduate education is provided by 11 universities.(33) and accredited by the College of Surgeons, a branch of the College of Medicine of South Africa (CMSA), through university-based programmes. CMSA mandates the threshold for theoretical and practical proficiency, which is assessed through a series of written and oral examinations. In addition, trainees must rotate through surgical departments over a period of four years. Although trainees maintain a logbook of surgical operations, there are no minimum requirements of the number or the type of operations, competencies, or whether operations performed should be supervised or autonomous. (33) While some training programmes employ informal, non-accredited trainee operative assessments, in-operative surgical skills and competency are not formally assessed as part of the CMSA requirements, nor is graduated supervision prescribed centrally as a training methodology.(33)

In Rwanda, surgical post-graduate education is provided either through the University of Rwanda (UR) or non-university hospitals affiliated with the College of Surgeons of East, Central, and Southern Africa (COSECSA). The Rwandan Medical Council and COSECSA provide accreditation. At UR, the surgical curriculum is based on a modular structure, where trainees rotate through various surgical departments, with academic exams to assess knowledge. Similar to South Africa, trainees maintain a logbook but no formal standards exist regarding a minimum number of operations or surgical proficiency, nor are there guidelines on supervision or autonomy requirements. (34) A number of reforms in surgical training were introduced in 2012 by UR to improve surgical skills training, including increasing supervision and mentorship opportunities, employing international visiting specialists, and increasing the number of teaching sites. (7)

COSECSA is an alternative accreditation pathway for general surgical trainees in Rwanda as well as 18 other countries in SSA. Trainees acquire technical training at 125 specific COSECSA-affiliated non-university hospitals in Rwanda and the other 18 countries. Although there are detailed academic requirements for surgical specialisation with formal written examinations, the skills-based assessment is limited to the submission of a logbook and the completion of recommend operations. No standards are prescribed regarding the minimum number of operations, proficiencies, or whether operations should be performed under supervision or autonomously. (38)

1.4. Surgical Education and Supervision Trends

Surgical trainees can learn technical skills through operating theatre supervision by fully qualified (consultant) surgeons. On the other hand, when they perform operations autonomously, trainees have the opportunity to practice these skills and gain confidence to ensure that they are able to perform operations independently upon graduation. Finding the balance between supervision and safe autonomy opportunities can be challenging. (39) However, it must also be noted that confidence is not necessarily an indicator of competence and vice versa.

In some HICs, over-supervision occurs which can undermine trainee competence and real or perceived proficiency. The Association of Surgeons in Training in the United Kingdom (UK) reported that many surgical trainees did not feel competent upon graduation, citing insufficient autonomous surgical training among other reasons. (40) A survey conducted by the US Fellowship Council found that 66% of recent general surgery graduates could not operate for more than 30 minutes autonomously in major operations. The findings highlighted trainee deficits in operative autonomy and progressive responsibility. (41) Over-supervision and the limited opportunity to operate independently may explain why 80% of recently qualified surgeons in the US were pursuing fellowships to gain more experience. (42, 43)

However, in SSA, the limited number of consultant surgeon-trainers, as well as the high surgical disease burden (1, 44) results in trainees operating autonomously more often than they are being supervised. (45, 46) In contrast to the over-supervision common in HICs, the results of a meta-analysis of SSA surgical programmes across East, Central and Southern Africa indicated that trainees felt that they received

inadequate practical training and supervision. Trainees also had fewer opportunities to perform elective operations as the primary surgeon (the surgeon performing key portions of the operation). (2) For example, in Kenya, consultants were the primary surgeons for 79% of elective cases involving trainees, while trainees performed the majority of emergency surgeries, most of which were not supervised. (47)

A study at the University Teaching Hospital in Kigali, Rwanda reported that general surgery trainees were the primary surgeon in 81% of emergency general surgery operations and operated autonomously in 72% of these operations. Conversely, trainees were the primary surgeon in only 44% of elective cases and were supervised in 67% of these operations. The high level of trainee autonomy during emergency operations and insufficient exposure to elective operations were identified by the study as deficiencies in the UR training curriculum. (48) The limited surgical operating facilities, the lack of supervising consultants, and the burden of emergency cases at the expense of elective operations, led to reduced supervision for elective operations in Rwanda. (7)

A South African study that reviewed logbooks of 95 surgical trainees from several training hospitals across the country, reported 61% of operations conducted were unsupervised, 18% were supervised, and 21% involved assisting another trainee. No significant difference was observed between the various training hospitals. The study acknowledged the high number of operations conducted by trainees, but also noted that there was a lack of diversity in the types of operations performed by trainees. However, there were no mechanisms to determine the quality of training or surgical skill level of trainees based on logbook evidence only. (46)

Similarly, a three-year retrospective study of an acute care department at the University of Cape Town, South Africa, reported that consultant surgeons were the primary surgeon in 17% of cases, and trainees in 83%. Specifically, trainees acted as primary surgeon in only 16% of elective cases and in 92% of non-trauma emergency operations. Consultants supervised trainees in 24% of all operations, with the consultant only assisting in 9% of non-trauma emergencies. This study also noted that surgical trainees performed a vital role in service provision and patient care in South Africa, without which, hospitals in resource-constrained settings would not be able to meet the significant surgical demands they face. (45) This observation is congruent with a meta-analysis of the surgical workforce in SSA that highlighted the acute shortage of qualified surgeons in SSA. (2)

While an environment of high surgical demands may result in limited supervision and opportunities to be involved in elective operations, there can be a number of advantages. The large number of operations SSA trainees perform autonomously may contribute to them gaining more experience and competence, through graduated supervision, in comparison with HIC trainees. (49) In addition, SSA trainee progression may also be a result of operative experience gained before starting formalised post-graduate surgical training. Many SSA trainees, including those in South Africa and Rwanda, have operating experience as medical officers after undergraduate qualification and prior to surgical specialisation training. (7, 31, 50)

In comparison to their US counterparts, SSA trainee surgeons had more opportunities to operate independently as trainees, thereby demonstrating greater experience in a broader variety of operations, necessary in understaffed and resource-constrained settings. (49) These results are supported by a UK study, which compared the surgical opportunities of UK trainees with South African trainees. The authors recommended UK training programs may consider following South Africa's example by increasing trainee operative time and opportunities, specifically on complicated cases. (51).

Due to the shortage of qualified surgeons, essential emergency surgery in many SSA countries is often performed by non-physician clinicians (NPC). (52-54) NPCs perform over 90% of surgical procedures in Mozambique and Malawi for example. (55) "Task shifting" and "task sharing" studies in 29 sub-Saharan African countries and pilot projects in Zambia, Malawi, and Tanzania have shown that systematic and effective training of NPC in some common and non-complicated emergency procedures at district and referral level hospitals allows surgical trainees and supervisors to improve operational exposure and training and focus on more complicated emergency and elective surgeries at tertiary level and training hospitals. (52, 55, 56) However, the service delivery need is so vast in LMICs that task-shifting to NPC could have little effect on improving surgeon training in the short term. There may even be a negative effect on surgical trainee access to specialist supervision, as supervisors will be needed to train and supervise NPC trainees at the expense of supervising surgical trainees. (57)

1.5. Safety Considerations of Trainee Participation in Operations

From a review of the literature, HIC trainees have fewer opportunities to act as primary surgeons and to do so unsupervised, compared with their SSA counterparts. This may be in part due to patient safety considerations. Particularly in HICs, there are increased concerns of patient safety when trainees are involved in the operation resulting in potential malpractice litigation. (23, 58-61)

Data on patient outcomes and trainee involvement are mixed and most are from HICs as there is a paucity in the literature on this subject in LMICs including SSA. (31, 62)

