What resources are used in emergency departments in rural sub-Saharan Africa? A retrospective analysis of patient care in a district-level hospital in Uganda

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ABSTRACT
Objectives To determine the most commonly used resources (provider procedural skills, medications, laboratory studies and imaging) needed to care for patients.
Setting A single emergency department (ED) of a district-level hospital in rural Uganda.
Participants 26710 patient visits.
Results Procedures were performed for 65.6% of patients, predominantly intravenous cannulation, wound care, bladder catheterisation and orthopaedic procedures. Medications were administered to 87.6% of patients, mostly often pain medications, antibiotics, intravenous fluids, antimalarials, nutritional supplements and vaccinations. Laboratory testing was used for 85% of patients, predominantly malaria smears, rapid glucose testing, wound care, blood counts, urinalyses and blood type. Radiology testing was performed for 17.3% of patients, including X-rays, point-of-care ultrasound and formal ultrasound.
Conclusion This study describes the skills and resources needed to care for a large prospective cohort of patients seen in a district hospital ED in rural sub-Saharan Africa. It demonstrates that the vast majority of patients were treated with a small formulary of critical medications and limited access to laboratories and imaging, but providers require a broad set of decision-making and procedural skills.

INTRODUCTION
Improving the delivery of acute care services has been proposed as a means to strengthen overall health infrastructure by supplementing primary care and reducing fragmentation caused by targeting markers of specific disease processes for improvement.1 Global research in the development of systems for acute and emergency care is hampered by the variety of settings in which emergency care takes place in different parts of the world, poor understanding of the reasons patients seek emergency care, poor standardisation of reporting measures and lack of consensus on the essential services that should be provided.2 The African Federation for Emergency Medicine (AFEM) has proposed a framework for emergency care development in the region.3 However, there are few longitudinal evaluations of facility-level data that assess the epidemiology of patient presentations, the consumable and non-consumable resources used for care and the clinical and procedural skills required to deliver emergency care in sub-Saharan Africa (SSA) on which to base these efforts.4–7 The limited data that exist are largely from urban areas or describe presentations over a short time frame, introducing possibility of bias, given the seasonal nature of some diseases thought to be prevalent in this area. It is estimated that 62% of the population of SSA lives in rural areas,8 indicating that data from rural areas are essential to guide emergency care development.

The uncategorised burden of disease likely contributes to the lack of funding and slow progress of development of emergency care in these countries.9 While several emergency medicine training programmes have been...
developed over the past decade and the AFEM has developed a curriculum for emergency care training, the educational content of these efforts has largely been drawn from international guidelines and expert consensus of foreign emergency physicians and local physicians providing emergency care in these settings.

Lack of information regarding the most frequently used procedural skills and the resources required to care for acutely ill and injured patients hinders the development of emergency care delivery and training in low-resource settings. This study describes the resources and clinical skills used to care for a large, longitudinal cohort of patients presenting to a not-for-profit district hospital in rural Uganda. It addresses some of the research gaps in service delivery, resource utilisation and training needs necessary to ensure effective emergency care as identified in a recent consensus statement. This knowledge could inform required training and protocols, emergency care formulary development and checklists of useful laboratory resources and diagnostic imaging modalities to refine the proposed framework for emergency care development in SSA.

**METHODS**

**Study design**

This is a retrospective analysis of prospectively collected data from a quality assurance (QA) database of patients seen at the Karoli Lwanga Hospital Emergency Department (ED) from November 2009 through February 2015. The database includes demographic information obtained on arrival in the ED, as well as diagnostic studies, medications administered and procedures performed during ED care. Laboratories, imaging and procedures ordered in the ED but delayed until the patient was admitted to the ward were included, so the numbers reflect the resources that providers felt were needed to care for the patients, regardless of whether the resources were immediately available in the ED.

**Background and study setting**

Karoli Lwanga Hospital is a private, not-for-profit district hospital located in the town of Nyakibale, in the Rukungiri district of rural Southwest Uganda. The district covers 1445 km², and the 2012 census listed 321,300 persons. Life expectancy is 50 years, compared with a national figure of 58.7 years. The HIV prevalence rate is 8.7% compared with a national rate of 7.2%. The maternal mortality rate is 50 years, compared with a national figure of 58.7 years. The HIV prevalence rate is 8.7% compared with a national rate of 7.2%.

