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Paediatric deaths within the first 24 hours in a metropolitan hospital system, South Africa

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Abstract*: Background:* Paediatric deaths occurring within 24 hours of presentation to hospital contribute substantially to overall in-hospital mortality. The underlying contributors to these early deaths have not been well delineated.
Objectives: To describe the characteristics (demographic features, ascribed aetiologies, predisposing factors) associated with deaths of paediatric patients within the first 24 hours of hospital presentation, and to determine modifiable factors that can be addressed to improve patient care and outcomes.
Design: A secondary data analysis of deaths of paediatric patients within a metropolitan hospital system in South Africa. Data were obtained from the Child Healthcare Problem Identification Program (Child PIP) database for the time period 1 January 2005 through 31 December 2014.
Setting: The three hospitals within a metropolitan hospital system, South Africa.
Results: Of 2080 in-hospital deaths, 563(27%) occurred within 24 hours of hospital arrival. Almost half (48.3%) of these deaths occurred in infants aged 28 days to 1 year. The main causes of early mortality were sepsis (18.6%), acute respiratory illness(17.2%), and gastroenteritis with resultant hypovolemic shock(16.3%).During the initial 5-year time period, 30.5% of children who died were HIV positive. This percentage decreased to 14% in the latter 5-year time period. A majority of deaths were considered avoidable (89.5%). Potentially modifiable contributors to death included delay in seeking care(45.3% of deaths), poor assessment(36.9%), and inadequate management (29.3%) and monitoring (17.0%)of patients.
Conclusions: Deaths within the first 24 hours after presentation to hospital were a major contributor to overall in-hospital mortality. Identified modifiable contributors to death can be addressed through improved education and training of both health care providers and family caregivers.

Key words: deaths, mortality, paediatric, South Africa, modifiable factors

The highest percentage of childhood deaths in South Africa, and internationally, occurs within 24 hours of a child entering a health care facility.[1-9] In Saving Children 2012-2013, a survey of child healthcare in South Africa utilizing data obtained from the Child Healthcare Problem Identification Program (Child PIP), 33% of deaths among children from birth to 18 years of age occurred within the first 24 hours after presentation to hospital.[1] International data have consistently identified early death (i.e., within 24 hours of presentation to hospital) as a major contributor to overall in-hospital mortality.[2-4,7,9-10] For example, in a study from Kenya, 31.5% of neonates admitted to a general paediatric ward died, and 49% did so within 24 hours of admission.[4] Two studies from Nigeria found that a substantial percentage of children who died after presenting to hospital died within 24 hours of arrival, 55.4% and 49%, respectively, in the two studies.[2,9] A study from Zimbabwe found that 34.6% of deaths after admission to a paediatric hospital occurred within 24 hours[3]. The substantial contribution of deaths within the first 24 hours to in-hospital mortality is not limited to the African continent. A study from China, covering the years 2011-2013, found that 40% of deaths occurred with 24 hours of admission[7]. Better understanding of these early hospital deaths will be necessary if childhood mortality is to be reduced.

Although overall in-hospital mortality rates at the hospitals within our metropolitan hospital system have declined over the past few years, there has not been a corresponding improvement in the relative percentage of deaths occurring within the first 24 hours.[1] The hospital system includes three hospitals: Hospital A – tertiary level, Hospital B – regional level, and Hospital C – district level. The characteristics of children dying within these facilities have not been well described. These

hospitals collect data for Child PIP, which provide information on potential modifiable factors that may have contributed to the deaths. The aim of this study was to describe the characteristics (demographic features, ascribed aetiologies, predisposing factors) associated with death of paediatric patients in the first 24 hours of hospital presentation, and to determine modifiable factors that can be addressed to improve patient care and outcomes.

Methods

Design

A secondary data analysis using the Child PIP database, which captures mortality data on paediatric patients (ages 0-18 years) who die within the hospital setting.