There is a perception that trainee participation in operations, particularly unsupervised, has a negative impact on patient outcomes and therefore, trainees should not operate autonomously or even as supervised primary surgeons. A retrospective study of trainee participation in general surgery operations involving 141,000 patients across 400 institutions in the US found that trainee participation was independently associated with longer operating times, intra- and post-operative complications, wound, pulmonary, and venous thromboembolic complications, and urinary tract infections. Interestingly, only 0.1% of these cases were performed without supervision. (61) Similar results were found in another retrospective US study of 54,467 trainee-led appendectomy operations, which found that trainee-led operations resulted in longer operating times and an increase in intra- and post-operative complications. The more senior the trainee and the more autonomy they

were allowed through the graduated supervision model, the greater the risk of longer operating times and complications. (63) A similar observation was made in a US study regardless of trainee experience. (64)

However, a national study in the UK involving 87,367 emergency laparotomy patients found that there were no significant adverse 90-day mortality or reoperation outcomes of operations involving trainees. Although the level of supervision was not measured in this study, the study assumed that many cases were unsupervised due to the graduated supervision model employed in the UK, and the fact that many emergency operations occurred after hours when supervising consultants were not present on site. (65) Other HIC studies of supervised and unsupervised trainee-led operations did not show significantly worse intra- and post-operation complications, and morbidity and mortality outcomes when compared with consultant-led operations. (66-69) On the contrary, an Australian study of trainee-led operations reported fewer post-operative complications. (70)

Availability of supervision when needed was also shown to be associated with improved outcomes for trainee-led operations. A retrospective study that reviewed the outcomes of 69,490 emergency general surgery operations from the UK, US, and Australia, demonstrated that having consultant surgeons available to supervise emergency general surgery operations improved post-operative mortality by 33%. Reducing consultant elective commitment and increasing their emergency general supervisory surgery availability decreased length of in-hospital stay of patients by 22%. (71)

Other studies advocate for increasing trainee operative time rather than reducing it, as is the current trend in HICs, but under the supervision of suitably experienced or competent consultants. (19, 72) One US study found that intra-operative complications, morality, morbidity, and healthcare cost were positively correlated with the experience level of the consultant supervising the trainee rather than the experience of the trainee. (73)

1.6. Improving Surgical Training in Sub-Saharan Africa

Although theoretical knowledge can be assessed through written and oral examinations, little attention has been given to the assessment of operative proficiency. (74) Skills development in other industries such as aviation and the military use competency- and simulation-based training methods. Surgery has fallen behind these industries, and simulators, technology, robotics, and competency-based training could improve the development of trainees' surgical skills. (75) However, in recent years, medical simulation-based training has been increasingly incorporated into surgical educational programmes in HICs. These simulations, which can range from low- to high- models, have shown to improve surgical trainee performance prior to operating on patients. (76, 77) For example, at Johns Hopkins School of Medicine, in the US, trainee use of pre-operative simulation showed an improvement in performance and efficiency. Trainees were significantly more confident and comfortable conducting the operations and stated that the exercises improved their skill level. (78)

However, one meta-data study concluded that there was little evidence for virtual reality and simulators accurately determining surgical skill, particularly within an operating theatre. Adequate supervision and objective assessment of trainees by consultant surgeon-trainers in an operating theatre was still vital for effective training. (79) Indeed, one study across 41 training institutions in the US showed that allowing trainees to lead operations as the primary surgeon, supervised and unsupervised, was critical to skills development and cognitive reasoning, as trainees learnt to overcome challenges and gained more confidence. (19)

Therefore, acquiring surgical technical skills through a multidisciplinary approach of classroom, clinic, virtual reality, high and low fidelity simulated operations, and increased time in the operating theatre could improve confidence and proficiency. (80)

Excluding potentially expensive virtual and simulation technologies, which are often inaccessible for many LMICs and SSA countries, a number of alternative suggestions have been offered to improve surgical trainee proficiency. Use of low-cost low-fidelity simulation on cadavers or animals, for example, have been shown to assist in practical skills acquisition (37) Standardisation of graduated supervision and more formalised measures of competency may improve training success. Trainees advance through a training pathway that is not based on year of study, time served, or number of operations logged, but by demonstrating measured and supervised competency in increasingly complicated operations. (15, 81) In addition, improved surgical training standards, increased supervision availability, and

improved patient care protocols have shown that surgical care in under-resourced hospitals in SSA can be provided affordably, safely, and effectively. (82, 83)

1.7. Exploratory Laparotomy as Measure of Surgical Training Effectiveness in SSA

As aforementioned, there is a paucity of information on surgical training in SSA, particularly in regard to technical training and skills transfer. (30, 31) Although graduated supervision is often employed, a review of the literature has shown that it has not been thoroughly defined or evaluated in SSA countries, including South Africa and Rwanda. Because an exploratory laparotomy (EL) is a mainstay operation, understanding graduated supervision for this operation may help evaluate basic surgical training.

EL, an essential operation that enters the abdomen through an abdominal incision and explores the peritoneal cavity for diagnostic and therapeutic purposes. EL can be performed to address elective and emergency surgical conditions, the latter for trauma and non-trauma indications. (84) It is performed for a variety of indications, including identification and repair of penetrating and blunt injuries, infectious emergencies, and other surgical conditions such as cancer. EL has a diagnostic and therapeutic role in abdominal emergencies. Indications for EL vary widely, depending on patient demographics and disease profile, and includes trauma and non-trauma abdominal catastrophes. Conditions that require emergency laparotomy have high morbidity and mortality rates if left untreated. (85-87) EL is one of the most prevalent surgical operation in LMICs. In Uganda for example, emergency

laparotomy is the second most common surgical operation after caesarean sections. (88) Likewise, non-trauma emergency laparotomy (NTEL) was the most common surgical operation, comprising 22% of all surgical operations performed in a Mozambique tertiary level hospital. (89)

The LCGS identified EL as an operation that should be capably and safely performed at all hospitals (including district hospitals), one of three so-called bellwether procedures. Therefore, surgeons in every country should be appropriately trained for this operation. (90, 91)

1.8. Study Rationale

The literature indicates SSA countries, including South Africa and Rwanda, do not have a large enough surgical workforce to meet operative demand. As a result, training programmes have high levels of surgical demand and trainees often perform operations as the primary surgeon, and unsupervised. Therefore, improving and expanding surgical training to increase the number of fully qualified surgeons is critical to improving surgical capacity in the region.

Graduated supervision is often employed as a means to learn operative skills to trainees, however, it has not been well defined or described in the literature for South Africa or Rwanda. Following this, an examination of consultant supervision and trainee autonomy, and associated patient outcomes, can contribute to a better understanding of graduated supervision in surgical education in these countries.

1.9. Hypothesis and Study Objectives

The hypotheses were firstly, trainees in Rwanda and South Africa would conduct the majority of NTEL operations and the majority of these would be unsupervised, and secondly, unsupervised trainee-led operations would not adversely affect patient mortality or reoperation.

The primary objective of the study was to describe the level of surgical trainee autonomy during NTEL operations at teaching hospitals in Rwanda and South Africa. The secondary objective was to identify potential associations between trainee autonomy, and patient mortality and reoperation.

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CHAPTER 2

Publication- Ready Article

2.1. Title

Surgical Trainee Supervision During Non-Trauma Emergency Laparotomy in Rwanda and South Africa

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2.6. Abstract

Objective: The primary objective was to describe the level of surgical trainee autonomy during non-trauma emergency laparotomy (NTEL) operations in Rwanda and South Africa. The secondary objective was to identify potential associations between trainee autonomy, and patient mortality and reoperation.

Design, Setting, and Participants: This was a prospective, observational study of NTEL operations at three teaching hospitals in South Africa and Rwanda over a one-year period from September 1, 2017 – August 31, 2018. A total of 543 operations on adults over the age of 18 years who underwent NTEL performed by the acute care and general surgery services were included.