The outpatient department (OPD) operates from 09:00 to 17:00 Monday through Friday and from 08:00 to 12:00 on Saturday. Ambulatory patients are informally triaged, usually by a nurse or clinical officer, and may be referred to the ED based on chief complaint or concerning signs or symptoms noted on patient evaluation. All patients thought to require hospital admission are sent from the OPD to the ED. In addition, patients who are non-ambulatory, severely ill or acutely injured are seen in the ED directly, as are those arriving during hours when OPD is closed. The ED hours varied during the time of the study, but always began at 08:00 and extended until at least 22:00. For the past several years, the ED sees patients between 08:00 and 02:00. For emergency patients arriving during overnight hours when the ED is closed, hospital security would phone the on-call physician or clinical officer. These patients are not included in this study; however, during a 6-month period when the ED was open 24 hours a day, only two patients on average arrived between 02:00 and 08:00 per day.

The ED is staffed by non-physician clinicians locally known as emergency care practitioners (ECPs); these are nurses who are enrolled in or have completed a 2-year training programme in emergency care. The training programme was developed by a US-based non-profit organisation, Global Emergency Care, that has been working to expand emergency care services in Uganda since 2008, in collaboration with Karoli Lwanga Hospital, Mbarara University of Science and Technology and the Ugandan Ministry of Health. During the period of the study, ECPs transitioned from full-time supervision by Emergency Medicine board-certified/board eligible physicians to more independent patient care with supervision by senior-level ECPs and intermittent supervision by EM physicians. This training programme and care delivery model have been described in more depth elsewhere.

Hospital-based Ugandan physicians were on-call for consultation for acute surgical emergencies and severely ill patients requiring admission.

**Data collection and analysis**

The study population includes all ED patient visits from 14 November 2009 to 28 February 2015. The start date reflects the initial day that data were collected on ED patients, which was approximately 4 months after the initial training of the ECPs began. Orders were placed by ECPs on a structured handwritten chart; this information was prospectively entered into the QA database by a trained research assistant at the time of ED disposition. Additionally, during most of the time period, the paper charts were scanned and securely saved as part of the QA processes. The QA database tracked 31 fields including demographics, vital signs, chief complaint, laboratory studies, imaging, medications administered, procedures performed, final diagnosis, disposition and condition on discharge. As this is the first programme to use task shifting for provision of emergency care in SSA, the QA database was created to monitor patient
presentations and outcomes, to better characterise acute care needs and to improve programme operations and educational content.

Data collection initially used Microsoft Excel (Microsoft, Redmond, Washington, USA) and was transitioned to Microsoft Access in March 2012. The database was deidentified prior to analysis. Data were merged and analysed in Stata Statistical Software V.13 (Stata Statistical Software: Release 13). The data were formatted and cleaned, and the variables of interest were abstracted from the general database prior to analysis by a single researcher. Descriptive tables of the most common skills and resources were created.

**RESULTS**

The cohort includes a total of 26,710 patient visits. Males accounted for 14,720 (55.1%) visits. Paediatric patients under 5 years of age were 20.5% of total visits, and patients aged 5–17 were 16.2% of visits. Adults 18–65 years accounted for 50.6% of visits, and elders over 65 accounted for 12.4% of visits (table 1).

One or more procedures were performed during 17,509 (65.6%) patient visits, with a total of 22,729 procedures performed. Multiple procedures were required for 3601 (14.8%) patient visits with a mean of 1.3 and a maximum of seven procedures among those who required a procedure. The most common procedure performed was intravenous cannulation. Wound care procedures were next, followed by bladder catheterisation, splinting and immobilisation, procedural sedation, lumbar punctures and incision and drainage of abscesses (I&D) (table 2).

A total of 73,317 doses of medications were administered. Medications were used for 23,401 (87.6%) patient visits, with 20,705 (77.5%) receiving more than one medication. The most common class of medications used was analgesics, including acetaminophen, non-steroidal anti-inflammatories and opioid analgesics. The next most common class prescribed was antibiotics, followed by antimalarials, intravenous fluids and nutritional supplements. Approximately 1800 medications could not be classified due to misspellings or non-standard abbreviations. Medication categories are listed in table 3, and the most commonly used medications from each category are listed in table 4. Specific medications given to more than 0.5% of the patient cohort are listed in table 5.

