

Decreased under 5 mortality and improved in-hospital clinical care after ETAT+ training and implementation at a pediatric emergency unit in Eastern Uganda: a quasi- experimental study

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Abstract

Background

At 52 deaths per 1000 live births, the burden of under 5 mortality in Uganda is more than twice the sustainable development goal target of 25 deaths per 1000 live births by 2030. The high under 5 mortality in Uganda could be attributed to unsupervised implementation of life-saving guidelines. We aimed to evaluate the effect of Emergency Triage Assessment and Treatment Plus admission care (ETAT+) guidelines refresher training and its implementation on clinical care, mortality, and length of hospital stay among children under five years.

Methods

We conducted a quasi-experimental study from September to October 2024 as the pre-implementation phase. Health care workers underwent a three-day refresher training in the ETAT+ guidelines. During the implementation phase we ensured availability of supplies to do emergency assessment. We collected data from November to December 2024 during the post-implementation phase. We compared in-hospital clinical care, mortality and duration of in-hospital stay among children under 5 years between the pre and post-implementation periods. We conducted generalized linear regression models of the binomial family with a log link and robust variance estimation to estimate prevalence ratios.

Results

We enrolled 1402 children, 696 during the pre-implementation phase and 707 during the post implementation phase. The intervention was associated with an increase in the likelihood of children having emergency vitals and investigations done and documented after the training: temperature [Adjusted Prevalence Ratio (APR) 3.93, 95% Confidence Interval (CI) (3.45–4.49) $p < 0.001$], oxygen saturation [APR 3.56, 95% CI (3.04, 4.15) $p < 0.001$], malaria-test [APR 1.33, 95% CI (1.26, 1.41) $p < 0.001$], hemoglobin estimation [APR 1.81, 95% CI (1.56, 2.12) $p < 0.001$]. The intervention was also associated with children being less likely to have a prolonged hospital stay [APR 0.88, 95% CI (0.85, 0.91) $P < 0.001$]. The intervention was not associated with significant differences in mortality [APR 0.71, 95% CI (0.37, 1.36) $p = 0.300$].

Conclusion

ETAT+ training and implementation was associated with improved clinical care and outcomes among children under five years. We recommend regular refresher ETAT+ trainings and implementation of ETAT+ guidelines at pediatrics emergency units. Given our study design, our findings are only suggestive of association and not causation, and need to be interpreted with caution.

Clinical trial number

: not applicable.

Background

The Emergency Triage Assessment and Treatment Plus admission care (ETAT+) guidelines were developed and adopted by the world health organization (WHO) to guide triage and management of very sick children under 5 years in low resource settings more than 20 years ago (1, 2). This training puts emphasis on appropriate triage, management and categorization of a child as having emergency signs, priority signs or non-urgent signs (1).

Despite the adoption and launch of ETAT+ guidelines in Uganda in 2010, the under-five mortality is still unacceptably high at 52 deaths per 1000 live births (3). This mortality rate is more than twice the sustainable development goal target to reduce under 5 mortality to 25 deaths per 1000 live births by 2030 (4). Evidence suggests that most of these deaths are preventable if the WHO case management clinical guidelines are adhered to (1). Some of the reasons for the persistently high under five mortality in Uganda could be inadequate training of staff and unsupervised or suboptimal implementation of the ETAT+ guidelines. Challenges to implementation of ETAT+ guidelines in other low resource settings include: shortage of staff, supplies, low knowledge and skills among health workers, poor attitude of health workers (5, 6). Various studies in developing countries have shown significant improvement in clinical outcomes and reduction of up to 45% in mortality of children admitted at the pediatrics emergency unit after appropriate implementation of ETAT guidelines (7–10).

However, since the launch of ETAT+ guidelines in Uganda, hardly any studies have been done to assess for impact of implementation of ETAT+ guidelines at pediatrics emergency units. We aimed to evaluate the effect of ETAT+ refresher training and its implementation on clinical care, mortality, and length of hospital stay among children under five years admitted to the pediatrics emergency unit at Mbale Regional Referral Hospital.

