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Decreased Pediatric Hospital Mortality After an Intervention to Improve Emergency Care in Lilongwe, Malawi

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abstract

BACKGROUND AND OBJECTIVE: Emergently ill infants and children are often inadequately recognized and stabilized by health care facilities in the developing world. This deficiency contributes to high inpatient mortality rates, particularly early during hospitalization. Our referral hospital in Lilongwe, Malawi, experiences high volume, acuity, and mortality rates. The entry point to our hospital for most children presenting with acute illness is the Under-5 Clinic. We hypothesized that early inpatient mortality and total inpatient mortality rates would decrease with an intervention to prioritize and improve pediatric emergency care at our hospital.

METHODS: We implemented the following changes as part of our intervention: (1) reallocation of senior-level clinical support from other areas of the hospital to the Under-5 Clinic for supervision of emergency care, (2) institution of a formal triage process that improved patient flow, and (3) treatment and stabilization of patients before transfer to the inpatient ward. We compared early inpatient and total inpatient mortality rates before and after the intervention.

RESULTS: After the intervention, early mortality decreased from 47.6 to 37.9 deaths per 1000 admissions (relative risk 0.80, 95% confidence interval 0.67–0.93). Total mortality also decreased from 80.5 to 70.5 deaths per 1000 admissions after the intervention (relative risk 0.88, 95% confidence interval 0.78–0.98).

CONCLUSIONS: Simple, inexpensive interventions to improve pediatric emergency care at this underresourced hospital in sub-Saharan Africa were associated with decreased hospital mortality rates. The description of this process and the associated results may influence practice and resource allocation strategies in similar clinical environments. *Pediatrics* 2012;130:e676–e682

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KEY WORDS

triage, pediatric emergency medicine, emergency medicine, international, hospital mortality, child health, ETAT, global health

ABBREVIATIONS

CI—confidence interval
CO—clinical officer
ETAT—Emergency Triage Assessment and Treatment
KCH—Kamuzu Central Hospital
U5—Under-5 Clinic
RR—relative risk

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Early recognition and stabilization of acutely ill infants and children improves outcomes. However, deficiencies in pediatric triage, assessment, and emergency treatment have been described in hospitals throughout the developing world.[1–4] These deficiencies contribute to high hospital mortality rates, particularly early during hospitalization.[4–7] The reasons for high rates of early mortality among hospitalized children in the developing world include delay in presentation to the hospital, inadequate provision of prehospital care services, and high prevalence of severe diseases. However, inadequate emergency services upon patients' arrival to health care facilities are also likely contributors.[7] Improving pediatric emergency care has been specifically identified as an underrecognized and important priority for improving the hospital care of children in the developing world.[1–4,6–9]

A process improvement initiative to improve pediatric emergency care at a referral hospital in Blantyre, Malawi, has been described in which caregivers trained staff in emergency care and triage, changed patient flow, and improved cooperation between inpatient and outpatient services. In addition, major investments to the physical facilities were made, including the construction of a dedicated pediatric emergency department. The result was a significant decrease in pediatric hospital mortality.[6]

Kamuzu Central Hospital (KCH) is located in the capital city of Lilongwe, Malawi, within a malaria-endemic region of southeastern Africa that also bears the health burdens associated with tropical diseases, high levels of malnutrition, and HIV/AIDS.[10] KCH serves as the referral hospital for the country's central region, as well as the community hospital for Lilongwe and surrounding areas. The pediatric ward at KCH has approximately 14 000 admissions per year.

The Under-5 Clinic (U5) at KCH is the first point of contact for children presenting to the hospital with acute medical conditions during the day, as well as the primary source of admissions to the inpatient unit. U5 also serves as a general pediatric outpatient clinic with approximately 200 to 400 visits per day. Variation in patient volume is related to surges in malaria-related cases during the rainy season. Approximately 10% to 15% of the patients seen in U5 are admitted to the inpatient ward. Trauma-related illness is not evaluated at U5.