Setting

The paediatric departments of the hospitals within the metropolitan system. Three hospitals serve the city as well as the western portion of the associated South African province. The service area includes a population of approximately 1.2 million children.

Data collection

All data within the Child PIP database from deaths occurring at the three hospitals for the time period 1 January 2005 through 31 December 2014 were included. The Child PIP is a mortality audit tool for children that was developed with the goal of improving care and reducing childhood mortality.[8] The process involves review of all inpatient deaths, which includes determining social, nutritional, and HIV status, assigning primary and secondary causes of death, and identifying modifiable factors that may have contributed to the death. Standardized forms are initially completed by the intern, medical officer or registrar who had been attending to the patient at the time of the demise. Deaths are then discussed on a monthly basis by the paediatric department at the morbidity and mortality meetings at the individual hospitals. Discussion includes background history, examination findings, initial assessment, management plan, course of illness, evolution of care plan, aetiology of death, and possible modifiable factors associated with the illness and clinical course of the patient. Final causes of death with modifiable factors are determined based on this review.

A modifiable factor is any factor that could have potentially contributed to the death of the child. The factors can be categorized by place or person. Place includes home, the local clinic/hospital, inter-facility transit, the emergency/outpatient department, and the inpatient ward. Person includes family, clinic, and administrative and clinical personnel.[8] Due to the large number of modifiable factors, only the more commonly noted in each of the three hospitals were considered in the secondary analyses. These included delay in seeking care (e.g., caregiver did not have patient evaluated before symptoms were moderate to severe), poor assessment (e.g., initial diagnosis was inaccurate), poor management (e.g., failure to follow standard of care for treatment of diagnosed condition), poor note keeping (e.g., health care provider's documentation not sufficient to allow for proper evaluation and follow through by other health care providers), and poor monitoring (e.g., failure to reassess patient with concerning clinical status).

Data are available in Child PIP from January 2005 onward. Although data collection started at Hospitals A and B in 2005, it was not initiated at Hospital C until 2008. Consequently, data for Hospital C are available for 7 of the 10 years (2008-2014).

Measurements

The number and percentage of children who died within 24 hours within the hospital system were obtained. Data on deaths included demographic characteristics, disease profiles, causes of death, and identified modifiable factors.

Inclusion criteria

Any death occurring in a child 0-18 years of age and reported to Child PIP from Hospital A, B, or C;
a death occurring anywhere within the hospital setting, including casualty, the paediatric outpatient department, a paediatric ward, or a paediatric intensive care unit within 24 hours of presentation.

There were no specific exclusion criteria. All deaths meeting inclusion criteria and reported to Child PIP were included in the analyses.

Data analysis

Descriptive statistics were obtained. The chi-square statistic was used to determine if variable distributions were similar across the three hospitals and the two time periods (i.e., whether there was a statistical relationship between hospital or time period and the categorical variables of interest). A p-value of 0.05 was considered statistically significant. Analyses were performed using Stata 10.0(StataCorp LP, College Station, Texas, USA).

Results

During the study period there were 2080 deaths among individuals from birth to eighteen years of age within the three hospitals. Of these, 563 (27.1%) occurred within 24 hours of presentation; 233 (41.4%) occurred at Hospital A, 220 (39.1%) at Hospital B, and 110 (19.5%) at Hospital C. Eighty (3.8%) children were dead on arrival. Tables 1 and 2 provide details.