Results: surgical trainees led three quarters of NTEL operations, and of these, 72% were performed autonomously in Rwanda and South Africa. Trainees were less likely to perform the operations autonomously for patients who were: age ≥ 60 years, had ASA classification ≥ III, had cancer or TB. Notably, trainee autonomy was not significantly associated with reoperation or mortality.

Conclusions: trainees were able to gain autonomous surgical experience without impacting mortality or reoperation outcomes, while still providing surgical support in a high-demand setting. More in-depth studies to understand the association of high trainee autonomy with surgical competency and patient safety is needed.

Keywords: Surgery, Training, Education, Supervision, Laparotomy, Africa

2.7. Introduction

Only six percent of surgical operations occur in low- and middle- income countries (LMICs), where over a third of the global population lives. (1) One reason for low operative volume is the shortage of fully qualified surgeons in Sub-Saharan Africa (SSA), including in South Africa and Rwanda. (1, 2) As a result, the appropriate training of SSA surgeons is essential to scaling-up surgical capacity in the region.

Within general surgery, a mainstay operation is an exploratory laparotomy (EL). EL is an abdominal operation involving exploration of the peritoneal cavity that is performed for a variety of emergency and elective conditions. EL can be lifesaving and learning to perform an EL independently and safely is a critical skill in general surgery education. , especially for emergency conditions that would have high morbidity and mortality if left untreated. (3-5) To this end, general surgeons worldwide need adequate training in this operation.

Surgical training is unique to medical specialisation because it involves acquiring theoretical knowledge through educational programmes, as well as technical skills through practical training. (6) In LMICs, surgical curricula often cover a broad spectrum of techniques to prepare trainees to operate in resource-constrained settings. (7-10)

Graduated supervision, which increases the level of autonomy in the operating theatre as trainees progress through their surgical training, is employed by most modern surgical training programmes, as a means to acquire technical skills. Autonomy provides opportunities for trainees to gain confidence, develop patient

management skills, improve problem-solving skills, encourage self-learning, and increase responsibility while reducing the workload of hospitals. (11-13) Achieving a balance between sufficient supervision, and operative autonomy can be challenging while still maintaining patient safety and quality of care. (8, 14-18) Ideally, specific milestones should be achieved in order to progress to the next level of autonomy. The use of the graduated supervision model is well-described in several North American training programmes (7, 8, 15) but less so in SSA countries. (10, 14) Often minimum volumes and breadth of operations performed as primary surgeon (the individual doing key portions of the operation) or as assistant surgeon are requirements for programme completion, but they alone do not measure for technical competency. (7, 8, 15)

The primary objective of this study was to describe the level of surgical trainee autonomy during non-trauma emergency laparotomy (NTEL) operations at teaching hospitals in Rwanda and South Africa. The secondary objective was to identify potential associations between trainee autonomy, and patient mortality and reoperation. This knowledge will contribute to a better understanding of the graduated supervision model in surgical education in these countries.

2.8. Materials and Methods

Study design and sites

This was a sub-study of a prospective, observational study of NTEL operations at three hospitals in South Africa and Rwanda over a one-year period from September 1, 2017 – August 31, 2018. (19)

Two academic teaching hospitals, Groote Schuur Hospital and New Somerset Hospital in Cape Town, South Africa were included. The third study site was The University Teaching Hospital of Kigali in Rwanda.

Data collection

Data were captured by doctors on the surgical team on a standardised data collection form that was used to capture data across all study sites was built using Research Electronic Data Capture software (REDCap).

Operations on adults over the age of 18 years who underwent NTEL performed by acute care and general surgery services at the study sites over the study period were included. NTEL was defined as a midline laparotomy with or without gastric, bowel, liver, spleen, pancreatic resection, or repair for non-trauma emergency conditions. Operations that started laparoscopically and converted to laparotomy were included. Traumatic indications for EL were excluded.

Trainee surgeons were defined as post-graduate surgical trainees (registrars) in an accredited university-affiliated general surgery programme, or medical officers (doctors with additional surgical training) working exclusively in the general surgery department. Consultant surgeons were defined as fully qualified surgeons licensed to practice autonomously.

The primary surgeon was defined as the operating surgeon who performed the key portions of the operation. The primary surgeon was either a consultant or trainee surgeon, and mutually agreed upon between the two cadres if both were scrubbed.

Operations where the trainee or consultant was the primary surgeon were considered “trainee-led” or “consultant-led”, respectively. Trainee-led operations could be performed under supervision or autonomously. Supervision for trainee surgeons was defined as the presence of a consultant, scrubbed or un-scrubbed, during an operation. Trainee autonomy is a subset of trainee-led operations where trainees perform operations as the primary surgeon without a consultant surgeon, either scrubbed or physically present for the operation. Consultants at all study sites were available for telephonic advice or to be physically present in the operating theatre if requested.

Data were prospectively captured and included patients’ age, gender, American Society of Anesthesiologists (ASA) score, operative indication, primary surgeon type, trainee autonomy, patient reoperation, and in-hospital mortality. NTEL indications included adhesive small bowel obstruction (ASBO), appendicitis, cancer, diverticulitis, hernia, inflammatory bowel disease, intussusception, mesenteric ischemia, pelvic inflammatory disease, peptic ulcer disease, peritonitis not otherwise specified, tuberculosis (TB), typhoid intestinal perforation, volvulus, and other. The category of “other” included uncommon indications such as colitis, intra-abdominal abscess, and ruptured ovarian cyst.

Statistical analysis

Descriptive statistics were used for demographic data.

Age was assessed for normality using a Shapiro Wilke test and the median and interquartile range (IQR) reported. For categorical data, counts and percentages were described. Logistic regression was used to model determinants of trainee

autonomy, mortality, and reoperation. For the outcomes of mortality and reoperation, variables considered in the univariate analysis *a priori* were age, gender, ASA score, and trainee autonomy. Forward selection was used using $p<0.10$ for inclusion in the multivariate model. All tests were considered to be statistically significant at $p<0.05$ except for disease indications where the Bonferroni correction was implemented to adjust for multiple comparisons. Univariate comparisons for disease indication were significant at $p\leq0.003$. All analyses were performed with Stata 13 statistical software (StataCorp LP, College Station, Texas).

Ethics

Ethical approval was given by the University of Cape Town Human Research Ethics Committee (319/2020), the University of Rwanda Review Board, and the University Teaching Hospital of Kigali Ethics Committee (456/CMHS IRB/2016). Pre-operative study consent was obtained from all participants at South African study sites. Participant consent was waived at the Rwandan site as de-identified data were collected.

2.9. Results

There were 543 NTEL operations included in this study: 219 from the Rwandan study hospital and 324 from South African study hospitals. The median age was 42 years old (IQR30-58 years old) and 221 patients (41%) were female. The five most common indications for NTEL were appendicitis (n=131, 24%), peptic ulcer disease (n=86, 16%), hernia (n=60, 11%), ASBO (n=54, 10%), and cancer (n=53, 10%). See table 1.

The majority of NTEL operations were trainee-led in both Rwanda (n=155, 71%) and South Africa (n=251, 78%). There was no significant difference in the likelihood of trainees leading operations in Rwanda compared with South Africa (p=0.078). Trainees were supervised in 28% of all trainee-led operations (n=112), with no significant difference between countries (Rwanda: n=40, 26%; South Africa: n=72, 29%; p=0.528). See table 2.

Operations by primary surgeon type

Trainee-led operations had a lower proportion of older and sicker patients compared with consultant-led operations (age ≥ 60 years: 19% vs. 35%, p<0.001; ASA ≥ III: 30% vs. 50%, p<0.001, respectively). NTEL for ASBO (91% vs. 9%, p=0.003), appendicitis (90% vs. 10%, p<0.001), hernia and cancer (57% vs 43%, p=0.001) were more likely to be trainee-led compared with consultant-led. However, indications categorised as “other” were predominantly consultant-led in comparison to trainee-led (55% vs. 45%, p<0.001). See table 3.

