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Original Article

Comparative mortality for children at one hospital in Kenya staffed with pediatric emergency medicine specialists

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ABSTRACT

Objectives: Three decades ago, in North America, pediatric emergency medicine was an evolving subspecialty of pediatrics, contributing in valuable and life-saving ways to the care of children. Currently, in LMICs (low middle-income countries) pediatric programs are expanding training and education in the subspecialty of pediatric emergency medicine. We aim to determine if care provided by a single institution with dedicated pediatric emergency resources and personnel in Kenya can change mortality rates in children with similar mRISC scores suffering from respiratory illness, as compared to previously published data from the same region of Eastern Africa. As mRISC is used at the time of a child's admission to the hospital to describe the severity of their respiratory illness, we will compare mortality rates by mRISC score to compare groups of patients with similar severities of illness between hospitals.

Methods: A retrospective chart review was performed using written medical records of pediatric patients 30 days to 5 years of age admitted to AIC Kijabe Hospital, Kenya from 2014 to 2018 for respiratory illness. Of 2692 possible admissions identified in the hospital's pediatric database, 377 admissions were included. 34 data points were recorded for each patient admission including demographic information, information involved in calculating the mRISC score, and additional respiratory information. The primary outcomes were mRISC score and mortality.

Results: 20 (5%) of included patients represented in-hospital mortalities. Across all mRISC scores, our mortality remained much lower than previously reported in the literature in Kenya.

Conclusions: Our study does support a positive correlation between pediatric emergency medicine training and skills and decreased childhood mortality; however, correlation does not prove causation. How this decrease in mortality was accomplished was likely a combination of many smaller efforts at quality improvement that add up and make a difference as pediatricians are known to be child advocates.

Introduction

Three decades ago in North America, pediatric emergency medicine was an evolving subspecialty of pediatrics, contributing in valuable and life-saving ways to the care of children [1–3]. Currently, in LMICs (low middle income countries) pediatric programs are expanding training and education in the subspecialty of pediatric emergency medicine [4–7].

We aim to determine if care provided by a single institution with dedicated pediatric emergency resources and personnel in Kenya can change mortality rates in children with similar mRISC scores suffering from respiratory illness, as compared to previously published data from the same region of Eastern Africa. As mRISC is used at the time of a child's admission to the hospital to describe the severity of their respiratory illness, we will compare mortality rates by mRISC score to compare groups of patients with similar severities of illness between hospitals.

Methods

Study site and population

We conducted a retrospective hospital-based study at AIC Kijabe Hospital in Kijabe, Kenya, reviewing patients admitted with respiratory illness from May 2014 to June 2018. AIC Kijabe Hospital, located in Kijabe, Kenya, is a non-profit, 340-bed faith-based hospital offering a broad range of inpatient and outpatient services with a catchment area of 100 km in Southwestern Kenya. The hospital includes inpatient