Table 1: Characteristics of deaths in the three hospitals (combined) occurring within 24 hours of presentation

Variable	N (%)
Age category	563
0-28 days	26 (4.6)
28 days to 1 year	272 (48.3)
1-5 years	169 (30.0)
5-13 years	88 (15.6)
13-18 years	3 (0.5)
Unknown	5 (0.9)
Weight category	563
Overweight for age	12 (2.1)
Normal weight for age	216 (38.4)
Underweight for age	169 (30.0)
Severely underweight	120 (21.3)
Unknown	46 (8.2)
Sex	563
Male	295 (52.4)
Female	261 (46.4)
Unknown	7 (1.2)
Caregiver	563
Mother	395 (70.2)
Grandmother	60 (10.6)
Father/Other	29 (5.2)
Unknown	79 (14.0)
Feeding history	563
Exclusive breastfeeding	109 (19.4)
No breastmilk ever	82 (14.6)
Mixed feeding from birth	70 (12.4)
Unknown	302 (53.6)
Referral status	563
Referred	322 (57.2)
Not referred	196 (34.8)
Unknown	45 (8.0)
HIV status	563
Positive	131 (23.3)
Negative	150 (26.6)
Exposed, not positive	109 (19.4)
Unknown	173 (30.7)
When death occurred	563
Weekday (07:00-19:00	178 (31.6)
Weeknight (19:00-07:00)	200 (35.5)
Weekend/public holiday	155 (27.5)
Unknown	30 (5.3)
Main cause of death	563
Sepsis	105 (18.6)
Pneumonia	97 (17.2)
Hypovolemic shock	92 (16.3)
Meningitis	50 (8.9)
Other condition	176 (31.3)
Unknown	43 (7.6)
Death believed preventable	563
Yes	259 (46.0)
No	59 (10.5)
Not sure	123 (21.8)
Unknown	122 (21.7)
Modifiable factors*	
Delay in seeking care	255 (45.3)
Poor assessment	208 (36.9)
Poor management	165 (29.3)
Poor note keeping	122 (21.7)
Poor monitoring	96 (17.0)

*Number (%) of patients with modifiable factor identified

*Not included in chi-square analysis, cell with n<5

Variable	Hospital A	B	C	*P*
N (%)	233	220	110	
Age category				0.800
0-28 days	7 (3.0)	12 (5.4)	7 (6.4)	
28 days to 1 year	111 (47.6)	107 (48.6)	54 (49.1)	
1-5 years	72 (30.9)	67 (30.4)	30 (27.3)	
5-13 years	37 (15.9)	32 (14.5)	19 (17.3)	
13-18 years*	3 (1.3)	0	0	
Unknown*	3 (1.3)	2 (0.9)	0	
Weight category				<0.001
Overweight for age*	5 (2.1)	7 (3.2)	0	
Normal weight for age	91 (39.0)	74 (33.6)	51 (46.4)	
Underweight for age	72 (30.9)	64 (29.1)	33 (30.0)	
Severely underweight	35 (15.0)	64 (29.1)	21 (19.1)	
Unknown	30 (12.9)	11 (5.0)	5 (4.5)	
Sex				0.044
Male	138 (59.2)	102 (46.4)	55 (50.0)	
Female	92 (39.5)	114 (51.8)	55 (50.0)	
Unknown*	3 (1.3)	4 (1.8)	0	
Caregiver				0.055
Mother	169 (72.5)	141 (64.1)	85 (77.3)	
Grandmother	23 (9.9)	32 (14.5)	5 (4.5)	
Father/Other	9 (3.9)	12 (5.4)	8 (7.3)	
Unknown	32 (13.7)	35 (15.9)	12 (10.9)	
Feeding history				0.104
Exclusive breastfeeding	39 (16.7)	40 (18.2)	30 (27.3)	
No breastmilk ever	27 (11.6)	38 (17.3)	17 (15.4)	
Mixed feeding from birth	35 (15.0)	24 (10.9)	11 (10.0)	
Unknown	132 (56.6)	118 (53.6)	52 (47.3)	
Referral status				<0.001
Referred	211 (90.6)	82 (37.3)	28 (25.4)	
Not referred	17 (7.3)	123 (55.9)	56 (50.9)	
Unknown	5 (2.1)	15 (6.8)	26 (23.6)	
HIV status				<0.001
Positive	41 (17.6)	68 (30.9)	22 (20.0)	
Negative	83 (35.6)	36 (16.4)	31 (28.2)	
Exposed, not positive	35 (15.0)	48 (21.8)	26 (23.6)	
Unknown	74 (31.8)	68 (30.9)	31 (28.2)	
When death occurred				0.881
Weekday (07:00-19:00	77 (33.0)	70 (31.8)	32 (29.1)	
Weeknight (19:00-07:00)	82 (35.2)	86 (39.1)	32 (29.1)	
Weekend/public holiday	66 (28.3)	60 (27.3)	30 (27.3)	
Unknown*	8 (3.4)	4 (1.8)	16 (14.5)	
Main cause of death				<0.001
Sepsis	46 (19.7)	41 (18.6)	18 (16.4)	
Pneumonia	29 (12.4)	47 (21.4)	21 (19.1)	
Hypovolemic shock	23 (9.9)	52 (23.6)	17 (15.4)	
Meningitis	26 (11.2)	16 (7.3)	5 (4.5)	
Other condition	94 (40.3)	60 (27.3)	22 (20.0)	
Unknown*	15 (6.4)	4 (1.8)	27 (24.5)	
Death believed preventable				<0.001
Yes	75 (32.2)	148 (67.3)	36 (32.7)	
No	24 (10.3)	13 (5.9)	22 (20.0)	
Not sure	69 (29.6)	32 (14.5)	22 (20.0)	
Unknown	65 (27.9)	27 (12.3)	30 (27.3)	
Modifiable factors†				
Delay in seeking care	80 (34.3)	113 (51.4)	62 (56.4)	
Poor assessment	92 (39.5)	68 (30.9)	48 (43.6)	
Poor management	86 (36.9)	40 (18.2)	39 (35.4)	
Poor note keeping	82 (35.2)	31 (14.1)	9 (8.2)	
Poor monitoring	33 (14.2)	40 (18.2)	23 (20.9)	