Associations with trainee autonomy

Of 406 trainee led operations, 294 (72%) were autonomous. Among trainee-led operations, trainees were less likely to perform the operations autonomously for patients who: age ≥ 60 years(odds ratio (OR)= 0.45, confidence interval (CI)= 0.27-0.76, p=0.003) or had ASA classification ≥ III (OR= 0.62, CI= 0.39-0.98, p=0.040) or had cancer (OR=0.30, CI = 0.14 – 0.64, p= 0.0.002) on univariate analysis.

On multivariate regression, trainees were less likely to operate autonomously for cancer (OR= 0.36, CI= 0.16-0.82, p=0.015) and TB indications (OR= 0.16, CI= 0.03-0.95, p=0.044). See table 4.

Associations with patient mortality among trainee-led operations.

Of the trainee led operations age ≥ 60 years, gender, ASA classification ≥ III and trainee autonomy were used to determine risk factors associated with mortality. On univariate regression analyses, age ≥ 60 years (OR= 2.78, CI= 1.27-6.08, p=0.010) and ASA classification ≥ III (OR= 15.35, CI= 5.92-39.83, p<0.001) were risk factors for mortality, but trainee autonomy was not (OR= 0.49, CI= 0.23-1.05, p=0.068). On multivariate regression, only ASA classification was a significant risk factor for mortality (OR= 13.32, CI= 5.05-35.14, p=<0.001),. See table 5.

Associations with re-operation among trainee-led operations.

Similarly of the trainee led operations age ≥ 60 years, gender, ASA classification ≥ III and trainee autonomy were used to determine risk factors associated with reoperation. ASA ≥ III was a significant predictor (OR= 2.08, CI= 1.09-3.98, p=0.027) for reoperation but age, gender, and trainee autonomy were not (p>0.10, and were therefore not included in a multivariate analysis). See table 6.

2.10. Discussion

In this study, surgical trainees led three quarters of NTEL operations, and of these, 72% were performed without supervision in Rwanda and South Africa. Notably, trainee autonomy was not significantly associated with reoperation or mortality.

The majority of NTEL, a common emergency general surgery operation, were trainee-led with a high degree of trainee autonomy in this study. There are several possible reasons for this. South Africa and Rwanda are two countries with high surgical disease burdens (1, 20) and surgeon shortages (21-23). A study from South Africa noted that the public health care system depends on surgical trainees to care for patients due to high service demands, (24) which in turn gives them to the opportunity to perform a large number of operations, mostly autonomously. (25) A study of trainees in seven SSA countries found that SSA trainees were exposed to higher surgical volumes and a broader range of operations than trainees in the United States (US). (26)

Secondly, after medical school in Rwanda and South Africa, doctors get operative experience prior to starting formalised post-graduate surgical training. After medical school, a two-year internship, and a year of mandatory community service, South African doctors commonly spend at least a year or more as surgical medical officers, where they gain experience in a wide range of surgical operations, before their surgical residency. (27) In Rwanda, all medical school graduates must complete a one-year internship followed by one to two years working at a district hospital prior to surgical training. Therefore, basic operative techniques may have been learned preceding entry into a formalised post-graduate training programme. (28) This may fast track South African and Rwandan surgical trainees to performing operations as the primary surgeon and operating autonomously, compared with training programmes in countries such as the US, where surgical trainees start surgical residency immediately upon graduating from medical school. (29)

While trainees led the majority of NTEL operations with a high degree of autonomy, consultants were always available to supervise if needed. A higher proportion of consultant-led operations involved older or sicker patients compared with trainee-led ones, given the high risk for intra- and post-operative complications among these cohorts. (30, 31) Furthermore, operations for indications less common in the study sites, such as colitis, and gastrointestinal bleeding, were more often led by consultants, possibly because of the trainees' lack of familiarity with these pathologies. Conversely, trainees more often led NTEL operations for three of the five most common indications at the study hospitals: ABSO, appendicitis and cancer.

Regarding trainee autonomy, consultants were more likely to supervise complex and operations for less common indications, such as abdominal cancer and TB. While abdominal cancers were more often trainee-led, operations that need EL are often advanced with obstruction or perforation, and carry a high risk of morality or complications (32, 33). Therefore often require senior supervision to ensure adequate tumour removal. Abdominal TB is usually treated non-operatively, and as such was an uncommon NTEL indication in our study. When abdominal TB leads to perforation or obstruction, this necessitates operative intervention but may require higher level decision making by a consultant. (34, 35).

The ideal surgical training programme balances trainee operative autonomy and supervision to acquire technical skills. Without formalised and standardised systems to assess technical skills during surgical training in Rwanda and South Africa, the effect of this high level of operative autonomy on surgical post-graduate education is

difficult to assess. This is of particular importance as operative autonomy could influence patient outcomes.

Given the shortage of fully qualified surgeons in Rwanda and South Africa, allowing a high level of operative autonomy during training is one type of task sharing, a strategy to expand surgical delivery by those with less training than completion of a surgical residency. Other countries have employed medical officers and mid-level providers, or non-physician clinicians, to perform various types of operations with positive patient health outcomes, (36-38) however, studies on NTEL outcomes have not specifically been reported. Further research to define the training, supervision, and level of operative autonomy of these other cadres is also needed in order to safely expand the surgical workforce.

Some studies reported adverse surgical outcomes associated with trainee autonomy and argued that the risk to patient safety was therefore too high to allow trainees to operate autonomously or even as supervised primary surgeons. (39, 40) Conversely, other studies showed trainee-led operations were safe with few adverse patient outcomes. (41-44). Notably, these studies were from HICs, with a paucity in the literature for SSA countries with few baseline studies reporting in mortality or reoperation. Our study demonstrated that ASA classification, but not the lack of supervision, was associated with patient mortality or reoperation in Rwanda and South Africa.

While this is encouraging, the surgical skills and prior experience or level of the trainees who operated autonomously was not known and not measured in this study.

Furthermore, this study did not capture the association of trainee autonomy with longer term patient outcomes, which may further indicate the quality and safety of having trainees operate autonomously.

An additional limitation was that individual reasons for supervision or autonomy were not measured nor was the time of the operation captured. At all study hospitals, supervision was available on demand, but consultants were not physically present at the hospital during the night. At times, a trainee would need to use personal judgment to decide when or if to call a consultant, based on their confidence, experience, and training programme culture. Consultants may have also decided to participate in the operation *a priori* based on indication, individual patient risk, or perceived trainee technical limitations.

Another limitation is that high trainee operative autonomy during NTEL is not representative of supervision during all surgical training and in all LMICs in SSA. This study focused on non-trauma, emergency operations and excluded emergency trauma and elective operations. In particular, elective operations, which are planned and usually performed during the day at the study sites, when consultants are physically present, would likely have had more consultant supervision. In addition, telephonic advice was not captured which can be considered a type of supervision, leading to an underestimation of trainee supervision.

2.11. Conclusions

This is first study to report high operative autonomy among surgical trainees in two SSA countries for an emergency general surgery operation. Our results indicate that

trainees were able to gain autonomous experience without impacting mortality or reoperation outcomes, while still providing surgical support in a high-demand setting. More in-depth studies to understand the association of high trainee autonomy with surgical competency and patient safety are needed. In addition, qualitative and quantitative studies exploring times of operation, confidence of the trainee and the real or perceived barriers to seeking consultant supervision may further provide insight into surgical training programmes in SSA.