Laboratory tests were ordered for 22,708 (85.0%) patient visits, with a total of 38,378 studies being performed. The most common study was malaria testing, done in 14,440 (54.0%) patient visits. Bedside glucose was checked in 5,666 (21.2%) patient visits. HIV testing was done in 5195 (19.4%) patient visits with CD4 testing for 465 (1.7%). Haemoglobin was run for 4108 (15.4%) patient visits. Urinalysis was performed for 3062 (11.5%) patient visits. Blood type was checked for 1366 (5.1%) patient visits (table 6).

Radiology studies were performed for 4630 (17.3%) patient visits. X-rays were performed or ordered on 1864 (7.0%) patient visits. The most common X-ray was a chest X-ray, done for 1071 patient visits (4.0% of the cohort, 45.6% of all X-rays requested.) Other X-rays included 477 lower and 275 upper extremity films, 89 pelvis films, 88 skull films and 73 abdominal films. X-rays were available only when a radiology technician was present, mostly weekday business hours, but with some call-in capacity on evenings and weekends. Point-of-care ultrasound (POCUS) was performed on 2194 (8.2%) patient visits.

| Table 1 Demographics | Number | Per cent |
|----------------------|--------|----------|
| **Sex**              |        |          |
| Male                 | 14,720 | 55.1     |
| Female               | 11,934 | 44.7     |
| Unspecified          | 56     | 0.2      |
| **Age**              |        |          |
| Children under 5 years | 5478 | 20.5     |
| Paediatric 5–17 years | 4337 | 16.2     |
| Adult 18–65 years    | 13,510 | 50.6     |
| Elderly >65 years    | 3,305  | 12.4     |

| Table 2 Procedures | Number | Per cent of procedures | Per cent of cohort |
|--------------------|--------|------------------------|--------------------|
| Intravenous        | 9,161  | 40.3                   | 34.2               |
| Wound care         | 7,246  | 31.9                   | 27.1               |
| Catheter           | 1,523  | 6.7                    | 5.7                |
| Splint and immobilisation | 743 | 3.3                   | 2.8                |
| Procedural sedation| 663    | 2.9                    | 2.5                |
| Lumbar puncture    | 511    | 2.3                    | 2.0                |
| Incision and Drainage | 511 | 2.2                   | 1.9                |

| Table 3 Medications by category | Doses | Per cent of medications given |
|---------------------------------|-------|-------------------------------|
| Analgesics                      | 22,981| 31.4                          |
| Antibiotics                     | 14,486| 19.8                          |
| Antimalarials                   | 5,495 | 7.5                           |
| Intravenous fluids              | 5,445 | 7.4                           |
| Nutritional                     | 4,785 | 6.5                           |
| Respiratory                     | 3,934 | 4.6                           |
| Gastrointestinal                | 2,584 | 3.5                           |
| Neurologic                      | 2,495 | 3.4                           |
| Cardiac                         | 2,489 | 3.4                           |
| Vaccines                        | 1,984 | 2.7                           |

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including 417 focused assessment with sonography in trauma (FAST) examinations, 139 abdominal studies, 107 echocardiograms and 73 transabdominal examinations for obstetrical or gynaecological indications. Formal ultrasound imaging by the hospital radiology technician was requested for 998 (3.7%) patient visits (table 7).

**DISCUSSION**

This is a longitudinal cohort of 26710 acutely ill patient visits cared for in a rural emergency department in SSA. The study builds on the work of previous authors in several important ways. First, to our knowledge, this is the largest data set of emergencies presenting to a rural district hospital in a low-resource country. Additionally, we report detailed information on procedures performed and resources used for care in this large cohort over a 5-year period. To deliver effective emergency care, ongoing research is required to further elucidate both training and resource needs in resource-limited settings. By documenting current practice patterns of emergency care in a functional ED in rural Uganda, the data could inform training and resource allocation for providers in similar settings.

In considering medical knowledge that should be included in emergency care training, the spectrum of diseases presenting acutely must be understood. Data from the Global Burden of Disease Study indicate an increasing contribution of non-communicable disease towards worldwide mortality, but it is unknown how much these diseases contribute to the burden of emergencies in SSA. The data show that ECPs cared for patients across all age ranges who presented with diverse complaints. Commonly used medications and diagnostic tests indicate that patients presented for emergency care with a broad array of communicable and non-communicable diseases. Our data suggest that even in rural areas with high rates of communicable diseases, non-communicable diseases contribute significantly to the need for acute care. Additionally, given the fact that analgesics were given to 31.4% of patients and approximately 2.5% of patients underwent procedural sedation, it can be inferred that the ECPs managed a large burden of acutely painful conditions. High rates of splinting and immobilisation, as well as the number of FAST examinations performed, indicate that trauma care is a prominent component of emergency care in this setting. This is