*Not included in chi-square analysis, cell with n<5
†Number (%) of patients with modifiable factor identified

The highest percentage of deaths (overall 272/563, 48.3%) occurred in the 28-day to one-year age group. Hospital B had a higher percentage of children (64%) who were severely underweight for age (i.e., greater than 3 standard deviations below the mean) compared to the other two hospitals (35% and 21% at Hospital A and

Hospital C, respectively). Across the hospitals the largest percentage of deaths occurred among those with unknown HIV status (Hospital A – 31.8%, Hospital B – 30.9%, Hospital C – 28.2%). At Hospitals A, B, and C, 35.6%, 16.4% and 28.2%, respectively, were HIV negative, while 17.6%, 30.9% and 20.0%, respectively, were HIV positive. The leading causes of death were sepsis (18.6%), acute pneumonia (17.2%), and hypovolemic shock (16.3%).

The majority of deaths (89.5%) across all hospitals were considered potentially avoidable. There were a total of 1391 modifiable factors contributing to deaths, with an average of 2.5 modifiable factors per death. Of these, 773 (55.6%) were related to clinical personnel, 370 (26.6%) to the caregiver, and 248 (17.8%) to administrative issues. Delay in seeking care was the most common modifiable factor at all three hospitals. Five modifiable factors were common among the top 6 at each hospital and data for these factors are included in Tables 1-3.

Time period comparison

Hospitals A and B began completing Child PIP from 2005, while Hospital C started from 2008. Deaths at Hospitals A and B for the 5-year period 1 January 2005 through 31 December 2009 were compared with those from the 5-year period from 1 January 2010 through 31 December 2014. In the period of January 2005 through December 2009 there were 1227 deaths, with 275 (22.4%) occurring within the first 24 hours. From January 2010 through December 2014 there were 743 deaths, which was a 40% decrease from the earlier time period. Of these deaths, 178 (24%) occurred within the first 24 hours. Please see Table 3 for details.