An analysis of inpatient mortality at KCH for 2008 found a rate of ~80 deaths per 1000 admissions, with ~60% of all inpatient deaths occurring within the first 2 days of admission. Because death occurring within 2 days of admission may be considered a proxy for the effectiveness of initial evaluation and stabilization,[6] a hospital-wide goal was set to improve emergency care for children at KCH, particularly at U5. We present a descriptive analysis of the development, implementation, and impact of an intervention undertaken to improve emergency care for children presenting to U5 at KCH. Our aim was to decrease both early and total inpatient mortality rates.

METHODS

Justification for the Intervention

A working group was formed in 2009 to identify areas for improvement in pediatric emergency care at U5. The working group consisted of the chair of the Department of Pediatrics at KCH, 2 staff pediatricians, the head nurse of pediatrics, the nurse in charge of the pediatric ward, and 3 midlevel providers, known as clinical officers (CO).

Areas identified for improvement included (1) prioritized provision of senior clinical support onsite at U5, (2) institution of a formal triage process and improvement of patient flow, and (3) provision of adequate treatment and stabilization of patients before transfer to the inpatient ward.

Prioritized Provision of Senior Clinical Support Onsite at U5

At the time of our initial evaluation, care at U5 was provided exclusively by COs. COs are midlevel care providers who receive 4 years of health care education after completing secondary school, only a fraction of which is pediatric specific. No senior-level clinicians (defined as physicians) were dedicated to emergency care at U5.

Institution of a Formal Triage Process and Improvement of Patient Flow

The acuity of U5 patients varies widely. Some children require only basic care, whereas others have emergent medical conditions. At the time of our working group's initial evaluation, no formal triage process was employed at U5. Patients were seen largely on a first come, first served basis (Fig 1).

Treatment and Stabilization of Patients Before Transfer to the Inpatient Ward

Before our intervention, systematic evaluation and stabilization of patients in a goal-directed manner did not occur at U5. This responsibility rested primarily on the inpatient service. Overcrowding and limited staffing of the inpatient ward often led to additional delays in treatment once a child was admitted.

Description of the Intervention

The working group developed and implemented systems-based changes designed to address the areas identified for improvement at U5. Members of the working group met periodically to evaluate the uptake and effectiveness of the interventions. Processes were subsequently modified to address identified problems.

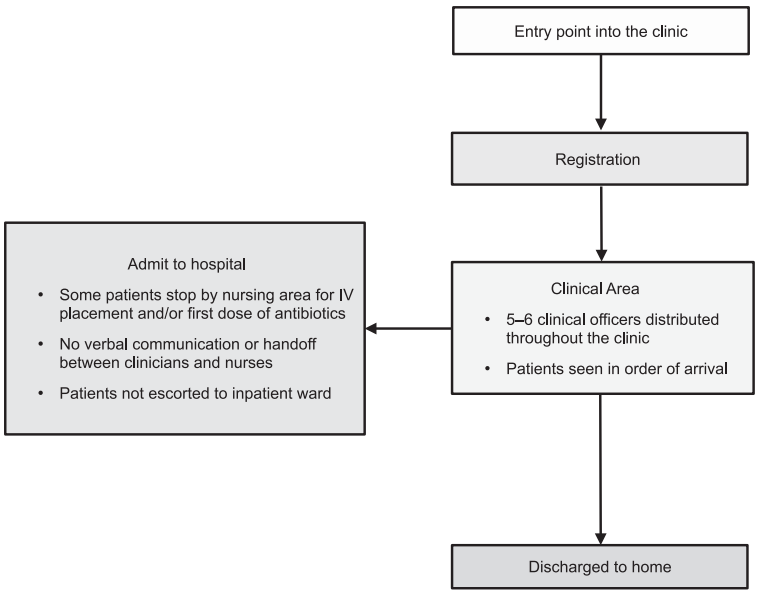

FIGURE 1
Flow of patients through the U5 Clinic at Kamuzu Central Hospital before intervention. IV, intravenous.

Prioritized Provision of Senior Clinical Support Onsite at U5

Pediatricians were reassigned from other duties within KCH to supervise clinical activities onsite at U5. These physicians worked at KCH through a nongovernmental organization, the Baylor International Pediatric AIDS Initiative,[11] and a donor organization, Volunteer Service Overseas.[12] Their role was to provide direct patient care at U5 and to supervise and instruct COs and trainees. Single-physician coverage was provided 5 of the 6 days per week that U5 was open.