| Class                  | Examples                              |
|------------------------|---------------------------------------|
| Analgesics             | Paracetamol/acetaminophen             |
|                        | Diclofenac                            |
|                        | Tramadol                              |
|                        | Pethidine/meperidine                   |
| Antibiotics            | Ceftriaxone                           |
|                        | Cloxacillin                           |
|                        | Gentamicin                            |
|                        | Metronidazole                         |
| Antimalarials          | Artemether/lumefantrine               |
|                        | Quinine                               |
|                        | Artesunate                            |
|                        | Sulfadoxine/pyrimethamine             |
| Nutritional supplements | Dextrose                              |
|                        | oral rehydration therapy              |
|                        | Multivitamin                          |
|                        | Ready-to-use therapeutic food         |
| Respiratory            | Oxygen                                |
|                        | Salbutamol                            |
|                        | Cough suppressant                     |
|                        | Nebulised magnesium                   |
| Gastrointestinal       | Omeprazole                            |
|                        | Metoclopramide                        |
|                        | Ranitidine                            |
|                        | Bisacodyl                             |
| Neurologic             | Diazepam                              |
|                        | Haloperidol                           |
|                        | Mannitol                              |
|                        | Amitriptyline                         |
| Cardiac                | Furosemide                            |
|                        | Nifedipine                            |
|                        | Aspirin                               |
|                        | Digoxin                               |

**Table 4** Most common medications by category

| Medication          | Doses   | Per cent of medications |
|---------------------|---------|-------------------------|
| Paracetamol         | 14697   | 20.0                    |
| Ceftriaxone         | 4697    | 6.41                    |
| Diclofenac          | 4508    | 6.2                     |
| Normal saline       | 3672    | 5.0                     |
| Coartem             | 3542    | 4.8                     |
| Tetanus vaccine     | 1862    | 2.5                     |
| Tramadol            | 1842    | 2.5                     |
| Quinine             | 1775    | 2.4                     |
| Cloxacillin         | 1686    | 2.3                     |
| Gentamicin          | 1602    | 2.2                     |
| Ringer’s lactate    | 1446    | 2.0                     |

**Table 5** Most common medications by number of doses

| Medication          | Doses   | Per cent of medications |
|---------------------|---------|-------------------------|
| Paracetamol         | 14697   | 20.0                    |
| Ceftriaxone         | 4697    | 6.41                    |
| Diclofenac          | 4508    | 6.2                     |
| Normal saline       | 3672    | 5.0                     |
| Coartem             | 3542    | 4.8                     |
| Tetanus vaccine     | 1862    | 2.5                     |
| Tramadol            | 1842    | 2.5                     |
| Quinine             | 1775    | 2.4                     |
| Cloxacillin         | 1686    | 2.3                     |
| Gentamicin          | 1602    | 2.2                     |
| Ringer’s lactate    | 1446    | 2.0                     |

**Table 6** Laboratory testing

| Medication          | Doses   | Per cent of medications |
|---------------------|---------|-------------------------|
| Paracetamol         | 14697   | 20.0                    |
| Ceftriaxone         | 4697    | 6.41                    |
| Diclofenac          | 4508    | 6.2                     |
| Normal saline       | 3672    | 5.0                     |
| Coartem             | 3542    | 4.8                     |
| Tetanus vaccine     | 1862    | 2.5                     |
| Tramadol            | 1842    | 2.5                     |
| Quinine             | 1775    | 2.4                     |
| Cloxacillin         | 1686    | 2.3                     |
| Gentamicin          | 1602    | 2.2                     |
| Ringer’s lactate    | 1446    | 2.0                     |
functions was generated. While our study did not seek to specifically map which signal functions the ECPs carried out, comparing the list of signal functions with medications administered, procedures performed and laboratory and diagnostic imaging testing used in our cohort, it is clear that there is significant overlap between the framework and the real-world practice of emergency care in this setting.

The medications most frequently used were pain medications, antibiotics, antimalarials, intravenous fluids, nutritional supplements, respiratory medications and cardiac medications. These medications are on the WHO Model List of Essential Medications and are expected to be widely available. Approximately 13% of patients received vaccinations as part of their emergency care, highlighting another health systems strengthening role of emergency care, in providing an additional venue for primary prevention. It is also encouraging to see some evidence that patients’ pain was addressed, as pain assessment and management has been identified as a deficit in prior studies.