In both time periods the highest percentage of early deaths occurred within the 28-day to 1-year age group. There was a smaller percentage of deaths in the severely underweight category within the more recent time period. The percentage of deaths that were HIV infected decreased from the initial (30.5%)to the latter time period(14.0%). The main causes of death were similar for the two time periods and most deaths were considered avoidable. Delay in seeking care was the most common modifiable factor identified in the first time period while incorrect assessment was most common in the second time period followed closely by a delay in seeking care.

Table 3: Characteristics of deaths by time period for Hospitals A and B combined

Variable	Time Period 2005 - 2009 N (%)	2010 - 2014	*P*
Age category	275	178	0.808
0-28 days	12 (4.4)	7 (3.9)	
28 days to 1 year	130 (47.3)	88 (49.4)	
1-5 years	90 (32.7)	49 (27.5)	
5-13 years	42 (15.3)	27 (15.2)	
13-18 years*	0	3 (1.7)	
Unknown*	1 (0.4)	4 (2.2)	
Weight category			<0.001
Overweight for age*	10 (3.6)	2 (1.1)	
Normal weight for age	82 (29.8)	83 (46.6)	
Underweight for age	80 (29.1)	56 (31.5)	
Severely underweight	72 (26.2)	27 (15.2)	
Unknown	31 (11.3)	10 (5.6)	
Sex			0.005
Male	131 (47.6)	109 (61.2)	
Female	139 (50.5)	67 (37.6)	
Unknown*	5 (1.8)	2 (1.1)	
Caregiver			0.666
Mother	184 (66.9)	126 (70.8)	
Grandmother	37 (13.4)	18 (10.1)	
Father/Other	14 (5.1)	7 (3.9)	
Unknown	40 (14.5)	27 (15.2)	
Feeding history			<0.001
Exclusive breastfeeding	32 (11.6)	47 (26.4)	
No breastmilk ever	38 (13.8)	27 (15.2)	
Mixed feeding from birth	31 (11.3)	28 (15.7)	
Unknown	174 (63.3)	76 (42.7)	
Referral status			0.038
Referred	166 (60.4)	128 (71.9)	
Not referred	95 (34.5)	45 (25.3)	
Unknown	14 (5.1)	5 (2.8)	
HIV status			<0.001
Positive	84 (30.5)	25 (14.0)	
Negative	49 (17.8)	70 (39.3)	
Exposed, not positive	46 (16.7)	37 (20.8)	
Unknown	96 (34.9)	46 (25.8)	
When death occurred			0.330
Weekday (07:00-19:00	84 (30.5)	62 (34.8)	
Weeknight (19:00-07:00)	108 (39.3)	60 (33.7)	
Weekend/public holiday	77 (28.0)	48 (27.0)	
Unknown	6 (2.2)	8 (4.5)	
Main cause of death			0.002
Sepsis	40 (14.5)	45 (25.3)	
Pneumonia	56 (20.4)	20 (11.2)	
Hypovolemic shock	50 (18.2)	24 (13.5)	
Meningitis	28 (10.2)	14 (7.9)	
Other condition	87 (31.6)	74 (41.6)	
Unknown*	14 (5.1)	1 (0.6)	
Death believed preventable			<0.001
Yes	127 (46.2)	96 (53.9)	
No	20 (7.3)	17 (9.6)	
Not sure	45 (16.4)	56 (31.5)	
Unknown	83 (30.2)	9 (5.0)	
Modifiable factors†			
Delay in seeking care	97 (35.3)	64 (36.0)	
Poor assessment	47 (17.1)	67 (37.6)	
Poor management	63 (22.9)	44 (24.7)	
Poor note keeping	59 (21.4)	35 (19.7)	
Poor monitoring	32 (11.6)	29 (16.3)	

*Not included in chi-square analysis, cell with n<5
†Number (%) of patients with modifiable factor identified

Discussion

The in-hospital mortality rates in the study period were 6.4% for Hospital A, 4.5% for Hospital B and 2.7% for Hospital C, which have been steadily declining according to Child PIP data.[1] In the time period comparison performed with data from Hospitals A and B, total deaths decreased by 40% from the first 5-year time period to the second. However, across all three hospitals the largest percentage of deaths continued to occur within the first 24 hours and remained relatively static. Within the hospital system, deaths occurring within the first 24 hours of presentation to hospital ranged from 21 to 28% across the three hospitals.