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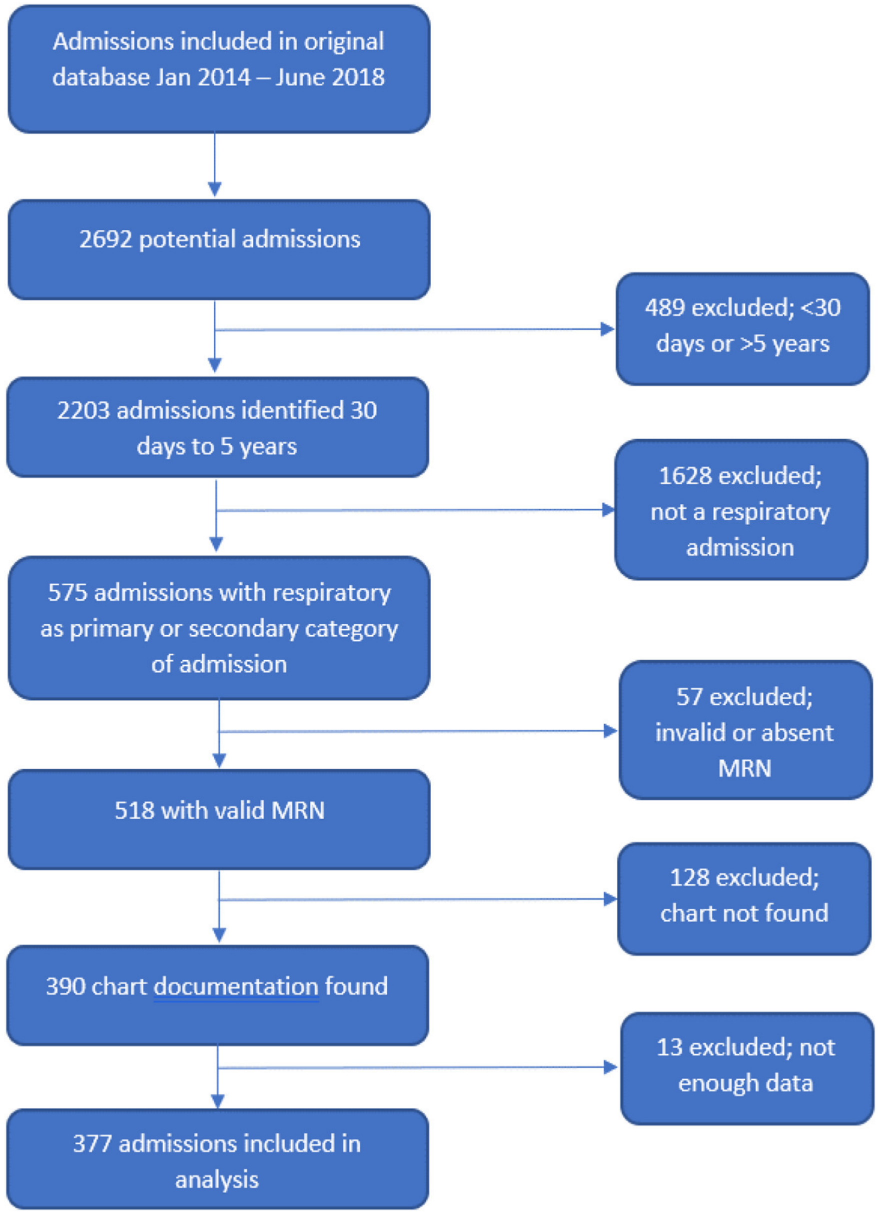

Fig. 1. Chart Review Selection

wards (2 inpatient adult medicine/surgery, a pediatric ward, an obstetrics/gynecology ward, and one private medical/surgical ward), critical care areas (2 adult and one pediatric high dependency units, one mixed adult/pediatric ICU and one NICU), nine operating rooms, an outpatient clinic and a 24-hour emergency department.

Support services include a clinical laboratory, a fully equipped pathology department, X-ray, ultrasound, electrocardiogram, pharmacy, physiotherapy, and central medical supply. Kijabe's laboratory offers immunohematology, hematology, biochemistry, parasitology, urinalysis, bacteriology, and blood banking services.

The Pediatric Ward at Kijabe hospital is comprised of 76 beds caring for surgical and medical patients aged from 1 day to 15 years. This includes a 6-bed monitored high dependency unit, from which children may be admitted to the 5-bed mixed pediatric-adult Intensive Care Unit, if necessary. Children requiring respiratory support may receive oxygen or bubble CPAP, and assisted ventilation as available. During the time of this study, pediatric patients admitted to the hospital were cared for by a combination of Kenyan trained pediatricians and United States trained pediatric emergency medicine physicians.

Patients included in this study were aged 30 days to 5 years and admitted to Kijabe Hospital between May 2014 and June 2018 for a respiratory complaint. Included ages 30 days to 5 years were chosen to not confound with separate neonatal/perinatal mortality while simultaneously capturing young childhood; a time of childhood typically with increased respiratory illness. During the time of our data collection, HIV positivity was present in 2% of admissions.

Data collection and case definitions

Potential subjects were identified from the pediatric department's patient database. The patient medical record was then requested from the hospital's medical records department. The physical files were retrieved by medical records personnel or trained study personnel. If three attempts to find the file, at least one of which was performed by the study personnel, returned void, then the file was considered missing and excluded.