There currently is no widely recognised list of essential emergency laboratory tests in low-resource settings, although the WHO is currently in the process of developing a consensus-based minimum package for this. From our data, it appears that point-of-care blood glucose testing, malaria smears (or rapid diagnostic malaria tests), assessment of haemoglobin, blood typing, HIV testing and fluid analysis (cerebrospinal fluid, urine, pleural fluid, ascites and joint aspirates) are all commonly used. While used to a lesser extent, our database and clinical experience indicated that pregnancy testing is important in this setting as well. The ability to perform HIV screening is critical. Uganda adopted a national guideline recommending opt-out testing in 2005, but missed opportunities for early diagnosis and initiation of antiretroviral treatment in difficult-to-reach populations persist. Due to stock-outs and lack of point-of-care testing performed by ECPs, this cohort of patients had a much lower rate of HIV testing than guidelines recommend. Testing for HIV in the acute care setting offers a much lower rate of HIV testing than guidelines recommend. Testing for HIV in the acute care setting offers patients a pathway to access the HIV continuum of care and begin treatment at an earlier stage in the diagnosis, which in turn has been shown to make management more effective and to reduce HIV transmission and the future burden of disease.

Future directions for research include comparing data from this facility with training needs and resource allocation at other facilities in SSA. Additionally, formally assessing the use of signal functions in this cohort could help refine the framework proposed to guide emergency care implementation in SSA.

There are several important limitations to this study. It is a single-centre study in rural Uganda with a unique training programme that was developed after a needs assessment of the burden of disease, but which took into account resource limitations at Karoli Lwanga Hospital. Thus, it is possible that our analysis failed to document

| Table 7 Imaging | Number of studies | Per cent of Imaging |
|-----------------|------------------|-------------------|
| X-ray           | 2441             |                   |
| Chest           | 1071             | 43.9              |
| Arm             | 477              | 19.5              |
| Leg             | 275              | 11.3              |
| Unspecified     | 150              | 6.1               |
| Pelvis          | 89               | 3.6               |
| Skull           | 88               | 3.6               |
| Abdomen         | 73               | 3.0               |
| POCUS           | 2289             |                   |
| Unspecified     | 1465             | 64.0              |
| FAST            | 417              | 18.2              |
| Abdominal       | 139              | 6.1               |
| Cardiac echo    | 107              | 4.7               |
| Formal US       | 1006             |                   |
| Unspecified     | 695              | 69.1              |
| Abdominal       | 146              | 14.5              |
| Pelvic/obstetric| 130              | 12.9              |

FAST, focused assessment with sonography in trauma; POCUS, point-of-care ultrasound; US, ultrasound.
potentially useful resources that were not available, thus were not part of the ECPs training. Other analyses of smaller portions of this data set looking at common diagnoses can help temper this limitation to some degree.34 Practice patterns and proficiencies of the ECPs may not be representative of other clinicians. Increased availability of the X-ray technician would likely have increased the number of patients undergoing imaging in the ED. CT imaging could aid in managing head trauma and some abdominal injuries but is not available at the site; however, this is true in most district hospitals in SSA. Likewise, there may be additional laboratory tests that would be useful but were not available routinely during the study period or were subject to ‘stock-outs’ of necessary reagents. While we did record tests ordered but not completed, if ECPs were aware of the stock-out, they may not have ordered a test even if they felt it was indicated. Given the retrospective nature of this review, we do not have a way of controlling for this lack of ordering due to knowledge of stock-outs.

Free text entry of data by non-medically trained research assistants resulted in a small amount of data being lost due to misspelling or incorrect transcription. Modifications to the data entry process have since reduced such errors. Additionally, patients arriving in the overnight hours when the ED was closed were not included in this analysis. Finally, there was no gold standard arbitration done to assess the true ‘need’ for the interventions performed or to critique other interventions that might have been indicated. Nonetheless, this provides a pragmatic assessment of the real-world practice of emergency care at a district hospital in a rural area of SSA.

CONCLUSIONS

This study tracks the resources used to diagnose, stabilise and treat a large cohort of consecutive patients seen in a not-for-profit, rural district ED in SSA. Analysis of the resources used and knowledge and skills applied for care for this patient cohort provides a rare glimpse of what emergency care delivery entails in rural SSA. The results of this study coupled with the previously developed framework to guide emergency care implementation will enable benchmarking and data-driven policy-making for improvement of facility-based emergency care delivery in low-resource settings within SSA.

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