2.12. Tables

Table 1: Patient demographics and indications for non-trauma emergency laparotomy by country

	Total	**Rwanda**	**South Africa**
Age, median (IQR)	42 (30 - 58)	37 (26 - 52)	46 (33 - 61)
Female gender, n (%)	221 (41)	71 (32)	150 (46)
ASA classification (≥ III), n (%)	191 (36)	74 (34)	117 (36)
Indications, n (%)			
Appendicitis	131 (24)	41 (19)	90 (28)
Peptic ulcer disease	86 (16)	25 (11)	61 (19)
Hernia	60 (11)	37 (17)	23 (7)
Adhesive small bowel obstruction	54 (10)	22 (10)	32 (10)
Cancer	53 (10)	9 (4)	44 (14)
Volvulus	41 (8)	35 (16)	6 (2)
Other	33 (6)	13 (6)	20 (6)
Peritonitis not otherwise specified	25 (5)	10 (5)	15 (5)
Typhoid intestinal perforation	16 (3)	16 (7)	0 (0)
Mesenteric ischemia	13 (2)	2 (1)	11 (3)
Diverticulitis	10 (2)	0 (0)	10 (3)
Intussusception	7 (1)	4 (2)	3 (1)
Pelvic inflammatory disease	7 (1)	5 (2)	2 (1)
Tuberculosis	6 (1)	0 (0)	6 (2)
Inflammatory bowel disease	1 (0)	0 (0)	1 (0)
Total	543 (100)	219 (100)	324 (100)

Note: ASA classification is the American Society of Anaesthesiologists physical status classification system. The indication category of “other” includes not categorised and uncommon indications for the study settings. Column percentages may not equal 100 due to rounding.

Table 2: Primary surgeon by country

Primary Surgeon	**Total** (n, %)	**Rwanda** (n, %)	**South Africa** (n, %)	**P value**
Consultant	137 (25)	64 (29)	73 (23)	0.078
Trainee	406 (75)	155 (71)	251 (78)	
Supervised	112 (28)	40 (26)	72 (29)	0.528
Autonomous	294 (72)	115 (74)	179 (71)	
Total	543 (100)	219 (100)	324 (100)	

Note: column percentages may not equal 100 due to rounding.

Table 3: Patient demographics and indications by primary surgeon type

	Consultant n= 137 (n, %)	**Trainee** n= 406 (n, %)	**P value**
Age (≥ 60)	48 (35)	77 (19)	**<0.001**
Female gender	66 (48)	155 (38)	**0.039**
ASA classification (≥ III)	69 (50)	122 (30)	**<0.001**
Indications			
Adhesive small bowel obstruction	5 (9)	49 (91)	**0.003**
Appendicitis	13 (10)	118 (90)	**<0.001**
Cancer	23 (43)	30 (57)	**0.001**
Diverticulitis	4 (40)	6 (60)	0.281
Hernia	23 (38)	37 (62)	0.013
Inflammatory bowel disease	0 (0)	1 (100)	1.000
Intussusception	2 (29)	5 (71)	1.000
Mesenteric ischemia	6 (46)	7 (54)	0.079
Peptic ulcer disease	17 (20)	69 (80)	0.204
Peritonitis not otherwise specified	8 (32)	17 (68)	0.425
Pelvic inflammatory disease	2 (29)	5 (71)	1.000
Tuberculosis	0 (0)	6 (100)	0.345
Typhoid intestinal perforation	6 (38)	10 (63)	0.251
Volvulus	10 (24)	31 (76)	0.898
Other	18 (55)	15 (46)	**<0.001**

Note: ASA classification is the American Society of Anaesthesiologists physical status classification system. The indication category of “other” includes not categorised and uncommon indications for the study settings. Comparisons were considered statistically significant at p≤0.05 for age, gender, and ASA classification, and p≤0.003 for indications. Row percentages may not equal 100 due to rounding.

Table 4: Factors associated with trainee autonomy among trainee-led operations

	Univariate			Multivariate		
	Odds ratio	**Confidence interval**	**P value**	**Odds ratio**	**Confidence interval**	**P value**
Age (≥ 60)	0.45	0.27 - 0.76	**0.003**	0.60	0.33 - 1.08	0.089
Female gender	0.85	0.54 - 1.32	0.459			
ASA classification (≥ III)	0.62	0.39 - 0.98	**0.040**	0.90	0.54 - 1.50	0.681
Indications						
Adhesive small bowel obstruction	1.20	0.60 - 2.39	0.605			
Appendicitis	1.98	1.17 - 3.36	0.011	1.40	0.77 - 2.56	0.274
Cancer	0.30	0.14 - 0.64	**0.002**	0.36	0.16 - 0.82	**0.015**
Diverticulitis	0.18	0.03 - 1.02	0.053	0.22	0.04- 1.31	0.097
Hernia	0.77	0.37 - 1.60	0.490			
Inflammatory bowel disease	1.00					
Intussusception	1.00					
Mesenteric ischemia	0.28	0.06 - 1.26	0.098	0.31	0.06 - 1.47	0.139
Peptic ulcer disease	1.79	0.94 - 3.42	0.077	1.54	0.76 - 3.13	0.229
Peritonitis not otherwise specified	0.41	0.15 - 1.09	0.075	0.37	0.13 - 1.03	0.058
Pelvic inflammatory disease	1.00					
Tuberculosis	0.18	0.03 - 1.02	0.053	0.16	0.03 - 0.95	**0.044**
Typhoid intestinal perforation	0.89	0.23 - 3.49	0.863			
Volvulus	1.33	0.56 - 3.19	0.518			
Other	0.56	0.19 - 1.61	0.279			

Note: ASA classification is the American Society of Anaesthesiologists physical status classification system. The indication category of "other" includes not categorised and uncommon indications for the study settings. Univariate test comparisons were considered statistically significant at p≤0.05 for age, gender, and ASA classification, and p≤0.003 for indications. Factors with p<0.10 on univariate analysis were included in the multivariate model, where p-values ≤0.05 were considered statistically significant.

Table 5: Factors associated with in-hospital mortality among trainee-led operations

	Univariate			Multivariate		
	Odds ratio	**Confidence interval**	**P Value**	**Odds ratio**	**Confidence interval**	**P Value**
Age (≥ 60)	2.78	1.27 - 6.08	**0.010**	1.66	0.68 - 4.06	0.266
Female gender	0.81	0.38 - 1.75	0.591			
ASA classification (≥ III)	15.35	5.92 - 39.83	**<0.001**	13.32	5.05 - 35.14	**<0.001**
Trainee autonomy	0.49	0.23 - 1.05	0.068	0.68	0.28 - 1.61	0.378

Note: ASA classification is the American Society of Anaesthesiologists physical status classification system. Factors with p<0.10 on univariate analysis were included in the multivariate model.

Table 6: Factors associated with patient reoperation among trainee-led operations

	Univariate			Multivariate		
	Odds ratio	**Confidence interval**	**P Value**	**Odds ratio**	**Confidence interval**	**P Value**
Age (≥ 60)	0.55	0.21 - 1.44	0.224			
Female gender	1.38	0.73 - 2.64	0.321			
ASA classification (≥ III)	2.08	1.09 - 3.98	**0.027**	2.08	1.09 - 3.98	**0.027**
Trainee autonomy	0.83	0.42 - 1.67	0.607			

Note: ASA classification is the American Society of Anaesthesiologists physical status classification system. Factors with $p<0.10$ on univariate analysis were included in the multivariate model.