Demographic information t was recorded including patient medical record number, age, date of birth, date of admission, sex, weight,

Table 1
Patient Demographics

	Admissions ($N = 377$)	Deaths ($N = 20$)
Sex, n (%)		
M	215 (57)	7 (35)
F	162 (43)	13 (65)
Age (n, %)		
1–2mo	35 (9.3)	2 (10)
3–12mo	258 (68.4)	16 (40)
1–5y	84 (22.3)	2 (10)
LOS mean (std)	7.7 (8.0)	6.6 (7.2)
ICU days (std)	0.4 (2.1)	3.1 (3.8)
HDU days (std)	1.0 (2.8)	1.6 (1.9)
Days on ventilator (std)	0.3 (1.6)	2.5 (3.1)
Days on oxygen (std)	4 (6.3)	3.3 (4.1)
Wt/Ht z score (n, %) 321	$N = 321$	$N = 15$
< −3SD	78 (24.3)	4 (26.7)
−2 to −3SD	54 (16.8)	3 (20)
−1 to −2SD	48 (15.0)	1 (6.7)
> −1SD	141 (43.9)	7 (46.7)
Mrisc score (n, %)		
0	92 (24.4)	4 (20)
1	136 (36.1)	3 (15)
2	89 (23.6)	5 (25)
3	32 (8.5)	4 (20)
4	19 (5.0)	2 (10)
5	3 (0.8)	0 (0)
6	6 (1.6)	2 (10)
Pulse ox (n, %)		
> 90	124 (33.2)	7 (35)
85–90	62 (16.6)	3 (15)
80–84	51 (13.7)	0 (0)
< 80%	102 (27.4)	7 (35)
Not recorded	34 (9.1)	3 (15)
Consciousness (n, %)		
A	346 (92.8)	16 (80)
V	7 (1.9)	0 (0)
P	15 (4.0)	2 (10)
U	2 (0.5)	2 (10)
Not recorded	3 (0.8)	0 (0)
TB (n, %)	52 (14.0)	4 (20)
Respiratory symptoms (n%)		
Wheezing	88 (23.6)	3 (15)
Stridor	11 (3.0)	1 (5)
Nasal flaring	113 (30.3)	7 (35)

Table 2
Mortality by mRISC score

	N	Mortality (n, %)	p
mRisc 0			
Kijabe	92	4 (4)	0.08
Siaya	2492	42 (2)	
mRISC 1			
Kijabe	136	3 (2)	0.01
Siaya	644	57 (9)	
mRISC 2			
Kijabe	89	5 (6)	0.03
Siaya	269	49 (18)	
mRISC 3			
Kijabe	32	4 (12.5)	0.03
Siaya	121	39 (32.2)	
mRISC 4			
Kijabe	19	2 (10.5)	0.004
Siaya	40	20 (50)	
mRISC 5			
Kijabe	3	0 (0)	0.07
Siaya	10	7 (70)	
mRISC 6			
Kijabe	6	2 (33)	0.24
Siaya	5	4 (80)	

height, z-scores for weight/age, height/age, and weight/height. All of this information was recorded as reported at time of admission. Total length of stay, length of stay in the ICU, length of stay in the HDU, days on oxygen, days on ventilation, and whether or not this admission ended in mortality were also recorded.

Data points involved in calculating the mRISC score were recorded as a binary and were recorded as reported at time of admission. Data points included: unconsciousness, inability to drink or breastfeed, presence or history of night sweats, chest wall indrawing, awake and alertness, diagnosis of malaria, diagnosis of malaria with the presence of chest wall indrawing, dehydration, weight/height z-score > −2SD. The mRISC value was calculated for each admission as described in previous studies. Because of the necessary binary nature of these findings in order to calculate an mRISC score, lack of a record of positive findings in the chart for each of these points was recorded as a negative finding.

In order to assess other trends in mortality in this patient population, additional respiratory data was recorded. These findings included pulse oximetry on admission on room air prior to O2 administration, CXR consistent with pneumonia, current tuberculosis treatment, nasal flaring, wheezing, stridor, and mental status as determined by AVPU. For pulse oximetry, nasal flaring, wheezing, stridor, and mental status; if the finding was not explicitly recorded in the chart, the data was inputted as "not recorded."