Institution of a Formal Triage Process and Improvement of Patient Flow

We chose the World Health Organization's Emergency Triage Assessment and Treatment (ETAT) guidelines as the basis of our triage process. ETAT guidelines were developed and validated for pediatric use in low-resource settings[13,14] and have been used in similar clinical environments.[6,15] They are based on few clinical signs and can be used by providers who have limited or no clinical training.[16] Initial triage is designed to occur in <30 seconds. Triage categories are emergency, priority, or nonurgent.

Selected COs, nurses, physicians, and health surveillance assistants were trained in ETAT protocols. Janitorial staff and unit clerks, who are often the first contact for patients, also received abbreviated triage training.

Patient flow through U5 was then reorganized according to ETAT principles (Fig 2). Initially one ETAT-trained employee was allocated to triage and weigh patients at the entry point of care. However, as a result of our ongoing process review, staffing was increased at the triage station to 2 employees during busy morning hours and the triage station was relocated to a more effective area. In addition, a worker was identified (often a member of the custodial staff) to "direct traffic" within U5.

An emergency care area within the U5 clinic was designated in red lettering. Other areas were color-coded as priority (yellow) or nonurgent (green), as has been previously described.[6] Patients triaged as emergency were directed immediately from the triage station to the emergency care area for treatment and stabilization. Patients triaged as priority or nonurgent were directed to a registration area, after which they proceeded to the clinical areas corresponding to their triage category.

Clinician assignments within U5 were allocated according to ETAT priorities. The emergency care area was staffed with 2 to 4 nurses, 2 to 3 COs, and 1 senior-level clinician. Two COs were dedicated to priority patients. One CO was assigned to evaluate children triaged as nonurgent.

With the exception of adding a senior-level clinician in the emergency care area, we did not increase the overall number of clinicians allocated to U5. We simply reorganized and assigned clinicians according to patient acuity.

Treatment and Stabilization of Patients Before Transfer to the Inpatient Ward

Children triaged as emergency began treatment immediately and were monitored in U5 for adequate response before transfer to the ward. In addition, patients who initially were triaged as priority or nonurgent, but after initial evaluation by a CO were thought to require admission, were redirected to the emergency care area where revaluation was performed under the supervision of the senior-level clinician. If admission was still deemed necessary, treatment was initiated before transfer to the ward (Fig 2).

After initial implementation, we realized that coordination with hospital ancillary services would likely improve the effectiveness of our intervention. For example, we worked with the laboratory to prioritize specimen processing and blood-product release to U5 so that children with acute, severe malaria-associated anemia and/or shock could be rapidly transfused. Previously, transfusions were delayed until patients reached the inpatient ward. Additionally, radiology agreed to prioritize U5 patients.