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APPENDICES

Appendix A: Questionnaire

Record ID: **MRN**: **Hospital**: CHUK ACS_GSH New Somerset NMMC
Age: **Gender**: M F **Date of surgery**:
Referred from: Home Private/GP Health center
Other hospital (lower level/private hospital) Other: _____

Symptom duration (days):
Comorbidities (mark all that apply):

DM	Hypertension	HIV	Tuberculosis
Chronic pulmonary disease	Ischemic heart disease	Hepatic impairment	Renal impairment
Malignancy	None	Unknown/Not documented	Other:

Diagnosis:

Appendicitis	Peptic ulcer disease	Hernia - inguinal - ventral - diaphragmatic - incarcerated - strangulated - obstructed	Cancer - esophagus - stomach - liver - gallbladder - pancreas - small intestine - large intestine - rectum - anus - gynecologic - other: _____	Volvulus - sigmoid - cecum - small intestine - compound (ileosigmoid knot)
Diverticulitis	Adhesions/Bands			
Typhoid	Inflammatory bowel disease			
Tuberculosis	Mesenteric ischemia			
Pelvic inflammatory disease	Peritonitis not otherwise specified			
Other:				

Characteristics (mark all that apply): Gangrene/ischemia Perforation
Purulence/abscess Metastasis beyond nodes Other: _____

Operation (mark all that apply):

Converted laparoscopy	Bowel resection	Primary bowel repair	Primary bowel anastomosis	Stoma
Appendectomy	Cholecystectomy	Splenectomy	Omental patch	Biopsy
Hernia repair without mesh	Hernia repair with mesh	Exploration/Washout only	Adhesiolyisis	Fascia left open
Other:				

ASA: I II III IV E
Primary surgeon: Consultant/staff Resident/registrar Medical officer
Consultant surgeon involvement: not present present-not scrubbed scrubbed

ICU: Yes Unknown NO - not needed
NO - no beds (no resources)
NO - too sick, too many comorbidities to qualify for ICU
Surgical site infection: Yes No
Type: Superficial Deep (fascia involved) Organ space (intra-abdominal abscess) Unknown

Reoperation: 0 1 2 >2 **Interventional procedure**: Yes No Unknown
Mortality (in-hospital): Yes No Unknown **30 day mortality:** Yes No Unknown
Length of hospital stay (days): _____

Appendix B: Consent Form

UNIVERSITY OF CAPE TOWN

CONSENT FORM: USE OF CLINICAL INFORMATION

Dear Patient/Guardian/Family member

1. INTRODUCTION

You have undergone or will undergo an exploratory laparotomy (midline abdominal incision) for an emergency surgical condition. We would like your consent to use your routinely collected data (without your name or any identifiers) to help improve patient care regarding emergency surgical conditions. This form helps explain what the study involves and how it affects you.

2. THE NATURE AND PURPOSE OF THE STUDY

This study will examine causes and outcomes of emergency laparotomy and allow doctors to improve patient care.

3. HOW THE STUDY WILL BE CONDUCTED

We will collect data by examining the medical records related to your procedure. You will not undergo or participate in any extra or specific tests related to this study. This data will be compared to other data from other patients from this and other hospitals to establish best working practices for future patients and help doctors and hospitals understand and manage these procedures better.

4. COSTS OR BENEFITS TO YOU

This study is a data study and your participation is limited to allowing researchers access to your medical records. This study will not affect or influence the outcome of your treatment and care in any way. You will not be exposed to any additional risks. You will also still receive the same treatment or care regardless of whether you agree to participate in the study or not. There will be no monetary cost or benefit to you should agree for your records to be used in the study.

5. CONFIDENTIALITY

All records obtained in this study will be regarded as confidential. Your name and personal details will not be used in any part of the study. Results will be presented and published in such a way that you will not be able to be identified at any time.

6. WITHDRAWAL FROM THE STUDY

Participation is entirely voluntary. You may choose to withdraw consent for your data to be used in this study at any time. You will not be prejudiced in any way.

7. STUDY DURATION

The study will last 12 months and will gather information from patients from this and other hospitals. As the study involves examination of routine data collected you will not be needed to participate beyond allowing researchers access to your medical records.

8. NUMBER OF PARTICIPANTS

The total participants in the study is determined by the number of patients who undergo exploratory laparotomies during the study period, at this and other hospitals, who consent to have their data used in the study.

9. ETHICS APPROVAL

The University of Cape Town's Faculty of Health Sciences Human Research Ethics Committee has been granted approval for this study. They can be contacted on 021 406 6338 in case you have any ethical concerns or questions about your rights or welfare as a participant in this research study.

10. CONTACT DETAILS OF STUDY SUPERVISOR

"OUR MISSION is to be an outstanding teaching and research university,
educating for life and addressing the challenges facing our society."

If you have further questions, please contact Associate Professor Kathryn Chu 0798952489.

11. CONSENT TO PARTICIPATE IN THIS STUDY

I have read or had read to me in a language that I understand the above information before signing this consent form. The content and meaning of this information has been explained to me. I have been given the opportunity to ask questions and am satisfied that they have been answered satisfactorily. I understand that if I do not participate it will not alter my treatment or care in any way. I hereby volunteer to for my records to be used in this study.

I have received a signed copy of this information consent agreement.

PATIENT FULL NAME: ……

SIGNATURE: ……

DATE: ……

Witness (for verbal consent) ……

Proxy Consent

If patient is unable to give consent due to medical condition/ mortality and consent is obtained from next of kin

FULL NAME ……

RELATIONSHIP TO PATIENT ……

SIGNATURE ……

DATE ……

MEANS IN WHICH OBTAINED TELEPHONIC PERSONAL

Person Taking Consent

FULL NAME: ……

TITLE: ……

SIGNATURE: ……

DATE: ……

Appendix C: Human Research Ethics Committee Approval Letter

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room G50- Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-enquiries@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

02 July 2020

HREC REF:319/2020

Prof K Chu
Department of General Surgery
J-Floor, OMB
Email: Kathryn.chu@uct.ac.za
Student: londapohl@gmail.com

Dear Prof Chu

PROJECT TITLE: SURGICAL TRAINEE SUPERVISION DURING NON-TRAUMA EMERGENCY LAPAROTOMIES IN RWANDA AND SOUTH AFRICA-MMED CANDIDATE- DR LINDA POHL- sub-study linked to 450/2017

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

This approval is subject to strict adherence to the HREC recommendations regarding research involving human participants during COVID -19, dated 17 March 2020.

Approval is granted for one year until the 30 July 2021.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

We acknowledge that the student: Dr Linda Pohl will also be involved in this study.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator must obtain appropriate institutional approval, where necessary, before the research may occur.

Please quote the HREC reference number in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

HREC 319/2020sa

Appendix D: UCT Department of Surgery Approval Letter

UNIVERSITY OF CAPE TOWN

Department of Surgery
Departmental Research Committee
Dr Timothy Pennel
D24 Office, Groote Schuur Hospital
Observatory 7925
South Africa
Tel (021) 404 3430
Email: **tim.pennel@uct.ac.za**

2 Jun 2020

Dr L Pohl

Department of Surgery
University of Cape Town

Dear Dr Pohl

RE: Project 2020/078

PROJECT TITLE: Surgical Trainee Supervision During Non-Trauma Emergency Laparotomies In Rwanda And South Africa

The above protocol has been reviewed by the Department of Surgery Research Committee. I am pleased to inform you that the committee approved the scientific merit of the study, and endorse the protocol for submission to the relevant ethics committee.

Although this letter serves as confirmation that the above protocol has successfully passed through the surgical DRC, respective ethics committees still require DRC chair signature before submission.

Please use the above project number in all future correspondence,

Yours sincerely

DR TIMOTHY PENNEL
CHAIR: SURGICAL DRC

DR MARITZ LAUBSCHER
CHAIR: PROTOCOL REVIEW COMMITTEE

"OUR MISSION is to be an outstanding teaching and research university, educating for life and addressing the challenges facing our society."

Appendix E. University of Rwanda Institutional Review Board Approval Letter

UNIVERSITY OF RWANDA — COLLEGE OF MEDICINE AND HEALTH SCIENCES

CMHS INSTITUTIONAL REVIEW BOARD (IRB)

Kigali, 07/12/2016

Dr Isaie Sibomana,
School of Medicine and Pharmacy, CMHS, UR

Approval Notice: No 456 /CMHS IRB/2016

Your Project Title ***"Acute Care Surgery In Rwanda"*** has been evaluated by CMHS Institutional Review Board.