The study was approved by the Institutional Review Board of Wake Forest School of Medicine and at Kijabe Hospital. Confidentiality was protected by collecting only information needed to assess study outcomes, minimizing to the fullest extent possible the collection of any information that could directly identify subject and using only a unique study identifier on the data collection form. Following data collection subject identifying information was destroyed, producing an anonymous analytical data set. Data access was limited to study investigators. Data and records were kept locked and secured, with any computer data password protected.

Statistical analysis

The data were analyzed using Microsoft Excel and SAS Enterprise Guide. Descriptive statistics were calculated as proportions and were described with percentages of totals and means reported with standard deviation. The Fisher Exact test was used to compare significance in mortality by mRISC score between hospitals as the primary endpoint and considered significant if $P < 0.05$.

Results

Of a potential 2692 admissions during our period of review, 575 records fit the age range of 30 days-5 years and presented with a respiratory complaint. The final inclusion of 377 admissions was those charts able to be physically located and with complete information able to be abstracted (Fig. 1).

Of 377 patient admissions, 20 (5%) represented in-hospital mortalities which was comparative to overall pediatric hospital mortality in Kijabe. Our patients were primarily between ages 3 and 12 months and were slightly more male than female (Table 1).

The mortality at our institution trended to increase with increasing mRISC score (Table 2), as expected from previous validations of the tool. However, across all mRISC scores our mortality remained much lower than previously reported in the literature in Kenya. The comparative mortality rates were lowest for Kijabe as compared to prior reports from Western Kenya with mRISC scores of 4, 5, and 6 (Table 2). The differences at higher mRISC scores were not significant secondary to small numbers, but the descriptive statistics (Fig. 2) show a clear result of decreased mortality for increasing mRISC score at our study institution. At the highest mRISC scores of 5 and 6, our institution showed a mortality of 0 to 33% respectively. This compares to 70 to

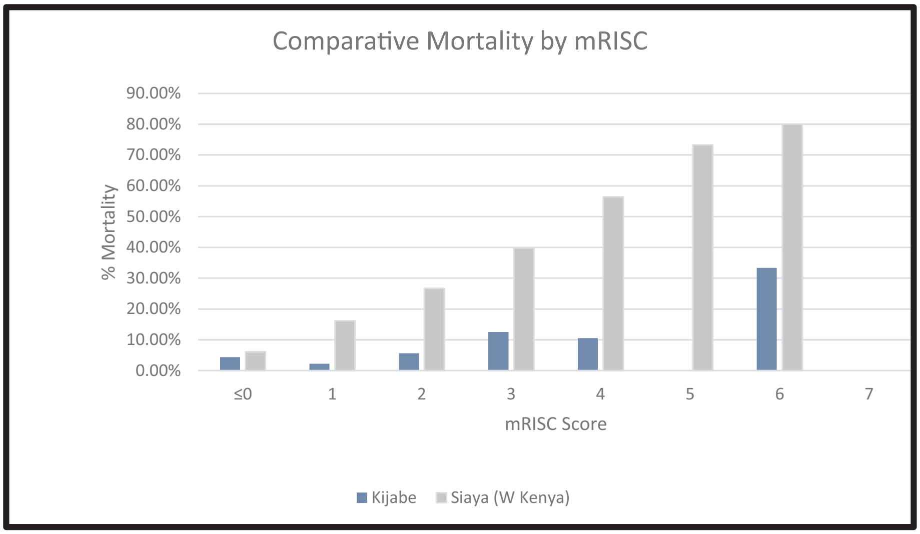

Fig. 2. Comparative Mortality by mRISC score

80% mortality for mRISC scores of 5 and 6 that has been previous published in Kenya at a hospital without pediatric emergency medicine physicians serving as teachers and advocates.

Discussion

Our study shows mortality predicted by mRISC scores differs in an institution with dedicated pediatric emergency and critical care resources and personnel, using low cost intervention and pediatric specific education and training, as compared to other regional facilities without dedicated pediatric resources and training. At Kijabe AIC Hospital children were cared for by 4 pediatricians, with 24/7 call and 2 pediatric emergency trained physicians, and at the time of this study, Kijabe Hospital was the only location in the region and country with pediatric emergency medicine trained physicians.