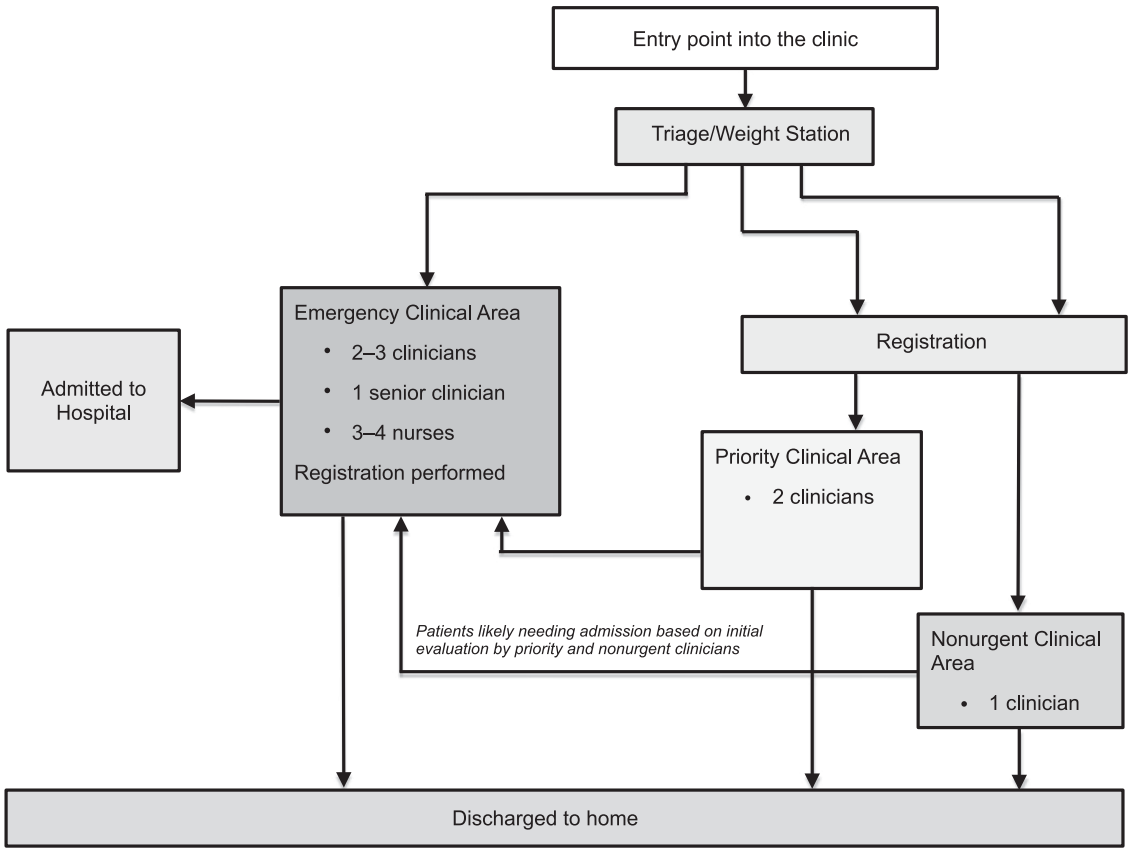

FIGURE 2
Flow of patients through the U5 Clinic at Kamuzu Central Hospital after intervention.

Finally, we worked with the pharmacy to improve the provision of medicine, equipment, and supplies for U5.

Study Design

We set as primary outcomes early and total inpatient mortality rates for patients admitted to KCH before and after the intervention at U5. Early mortality was defined as deaths occurring within 2 days of admission. Data were collected from admission and death logbooks kept onsite at the pediatric ward.

Logbooks were kept by pediatric nursing staff as part of the standard record-keeping process at KCH. Information was entered manually into the logbooks at the time of the event (admission or death) and consistently contained the name of the patient and the date of the event. Accurate demographic data were not available. Once a logbook was completed, it was kept in the records department at KCH.

Initial planning of the intervention began in April 2009. Hospital employees were trained in ETAT in July 2009 after which triage, patient flow changes, and human resource reallocations were phased in until October 2009. Construction to renovate the U5 facilities occurred between April 15 and June 7, 2010. Elements of the intervention continued during and after construction.

Statistical Analysis

Because of the seasonal variation of malaria-related disease, early and total mortality were compared with χ^2 analysis in analogous months before (November 1, 2008–March 31, 2009) and after (November 1, 2009–March 31, 2010) the intervention. The relative risk (RR) of mortality with 95% confidence intervals (CI) was calculated to compare the pre- and postintervention time periods.

Data during implementation and after construction were not included in the primary analysis. A statistical process control chart was created by using MiniTab (State College, PA) to compare all available early death data over time and in relation to the intervention.

The study protocol was approved by Institutional Review Boards of the National Health Sciences Research Committee of Malawi, Baylor College of Medicine, and the University of Utah School of Medicine.

RESULTS

After the intervention, early mortality decreased from 47.6 to 37.9 deaths per 1000 admissions during the 5-month

period of comparative analysis (RR 0.80, 95% CI 0.67–0.93). Total mortality also decreased, from 80.5 to 70.5 deaths per 1000 admissions, after the intervention (RR 0.88, 95% CI 0.78–0.98; Table 1). During the same time period, the number of expected early deaths was reduced by 72, from 357 to the 285 observed (95% CI 22–120) and the number of expected total deaths was reduced by 75, from 604 to the 529 observed (95% CI 14–142). A statistical process control chart including postconstruction data also demonstrates improved early mortality after the intervention (Fig 3).

DISCUSSION

We found a significant decrease in both early and total pediatric hospital mortality rates after an intervention to improve pediatric emergency care at our resource-limited hospital in sub-Saharan Africa. The observed decrease in both early and total inpatient mortality rates illustrates that mortality was not simply being delayed.