Methods

Study design and study setting

We conducted a pre and post-intervention quasi-experimental study between 1st September and 20th December 2024. The study was conducted at the pediatrics emergency unit of Mbale Regional Referral hospital in eastern Uganda. Mbale regional referral hospital is a busy hospital in eastern Uganda with a

catchment population of over 4–5 million people. It is the main referral center for the four district hospitals and ten health sub-districts in and around the Elgon sub-region. The pediatrics emergency unit is the ward where critically ill children are initially admitted and stabilized. Most of them are transferred to the general pediatrics ward after 24 hours for continued care. The pediatrics emergency department admits children aged one month and above, neonates are admitted directly to the neonatal unit. The unit receives about 10000 admissions annually and most admissions are due to severe malaria and its complications, complications of sickle cell disease, diarrhea with dehydration, pneumonia and severe acute malnutrition and its complications. At the time of the study, the emergency unit and general pediatrics ward were being run by two pediatricians, one medical officer, two clinical officers, 8 intern doctors, 8 senior house officers and 15 nurses.

Prior to the implementation of the ETAT+ guidelines during the study, the front-line health workers routinely saw patients on first come first served basis, except for a few cases where a child was obviously very ill at admission. Only personal thermometers were available for use and were dependent on the owner being on duty. There was only one pulse oximeter on the emergency unit which was not often in use due to unreliable supply of batteries. Malaria rapid diagnostic tests and hemoglobin estimation was done in the laboratory if supplies were in stock.

Clinical trial number

not applicable.

Study population

We enrolled children aged 1 to 60 months admitted to the pediatrics emergency unit with either an emergency or priority sign during the study period. Emergency signs included: obstructed or difficulty in breathing, central cyanosis, cold hands with capillary refill > 3s, weak and fast pulse or slow pulse, coma, convulsions or confusion, diarrhea or vomiting with severe dehydration (11). Priority signs included: Tiny baby, fever, severe trauma or other surgical need, major burns, severe pallor, poisoning, restlessness or lethargy, respiratory distress, urgent referral, severe acute malnutrition or edema of both feet (11). The inclusion criteria were the same during the pre and post implementation period.

Sample size estimation and sampling

We expected a 12% decrease in overall mortality from comparable to a study done in Malawi in a similar setting (8). The under-5 mortality prior to the beginning of the study was 5.5% as per the hospital records. Using the Open Epi calculator, we calculated a sample size of 624 children in each period (12, 13). Participants were recruited by consecutive sampling until the required sample size was reached.

Study procedure

During the pre-implementation phase, we reviewed patient files of all children aged ≤ 5 years admitted to the emergency pediatrics unit from September 2024 to October 2024. We collected information on whether emergency vital signs and investigations were performed for each patient. The emergency vital signs included temperature, pulse, respiratory rate, and oxygen saturation, while the emergency tests included hemoglobin estimation and a malaria test. We also captured the length of hospitalization and outcome at discharge. We also captured the emergency or priority signs that the patient presented with. The WHO emergency signs include central cyanosis, weak, fast, slow (below 60 beats per minute), or absent pulse among others. The priority signs include tiny baby infants below two months), urgent referral and respiratory distress among others (11). After the pre-implementation phase, all front-line health care workers underwent a refresher training on the ETAT+ guidelines. Similar data were then collected during the post implementation phase from November 2024 to December 2024.

ETAT+ training

Front line health workers (nurses, doctors, interns, clinical officers and senior house officers) were trained by nationally certified trainers for three days. The training was in accordance with the recommended WHO guidelines on emergency triage assessment and treatment (1). Nationally certified trainers facilitated theoretical sessions such as: triage, resuscitating a collapsed child, managing dehydration, shock, hypoglycemia, and malaria. The practical sessions included: use of an inhaler, intraosseous access, use of an infusion pump, how to operate a hemocue and color-coding during triage.

ETAT+ implementation

During the implementation period, color coded wrist bands were provided and used to triage participants (red-emergency sign, yellow-priority sign, green-neither emergency nor priority sign). A research assistant ensured equipment and sundries for conducting emergency vitals and investigations were available for use during the implementation phase. Equipment used included: a pulse oximeter, a thermometer, a hemocue and malaria rapid diagnostic tests. The equipment was made available on the ward to enable point of care tests to be done. There was no other concurrent intervention at the time of implementation of the study.