The Saving Children report found the main causes of death during the first 24 hours after hospital presentation to be acute respiratory tract infections, diarrheal disease, sepsis, meningitis, and tuberculosis.[1] Hospitals within this system had similar causes of early in-hospital mortality. The leading causes of death were sepsis at Hospital A, acute gastroenteritis with shock at Hospital B, and pneumonia at Hospital C. These are all potentially preventable causes of death.[11] Mortality from these diseases is associated with poor socioeconomic circumstances and lack of basic amenities (e.g., clean running water, proper sanitation).[12] Although specific data on water access/quality and sanitation were not available, studies indicate that interventions focused on water access/ quality and sanitation reduce morbidity and mortality associated with respiratory and diarrheal illnesses.[13,14]

The majority of paediatric deaths within the hospital system were considered preventable. This suggests that there is suboptimal quality of community based services for advice and support in terms of hygiene, primary health care, and identification of danger signs. Community health workers have been found beneficial in provision of education and prevention interventions for care of neonates and children.[15,16] Clinical personnel factors, which included poor assessment and inadequate management and monitoring, were the most commonly identified modifiable factors. Training and implementation of the Integrated Management of Childhood Illness (IMCI) strategy has been found to improve health care worker performance and to reduce childhood and neonatal mortality.[17-19]

The most common single contributing factor across all three hospitals was a delay in seeking care. Many caregivers are unaware of signs and symptoms of preventable and treatable conditions.[20,21] Caregiver inability to pick up danger signs may reflect a failure of education by community caregivers and primary health care workers.[11] Late recognition of illness, and associated delay in seeking treatment, have been found to contribute to neonatal mortality.[22] A delay in getting to a healthcare facility is often a result of lack of resources due to poverty or delay in transport due to lack of ambulance services available to reach rural areas.[1] Longer duration of transport has been found to be associated with increased neonatal mortality.[23] If there is poor assessment and management of an ill child at the clinic or base hospital, as suggested by the current study, there is likely to be late referral to a regional or tertiary centre. Associated inadequate stabilization prior to transfer can result in patients potentially arriving at the referral hospital in a moribund condition, increasing the likelihood of early in-hospital mortality. Poor assessment may reflect lack of skills, training, and experience with managing paediatric emergencies, while inadequate management can be due to lack of knowledge, lack of equipment, and limited resources, all of which are unfortunately common in lower-income countries or environments.[1] Poor monitoring can result from staff shortages, lack of training about reassessment of a critically ill child, and no or limited equipment for ongoing monitoring.[1,24]

International data for early hospital morality for paediatric patients are limited. A 2004 study from Nigeria found that 40% died within 24 hours,[5] while a 2010 Nigerian study reported that 57% of deaths occurred during this early time period,[6] which is nearly double the percentage found in the current study. In a study from Kenya, 49% reportedly died within the first 24 hours of admission.[4] As in our study, the 2010 study from Nigeria found that the majority of deaths occurred due to late presentation to hospital.[6] The study from Kenya attributed many deaths to lack of backup laboratories, poor diagnostic resources, and poor supportive services (e.g., limited access to intensive care).[4] In the 2004 study from Nigeria, 37% of those dying within the first 24 hours had received no treatment from the time of admission until death.[5] In a study from Romania the factors associated with early deaths included poverty, lack of access to basic healthcare due to decreased medical and transport facilities, poor maternal education and, similar to our study, inability of parents to pick up danger signs of illness in a child.[10]