		Involved in the decision		
			No (Reason)	
Name of Members	**Institute**	Yes	**Absent**	**Withdrawn from the proceeding**
Prof Kato J. Njunwa	UR-CMHS		X	
Prof Jean Bosco Gahutu	UR-CMHS	X		
Dr Brenda Asiimwe-Kateera	UR-CMHS	X		
Prof Ntaganira Joseph	UR-CMHS		X	
Dr Tumusiime K. David	UR-CMHS		X	
Dr Kayonga N. Egide	UR-CMHS	X		
Mr Kanyoni Maurice	UR-CMHS	X		
Prof Munyanshongore Cyprien	UR-CMHS		X	
Mrs Ruzindana Landrine	Kicukiro district		X	
Dr Gishoma Darius	UR-CMHS	X		
Dr Donatilla Mukamana	UR-CMHS		X	
Prof Kyamanywa Patrick	UR-CMHS		X	
Prof Condo Umutesi Jeannine	UR-CMHS		X	
Dr Nyirazinyoye Laetitia	UR-CMHS	X		
Dr Nkeramihigo Emmanuel	UR-CMHS		X	
Sr Maliboli Marie Josee	CHUK	X		
Dr Mudenge Charles	Centre Psycho-Social	X		

After reviewing your protocol during the IRB meeting of where quorum was met and revisions made on the advice of the CMHS IRB submitted on 28th November 2016, **Approval letter has been granted to your study.**

Please note that approval of the protocol and consent form is valid for **12 months**.
You are responsible for fulfilling the following requirements:

1. Changes, amendments, and addenda to the protocol or consent form must be submitted to the committee for review and approval, prior to activation of the changes.

EMAIL: researchcenter@ur.ac.rw P.O. Box: 3286, Kigali, Rwanda WEBSITE. http://cmhs.ur.ac.rw/

2. Only approved consent forms are to be used in the enrolment of participants.

3. All consent forms signed by subjects should be retained on file. The IRB may conduct audits of all study records, and consent documentation may be part of such audits.
4. A continuing review application must be submitted to the IRB in a timely fashion and before expiry of this approval
5. Failure to submit a continuing review application will result in termination of the study
6. Notify the IRB committee once the study is finished

Sincerely,

Date of Approval: The 07th December 2016
Expiration date: The 07th December 2017

for Professor Kato J. NJUNWA
Chairperson Institutional Review Board,
College of Medicine and Health Sciences, UR

Ce:
- Principal College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate studies, UR

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Appendix F: Instructions to Authors for Journal of Surgical Education

The following is from: https://www.elsevier.com/journals/journal-of-surgical-education/1931-7204/guide-for-authors

The Journal of Surgical Education (JSE) is dedicated to advancing the field of surgical education through original research. The journal publishes research articles in all surgical disciplines on topics relative to the education of surgical students, residents, and fellows, as well as practicing surgeons. Our readers look to JSE for timely, innovative research findings from the international surgical education community. As the official journal of the Association of Program Directors in Surgery (APDS), JSE publishes the proceedings of the annual APDS meeting held during Surgery Education Week.

ORIGINAL MANUSCRIPTS

Manuscripts must meet the following criteria (taken from JAMA's Instructions for Authors5): the material is original; the writing is clear; the study methods are appropriate; the data are valid; the conclusions are reasonable and supported by the data; the information is important; and the topic is of interest to surgeons, educators, or trainees in any surgical disciplines. All original research papers are to follow the instructions for manuscript submission, with three additions. Each original manuscript should include four to six key words or phrases that describe the key concepts, content, or medical terminology discussed within the manuscript. These key words should appear on the title page. For help in finding key words or phrases look in the Medical Subject Headings from Index Medicus. The second page of all

original research manuscripts should contain a structured abstract of, at most, 300 words, summarizing the objectives, design, setting, participants, results, and conclusions of the study. The third requirement for an original manuscript is to select at least one of the six ACGME competencies that the manuscript addresses and list these at the end of the structured abstract.

Original manuscripts that are not "scientific" in nature, form, or scope, like reviews, historical articles, information articles, or other special section articles, are not required to have key words or abstracts.

All original manuscripts should be identified as dealing with one of the six ACGME competencies.

APDS PRESENTATIONS

A manuscript must be submitted for all plenary presentations at the annual APDS meeting. These are to be submitted according to the time lines established by the program committee and Editor-in-Chief of the journal.

LETTERS TO THE EDITOR

Letters to the editor are welcome. Letters referring to a recent journal article are best received as soon as possible after that article is published. If letters about an article continue to pour in long after an article's publication, these letters may be published, but they will not be as timely and substantial. Letters should be no more than three double-spaced, typed pages, including references. Receipt of letters will be acknowledged. Unpublished letters will be returned only by request. Often a reply

from the principal author of the article in question will be printed along with your letter. Letters not related to a JSE article will be reviewed by the editorial staff, but rarely are accepted.

PERSPECTIVES

Perspectives are brief (max 1500 words) pieces on a current topic in surgical education. These submissions should provide an opinion or perspective on the topic, but also be grounded in the current evidence and published literature. Submissions should be original work and not published previously, but they do not need to contain original data.

HOW I DO IT

How I Do It articles enable authors to describe novel educational techniques or programs without the requirement for rigorous data; data are welcomed but not required. These submissions should be brief (max 1200 words) explanations of innovative curricula, teaching techniques, or programmatic improvements that could be applied or modified by other programs or educators to benefit surgical trainees.

Contact details for submission

Sherry Campbell
Managing Editor
jsured@hotmail.com

Submission checklist

You can use this list to carry out a final check of your submission before you send it to the journal for review. Please check the relevant section in this Guide for Authors for more details.

Ensure that the following items are present:

One author has been designated as the corresponding author with contact details:

• E-mail address

• Full postal address

All necessary files have been uploaded:

Manuscript:

• Include keywords

• All figures (include relevant captions)

• All tables (including titles, description, footnotes)

• Ensure all figure and table citations in the text match the files provided

• Indicate clearly if color should be used for any figures in print

Graphical Abstracts / Highlights files (where applicable)

Supplemental files (where applicable)

Further considerations

• Manuscript has been 'spell checked' and 'grammar checked'

• All references mentioned in the Reference List are cited in the text, and vice versa

• Permission has been obtained for use of copyrighted material from other sources (including the Internet)

• A competing interests statement is provided, even if the authors have no competing interests to declare

• Journal policies detailed in this guide have been reviewed

• Referee suggestions and contact details provided, based on journal requirements

• Include abstract and title page within their manuscript file

For further information, visit our Support Center.

Ethics in publishing

Please see our information pages on Ethics in publishing and Ethical guidelines for journal publication.

Declaration of interest

All authors must disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work. Examples of potential competing interests include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding. Authors must disclose any interests in two places: 1. A summary declaration of interest statement in the title page file (if double-blind) or the manuscript file (if single-blind). If there are no interests to declare then please state this: 'Declarations of interest: none'. This summary statement will be ultimately

published if the article is accepted. 2. Detailed disclosures as part of a separate Declaration of Interest form, which forms part of the journal's official records. It is important for potential interests to be declared in both places and that the information matches. More information.

Submission declaration and verification

Submission of an article implies that the work described has not been published previously (except in the form of an abstract, a published lecture or academic thesis, see 'Multiple, redundant or concurrent publication' for more information), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. To verify originality, your article may be checked by the originality detection service Crossref Similarity Check.

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Inclusive language acknowledges diversity, conveys respect to all people, is sensitive to differences, and promotes equal opportunities. Content should make no assumptions about the beliefs or commitments of any reader; contain nothing which might imply that one individual is superior to another on the grounds of age, gender, race, ethnicity, culture, sexual orientation, disability or health condition; and use inclusive language throughout. Authors should ensure that writing is free from bias,

stereotypes, slang, reference to dominant culture and/or cultural assumptions. We advise to seek gender neutrality by using plural nouns ("clinicians, patients/clients") as default/wherever possible to avoid using "he, she," or "he/she." We recommend avoiding the use of descriptors that refer to personal attributes such as age, gender, race, ethnicity, culture, sexual orientation, disability or health condition unless they are relevant and valid. These guidelines are meant as a point of reference to help identify appropriate language but are by no means exhaustive or definitive.