Data collection and management

Two trained research assistants, who were medical officers, reviewed medical records and extracted data using a standardized questionnaire designed in the Kobo toolbox (<https://www.kobotoolbox.org/>) on password protected phones. Kobo Toolbox is an open-source software developed by the Harvard Humanitarian Initiative with support from United Nations agencies, CISCO, and partners to support data management by researchers and humanitarian organizations. The servers are secure and encrypted with strong safeguards and protection against data loss. The principal investigator would review the entries daily to ensure data quality and completeness. We collected data on sociodemographic characteristics, medical examination, investigation and outcome at discharge.

Outcomes

Our primary outcome was inpatient mortality: defined as death during in hospital admission.

All deaths were confirmed by the doctor on duty, and a Ministry of Health death notification form was filled. Secondary outcomes were emergency vitals taken (oxygen saturation, temperature, pulse rate, respiratory rate), emergency investigations done (malaria test, hemoglobin estimation) and prolonged duration of hospital stay defined as greater than 5 days (14–17).

Data analysis

We analyzed data in Stata version 18.0 (StataCorp; College Station, TX, USA). Data were compared descriptively, using frequencies and percentages for categorical variables and means, standard deviations, medians and ranges for continuous variables. Pearson's Chi-square test or Fisher's exact test were used to test for proportion differences for categorical variables, while the independent t-test was used to compare group means for continuous variables. We conducted generalized linear regression models of the binomial family with a log link and robust variance estimation to estimate prevalence ratios of the different outcomes before and after the intervention; adjusting for baseline characteristics that were different between the two groups: age of child, urgent referral status, coma or convulsion, fever, severe pallor, and respiratory distress as confounders.

Results

Between September 2024 and October 2024, a total of 1589 children were admitted to the pediatrics emergency unit during the pre-implementation phase and 1292 children were admitted from November 2024 to December 2024 during the post-implementation phase.

During the pre-implementation period, 970 children under 5 years were admitted to the acute care unit; 696 children were included in this study (Fig. 1). During the post-implementation phase, 895 children under 5 years were admitted to the acute care unit, 707 children were included in this study. The reasons for exclusion included having neither an emergency nor priority sign.

Socio-demographic characteristics of the participants

The participants recruited in the pre- and post- implementation phases had similar socio-demographic characteristics (Table 1). More than half of the children were infants (1-24 months) 61% (861/1403), male 57.4% 805/1403 and being taken care of by the mother 79.1% (1,110/1403). The mean age of the children was 24.9 months (SD 18.4), pre-implementation 26.1 months (SD 18.8), post-implementation 23.7months (SD 17.8), t test 0.012.

Table 1. Socio-demographic characteristics of children ≤ 60 months of age admitted at the pediatrics emergency unit at a regional referral hospital in Eastern Uganda				
	Pre-implementation	Post implementation	Total	χ ² Test
	N (%)	N (%)	N (%)	
	696 (49.6)	707 (50.4)	1,403 (100.0)	
Age in months				
Infant (1- 24)	404 (58.0)	457 (64.6)	861 (61.4)	0.024
Toddler (25 to 36)	102 (14.7)	98 (13.9)	200 (14.3)	
Preschool (37-60)	190 (27.3)	152 (21.5)	342 (24.4)	
Order of birth				
First born	162 (23.3)	168 (23.8)	330 (23.5)	0.067
Second born	164 (23.6)	197 (27.9)	361 (25.7)	
Third born	141 (20.3)	109 (15.4)	250 (17.8)	
Fourth born or older	229 (32.9)	232 (32.9)	461 (32.9)	
Sex				
Female	279 (40.1)	319 (45.1)	598 (42.6)	0.057
Male	417 (59.9)	388 (54.9)	805 (57.4)	
Relationship of caregiver				
Father	74 (10.6)	62 (8.8)	136 (9.7)	0.679
Grand parent	55 (7.9)	55 (7.8)	110 (7.8)	
Mother	543 (78)	567 (80.2)	1,110 (79.1)	
Other	24 (3.4)	23 (3.3)	47 (3.3)	
Referral				
No	385 (55.3)	452 (63.9)	837 (59.7)	0.001
Yes	311 (44.7)	255 (36.1)	566 (40.3)	
*Referring facility				
District Hospital	36 (11.6)	16 (5.9)	51 (9)	0.122
Health center III	24 (7.7)	18 (7.1)	42 (7.4)	
Health center IV	203 (65.3)	181 (71.3)	384 (68)	
Private clinic	48 (15.4)	40 (15.7)	88 (15.6)	

*N=566 for referring facility χ² test - Pearson's Chi-squared test

Clinical presentation of the participants

Most of the presenting complaints of the children recruited during the pre and post implementation phases of the study were similar as presented in Table 2 and Table 3. Most of the children had a priority sign as the main presenting complaint 67.2% (943/1403). The most common presenting complaints were fever 95.0% (1,333/1403) and lethargy 51.4% (721/1403).