Over the years of the study there was a decrease in in-hospital mortality, with a substantial decrease in the percentage of deaths with HIV as a co-morbid condition. The fact that the number of HIV exposed children increased and the percentage with unknown status decreased likely reflects improved testing of mothers and children over the years due to an increase in the number of HIV counsellors at the primary health care and hospital level and increased public awareness and decreased stigma related to HIV disease.[25,26] There has been a marked increase in diagnostic testing and utilization of antiretroviral medications in South Africa since the implementation of the prevention of mother to child transmission (PMCT) program, first introduced in 2002.[27]

There was a decrease in the percentage of deaths among severely malnourished children over time. All hospitals use specific admission packs in paediatric units that place emphasis on categorizing the nutritional status of children, which helps to ensure proper nutritional and medical management of the child. The WHO guidelines on managing severe acute malnutrition were also implemented in all wards.[12,28] Exclusive breastfeeding practices for 6 months had improved over the years and

exclusive breastfeeding has been found to decrease the risk of diarrhea and pneumonia.[29]

Limitations

In the Child PIP mortality meetings held at the three hospitals it has been noted that many data forms are incomplete. With busy staff and under-resourced facilities, obtaining consistently accurate and reliable information can be difficult. Modifiable factors for a death have to be carefully considered by health care staff so that important contributing factors are not excluded. Additionally, data are available for deaths, but not for all patients who present to the facility. A deeper understanding of risk and modifiable factors would require a comparison of those who die with those who do not. Specific data on household members, socioeconomic characteristics, and patients' access to clean water and adequate sanitation facilities were not available. Barriers to clinic/hospital access and transport were also not explicitly ascertained.

Conclusions

The largest percentage of in-hospital deaths occurred within the first 24 hours after presentation. Of these, the largest percentage was among children aged28 daysto1 year with normal nutritional status. The number of paediatric deaths occurring within the system hospitals decreased over time. The main causes of death were consistently pneumonia, gastroenteritis with hypovolemicshock, and sepsis. HIV care has improved, with a smaller percentage of deaths occurring among children who are HIV positive. Most deaths are considered preventable, with major modifiable contributors to death being delay in seeking care, poor clinical assessment, and inadequate management and monitoring once within the healthcare system.

Improving caregiver education should have a positive impact on mortality. Strengthening local primary health care and community education are critical to provision of quality paediatric care. Community caregivers can play a significant role, through educating families about proper hygiene, sanitation, breastfeeding, immunization, identification of danger signs, and initiation of basic treatment (e.g., oral rehydration solution), and how to access the clinic or hospital timeously. All clinical personnel involved in paediatric care need to be educated about emergencies and how to manage them appropriately. Clinical triage and management should be focused on infants, who are at highest risk of illness and mortality.

Recommendations

Based upon the modifiable contributors to death noted in the study, and data from the literature, the following are provided as potential interventions to improve health outcomes for patients in less-resourced settings.

1) Given the primary causes of death noted in the present study, improve patient access to basic amenities like water, sanitation and hygiene based on their association with morbidity and mortality from respiratory and diarrheal illnesses.[12-14]
2) As delay in seeking care may reflect issues of access, improve the ratio of community caregivers and primary health care facilities to the population and ensure that ambulance services are accessible to rural communities.[1,11,16,23]
3) Ensure training of paediatric staff with Emergency Triage Assessment and Treatment (ETAT) and IMCI; practitioners need to be confident in identifying, assessing, and managing ill children,[17-19,30-31] and nursing staff who have the first encounter with children need to be able to triage and start appropriate initial management.[30-32]
4) Focus training on emergency triage and management on infants less than 1 year of age who are at highest risk of illness and mortality.
5) Improve handoff communication - there needs to be a seamless continuum of care for patients once stabilized, which includes ongoing monitoring and reassessment,[8,33] as indicated by commonly identified problems with note keeping and patient monitoring.
6) Ensure staffing issues are promptly addressed to improve management and monitoring of critically ill patients.[24]

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