We gained valuable insight from the process described by the group in Blantyre, Malawi, where training and implementation of ETAT, together with increased dedication of resources for pediatric emergency care, improved hospital mortality rates. However, our findings are significant and novel in that we specifically describe the prioritization of senior-level clinical support for pediatric emergency care as a critical element of our intervention.

All elements of our intervention were implemented simultaneously to effect the largest and most expeditious impact. It is difficult, therefore, to identify an individual effect of specific elements of our intervention. However, our results show that the interaction among all of the elements was associated with decreased pediatric hospital mortality.

Although record keeping and data acquisition in resource-limited settings are challenges that have been recognized,[17] we are confident that our chosen outcome measures not only reflect our intervention but arise from accurate data sources. Our data are limited, however, in that our sources could not provide information to evaluate demographic differences reliably and consistently between our pre- and postintervention cohorts. Therefore, we cannot exclude the possibility that differences in diagnoses, gender, or age among the populations contributed to the observed changes in mortality rates. We also acknowledge that changes in the overall community health could have contributed to our results. However, surveillance data on malaria, a significant contributor to hospital volume, morbidity, and mortality in Malawi, indicate that cases have been stable or increasing since 2007.[18]

Accurate denominator data necessary to compare admission rates are not available, which may be a limitation in interpreting our results. However, we did observe, in contrast to what was seen in Blantyre after a comparable intervention,[6] that the absolute number of admissions decreased after our intervention (Table 1). We hypothesize that this is partially attributable to increased oversight at U5 by senior-level clinicians. This effect has been observed in other emergency care settings.[19] Decreasing the number of admissions has the benefit of decongesting an overcrowded inpatient ward, but this may also increase the overall acuity of admitted patients. Yet despite this potential effect, a decrease in inpatient mortality was observed after our intervention.

The majority of children admitted to KCH come through U5, but a significant number of patients also report directly to the ward during the nighttime hours. Although many inpatient caregivers also received ETAT training, no systematic changes in patient intake, patient flow, or human resource allocation were undertaken on the inpatient ward in coordination with our intervention at U5. Therefore, our cohorts include patients not fully affected by our intervention because we could not consistently distinguish patients admitted through U5 from those who arrived to the inpatient ward through another path. However, this limitation is likely to underestimate, rather than overestimate, the impact of the intervention.

The sustainability of our project locally and its generalizability to other settings may be influenced by several factors including the availability of adequate human and financial resources. Shortage of qualified health care workers is a well-established challenge to health care systems in the developing world.[20–27] Physicians are in short supply, and midlevel providers frequently oversee the care of patients.[25–27] Our process benefitted from the participation of physicians from academic medical centers in the United States and the United Kingdom who were involved in the planning, training, and implementation of our intervention. Four of these physicians (JR, ZA, CN, CD) also provided clinical care at U5. However, before the project began, these physicians were integral members of the Department of Pediatrics at KCH working in other

TABLE 1 Early and Total Inpatient Deaths Before and After the Intervention to Improve Pediatric Emergency Care

	Preintervention[a] (n = 7781)	Postintervention[b] (n = 7505)	Relative Risk of Death Postintervention Compared With Preintervention (95% CI)
Early Deaths	371	285	0.80 (0.67–0.93)
Total Deaths	626	529	0.88 (0.78–0.98)

[a] November 1, 2008–March 31, 2009.
[b] November 1, 2009–March 31, 2010.