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services in which the editor has an interest. Any such submission is subject to all of the journal's usual procedures, with peer review handled independently of the relevant editor and their research groups. More information on types of peer review.

Use of word processing software

It is important that the file be saved in the native format of the word processor used. The text should be in single-column format. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. In particular, do not use the word processor's options to justify text or to hyphenate words. However, do use bold face, italics, subscripts, superscripts etc. When preparing tables, if you are using a table grid, use only one grid for each individual table and not a grid for each row. If no grid is used, use tabs, not spaces, to align columns. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the Guide to Publishing with Elsevier). Note that source files of figures, tables and text graphics will be required whether or not you embed your figures in the text. See also the section on Electronic artwork.
To avoid unnecessary errors you are strongly advised to use the 'spell-check' and 'grammar-check' functions of your word processor.

Article structure

Subdivision - unnumbered sections

Divide your article into clearly defined sections. Each subsection is given a brief heading. Each heading should appear on its own separate line. Subsections should

be used as much as possible when cross-referencing text: refer to the subsection by heading as opposed to simply 'the text'.

Introduction

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods

Provide sufficient details to allow the work to be reproduced by an independent researcher. Methods that are already published should be summarized, and indicated by a reference. If quoting directly from a previously published method, use quotation marks and also cite the source. Any modifications to existing methods should also be described.

Results

Results should be clear and concise.

Conclusions

The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

Appendices

If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq.

(A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Essential title page information

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• Author names and affiliations. Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. You can add your name between parentheses in your own script behind the English transliteration. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.
• Corresponding author. Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. This responsibility includes answering any future queries about Methodology and Materials. Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.
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Highlights are mandatory for this journal as they help increase the discoverability of your article via search engines. They consist of a short collection of bullet points that capture the novel results of your research as well as new methods that were used during the study (if any). Please have a look at the examples here: example Highlights.

Highlights should be submitted in a separate editable file in the online submission system. Please use 'Highlights' in the file name and include 3 to 5 bullet points (maximum 85 characters, including spaces, per bullet point).

Structured abstract

A structured abstract, by means of appropriate headings, should provide the context or background for the research and should state its purpose, basic procedures (selection of study subjects or laboratory animals, observational and analytical methods), main findings (giving specific effect sizes and their statistical significance, if possible), and principal conclusions. It should emphasize new and important aspects of the study or observations.

Abstract

Objective: State the main question or objective of the study and major hypothesis tested, if any.

Design: Describe the design of the study indicating, as appropriate, use of randomization, blinding, criterion standards for diagnostic tests, temporal direction (retrospective or prospective), and so on.

Setting: Indicate the study setting (name of institution and location), including the level of clinical care (eg, primary or tertiary, private practice or institutional).

Participants: State selection procedures, entry criteria, and number of participants entering and finishing the study.

Results: The main results of the study should be given. Measurements that require explanation for the expected audience of the article should be defined.

Conclusions: Only those conclusions of the study that are directly supported by the evidence reported by the author should be given, along with their clinical application.

Keywords

Immediately after the abstract, provide a maximum of 6 keywords, using American spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

Abbreviations

Define abbreviations that are not standard in this field in a footnote to be placed on the first page of the article. Such abbreviations that are unavoidable in the abstract

must be defined at their first mention there, as well as in the footnote. Ensure consistency of abbreviations throughout the article.

Acknowledgements

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

Formatting of funding sources

List funding sources in this standard way to facilitate compliance to funder's requirements:

Funding: This work was supported by the National Institutes of Health [grant numbers xxxx, yyyy]; the Bill & Melinda Gates Foundation, Seattle, WA [grant number zzzz]; and the United States Institutes of Peace [grant number aaaa].

It is not necessary to include detailed descriptions on the program or type of grants and awards. When funding is from a block grant or other resources available to a university, college, or other research institution, submit the name of the institute or organization that provided the funding.

If no funding has been provided for the research, please include the following sentence:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Units

Follow internationally accepted rules and conventions: use the international system of units (SI). If other units are mentioned, please give their equivalent in SI.

Math formulae

Please submit math equations as editable text and not as images. Present simple formulae in line with normal text where possible and use the solidus (/) instead of a horizontal line for small fractional terms, e.g., X/Y. In principle, variables are to be presented in italics. Powers of e are often more conveniently denoted by exp. Number consecutively any equations that have to be displayed separately from the text (if referred to explicitly in the text).

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Footnotes should be used sparingly. Number them consecutively throughout the article. Many word processors can build footnotes into the text, and this feature may be used. Otherwise, please indicate the position of footnotes in the text and list the footnotes themselves separately at the end of the article. Do not include footnotes in the Reference list.

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• Aim to use the following fonts in your illustrations: Arial, Courier, Times New Roman, Symbol, or use fonts that look similar.

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• Use a logical naming convention for your artwork files.

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• Submit each illustration as a separate file.

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Ensure that each illustration has a caption. Supply captions separately, not attached to the figure. A caption should comprise a brief title (not on the figure itself) and a description of the illustration. Keep text in the illustrations themselves to a minimum but explain all symbols and abbreviations used.

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Please submit tables as editable text and not as images. Tables can be placed either next to the relevant text in the article, or on separate page(s) at the end. Number tables consecutively in accordance with their appearance in the text and place any table notes below the table body. Be sparing in the use of tables and ensure that the data presented in them do not duplicate results described elsewhere in the article. Please avoid using vertical rules and shading in table cells.

References

Citation in text

Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in

the reference list they should follow the standard reference style of the journal and should include a substitution of the publication date with either 'Unpublished results' or 'Personal communication'. Citation of a reference as 'in press' implies that the item has been accepted for publication.

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A DOI is guaranteed never to change, so you can use it as a permanent link to any electronic article. An example of a citation using DOI for an article not yet in an issue is: VanDecar J.C., Russo R.M., James D.E., Ambeh W.B., Franke M. (2003). Aseismic continuation of the Lesser Antilles slab beneath northeastern Venezuela. Journal of Geophysical Research, https://doi.org/10.1029/2001JB000884. Please note the format of such citations should be in the same style as all other references in the paper.

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As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates,

reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list.

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Text: Indicate references by (consecutive) superscript arabic numerals in the order in which they appear in the text. The numerals are to be used outside periods and commas, inside colons and semicolons. For further detail and examples you are referred to the AMA Manual of Style, A Guide for Authors and Editors, Tenth Edition, ISBN 0-978-0-19-517633-9.

List: Number the references in the list in the order in which they appear in the text.

Examples:

Reference to a journal publication:

1. Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. J Sci Commun. 2010;163:51–59. https://doi.org/10.1016/j.Sc.2010.00372.

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2. Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. Heliyon. 2018;19:e00205. https://doi.org/10.1016/j.heliyon.2018.e00205.

Reference to a book:

3. Strunk W Jr, White EB. The Elements of Style. 4th ed. New York, NY: Longman; 2000.

Reference to a chapter in an edited book:

4. Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith RZ, eds. Introduction to the Electronic Age. New York, NY: E-Publishing Inc; 2009:281–304.

Reference to a website:

5. Cancer Research UK. Cancer statistics reports for the UK. http://www.cancerresearchuk.org/aboutcancer/statistics/cancerstatsreport/; 2003 Accessed 13 March 2003.

Reference to a dataset:

[dataset] 6. Oguro, M, Imahiro, S, Saito, S, Nakashizuka, T. Mortality data for Japanese oak wilt disease and surrounding forest compositions, Mendeley Data, v1; 2015. https://doi.org/10.17632/xwj98nb39r.1.

Journal abbreviations source

Journal names should be abbreviated according to the List of Title Word Abbreviations.

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