In Low to Middle Income Countries (LMIC), pediatric respiratory disease continues to be a significant cause of mortality [8]. The RISC (Respiratory Index of Severity in Children) and the mRISC (modified Respiratory Index of Severity in Children) score have been developed to quantify the severity pediatric respiratory illness based on the risk of mortality associated with increasing score [9,10]. The mRISC score uses bedside history and physical findings such as chest in-drawing, level of consciousness, ability to feed, presence of night sweats, malaria status, and dehydration and malnutrition status to calculate a score that has been used to quantify risk of mortality from respiratory illness [8].

Severe acute respiratory illness is often cared for by trained pediatric emergency medicine for initial stabilization and are then handed over to critical care physicians in the parts of the world considered resource rich. Sections in Emergency Medicine were established by the American Academy of Pediatrics in 1981 and the Canadian Pediatric Society in 1986. In the 1980s the American Academy of Pediatrics called for every child going into a pediatric emergency department to have available a physician with general medical, surgical, and critical care expertise that a pediatric emergency medicine physician could provide [1]. In LMICs there is interest to build on current pediatric programs and expand training and education in pediatric emergency medicine [5]. In recent years we have seen the development of the African Federation of Emergency Medicine, African training programs in emergency medicine, and pediatric emergency medicine fellowships in South Africa and Kenya [4,11]. The interest in expanding pediatric emergency medicine training and practices is also evidenced by the development of the Pediatric Emergency Medicine Special Interest Group (PEMSIG) as part of the International Federation of Emergency Medicine (IFEM).

Our study does support a positive correlation between pediatric emergency medicine training and skills and decreased childhood mortality, however correlation does not prove causation. How this decrease in mortality was accomplished was likely a combination of many smaller efforts at quality improvement that add up and make a difference as pediatricians are known to be child advocates.

If increasing pediatric emergency presence improves childhood mortality in an area, then the question becomes, "How do we bring more education and skills mastery in rapid pediatric resuscitation to LMICs?" One possible solution involves replicating the support that is in place in our study source hospital in Kijabe, Kenya. Pediatric Emergency Medicine trained physicians are living and working alongside Kenyan pediatricians so that skills and ideas can be cross cultivated with local culture and available resources. This local level partnership is essential in long term support of a pediatric program in a LMIC. Investment in an area looks like long-term commitment and people willing to invest this time and energy.

The second layer increases the circle of support through many multi-center relationships that may be over distance. This model of multicenter support of an institution in a LMIC has been done and is successful. In sharing the travel, teaching, and research, many institutions can support an institution in a LMIC over time, and the long term goals of international support become manageable [12].

The third layer of support develops naturally after local embedded commitment and long distance support networks are established and that involves training the next trainers. In Kijabe, Kenya this has taken the form of developing a fellowship in pediatric emergency and critical care for Kenyan (and surrounding area pediatricians). This requires time and patience to work with local authorities and laws to establish the learning program, but in Kijabe, Kenya fellows in Pediatric Emergency and Critical Care (PECC-Kenya) are learning emergency medicine skills in a newly established fellowship.

From a mecca of pediatric emergency medicine practice and training can emerge modules to improve care that can be exported to surrounding areas. The trainees themselves will export ideas and practices to improve care as they finish training and move to surrounding areas to work. As one graduates and teaches many, and these many teach many more, the positive effect will become exponential on child mortality. In addition to trained carriers of the message, modules of training can be developed to teach local practitioners improved patient care practices. This model has been done in programs such as HBB through the AAP. The train-the-trainer model can be used for trauma resuscitation, asthma care, sepsis care, the options are endless. This article does have some limitations that are inherent to chart reviews in an international environment. First, while the total sample size of the study is relatively large, there are only 20 included cases of mortality within the sample. Since this study is looking specifically at trends in mortality, that represents a small sample size because of overall low mortality in the institution. Second there is variance in styles of documentation, as well as completeness and thoroughness of the written charts, and this study relied on the accuracy of the recorded information.

Conclusion

In conclusion, pediatricians trained in pediatric emergency medicine principles are shown to reduce childhood mortality in LMICs likely through dissemination of education, practice patterns, and advocacy measures.

Dissemination of results

Results from this study (research/trail/etc.) were shared with staff members at the data collection site through an informal presentation.

Authors' contribution

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: AG contributed 25%; AS 25%; and KF contributed 50%. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

The authors declared no conflicts of interest.

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