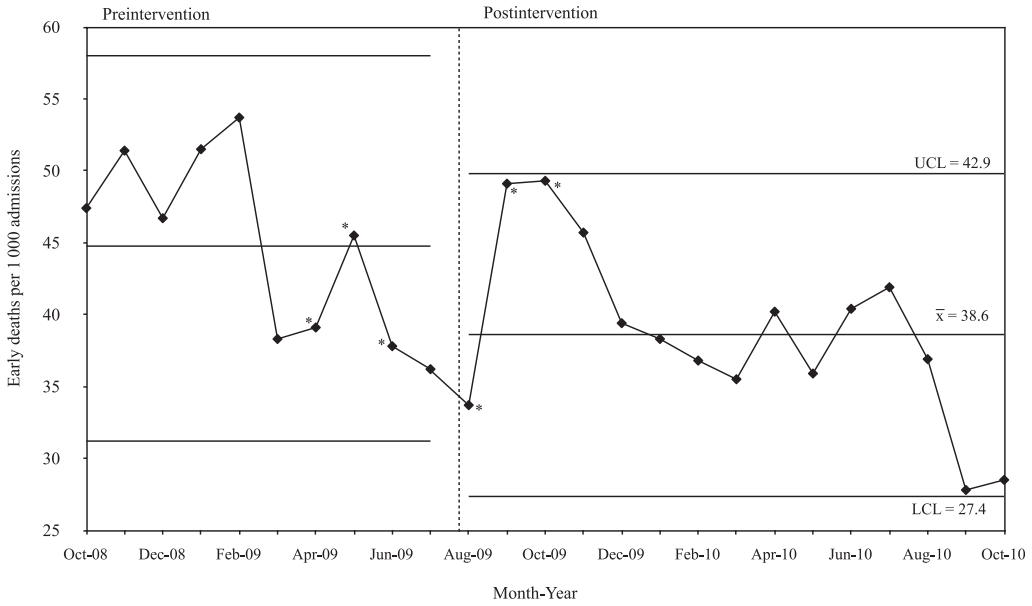

FIGURE 3

Statistical process control chart demonstrating early mortality before and after the intervention with the upper control limit (UCL) and lower control limit (LCL) at ± 3 SD from the mean ($\bar{x}$). * Months with incomplete early death data. Early mortality was estimated by considering percentage of early deaths occurring as part of a complete death record. That percentage was then multiplied by the total number of death records for the month.

areas of the hospital, and the decision to reassign them to U5 was made at the potential expense of other areas of the hospital where they were previously stationed. Although a similar intervention, with similar results, provided solely by local caregivers would better address questions of reproducibility in hospitals throughout the region, our process still reflects a decision to prioritize pediatric emergency care in the context of severely limited human resources. In light of our results, policy makers, aid organizations, hospital administrators, and pediatric departments in similar clinical settings may consider similar reallocation strategies even in the absence of participants from western medical centers.

The direct expenses for our project were primarily related to the initial ETAT training. Approximately US$13 000 was obtained from the World Health Organization within the context of a national ETAT training program to train KCH health care workers and purchase ETAT-related clinical job aids. Coordinating with locally based ETAT training programs has been previously identified as an important element to the uptake and sustainability of ETAT.[15] The physicians from Western academic medical centers were not paid additional consulting fees specific to their work on this project; however, if their baseline salaries were considered in the budget for our process, the estimated costs of our intervention would increase substantially.

Improvements have also been made to the physical facilities at U5, but in contrast to the decreased mortality rates reported in Blantyre, our primary results do not reflect these structural improvements. However, our statistical process control chart (Fig 3) does include data during and after renovations and demonstrates ongoing improvement in early mortality, which we suspect has been affected by the improved physical facilities.

It was our intent that collaboration and mentoring between senior-level clinicians and the COs, nurses, and health care trainees at U5 would improve clinical practice over time and support the sustainability of the intervention. We also recognize, as has been described in a national effort to implement an ETAT-based training program in Kenya,[15] that a continuous and adaptable ETAT training program at our hospital will be necessary to sustain the observed improvements in mortality.

We also acknowledge that the vast majority of acutely ill children in this region of the world do not present initially to referral hospitals like KCH but rather to health clinics and district-level hospitals. However, we believe that the principles outlined in our intervention can be applied at relatively low cost and may be adaptable to conditions in hospitals throughout the region. In addition, although children with injuries were not evaluated or treated at U5, it is reasonable to assume that similar interventions could also improve outcomes for patients with trauma-related illness, a population of increasing significance in the developing world.

Our results suggest that process improvement interventions at the initial point of hospital care can have a significant impact on patient mortality. Yet

the importance of pediatric emergency care remains underprioritized within hospitals of the developing world even as pediatric emergency medicine has emerged as an important discipline in the developed world. We encourage caregivers in clinical settings comparable to ours to identify opportunities to improve pediatric emergency services.

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