Table 2. Clinical presentation of children ≤ 60 months of age with emergency signs at admission to the pediatrics emergency unit at a regional referral hospital in Eastern Uganda				
	Pre-implementation N (%) 696 (49.6)	Post implementation N (%) 707 (50.4)	Total N (%) 1,403 (100.0)	χ² Test
Only emergency sign	17(2.4)	6(0.8)	23(1.6)	0.053
Both emergency and priority sign	220(31.6)	217(30.7)	437(31.1)	
Only priority sign	459(65.9)	484(68.5)	943(67.2)	
Obstructed or difficulty in breathing or fast breathing				
Not present	605 (86.9)	612 (86.6)	1,217 (86.7)	0.841
Present	91 (13.1)	95 (13.4)	186 (13.3)	
Central cyanosis				
Not present	692 (99.4)	704 (99.9)	1,396 (99.6)	0.174
Present	4 (0.6)	1 (0.1)	5 (0.4)	
Cold hands with capillary refill > 3 seconds,				
Not present	691 (99.3)	704 (99.6)	1,395 (99.4)	0.465
Present	5 (0.7)	3 (0.4)	8 (0.6)	
Weak and fast pulse, slow (<60) or absent pulse.				
Not present	692 (99.6)	706 (99.9)	1,398 (99.7)	0.308
Present	3 (0.4)	1 (0.1)	4 (0.3)	
Coma, Convulsion/ Confusion				
Not present	573 (82.3)	654 (92.5)	1,227 (87.5)	<0.001
Present	123 (17.7)	53 (7.5)	176 (12.5)	
Diarrhea / vomiting with Sunken eyes- Severe dehydration				
Not present	610 (87.8)	622 (88)	1,232 (87.9)	0.905
Present	85 (12.2)	85 (12.0)	170 (12.1)	

χ² test - Pearson's **Chi-squared test**

Table 3. Clinical presentation of children ≤ 60 months of age with priority signs at admission to the pediatrics emergency unit at a regional referral hospital in Eastern Uganda				
	Pre-implementation N (%) 696 (49.6)	Post implementation N (%) 707 (50.4)	Total N (%) 1,403 (100.0)	χ² Test
Tiny infant: any sick child less than 2months				
Not present	681 (97.8)	697 (98.7)	1,378 (98.3)	0.204
Present	15 (2.2)	9 (1.3)	24 (1.7)	
Temperature (Fever)				
Not present	48 (6.9)	22 (3.1)	70 (5.)	0.001
Present	648 (93.1)	685 (96.9)	1,333 (95)	
Severe Trauma or other urgent surgical need				
Not present	695 (99.9)	705 (100)	1,400 (99.9)	0.314
Present	1 (0.1)	0 (0)	1 (0.1)	
Major burns				
Not present	696 (100)	707 (100)	1,403 (100)	.
Severe pallor				
Not present	469 (67.5)	563 (79.6)	1,032 (73.6)	<0.001
Present	226 (32.5)	144 (20.4)	370 (26.4)	
Poisoning				
Not present	692 (99.4)	707 (100)	1,399 (99.7)	0.044
Present	4 (0.6)	0 (0)	4 (0.3)	
Restless and irritable or lethargic				
Not present	348 (50)	334 (47.2)	682 (48.6)	0.301
Present	348 (50)	373 (52.8)	721 (51.4)	
Respiratory distress				
Not present	554 (79.6)	604 (85.4)	1,158 (82.5)	0.004
Present	142 (20.4)	103 (14.6)	245 (17.5)	
Urgent referral				
Not present	382 (55)	476 (67.4)	858 (61.2)	<0.001
Present	313 (45)	230 (32.6)	543 (38.8)	
Severe acute malnutrition / Edema of both feet.				
Not present	660 (95.1)	668 (94.5)	1,328 (94.8)	0.603
Present	34 (4.9)	39 (5.5)	73 (5.2)	

χ² test - Pearson's **Chi-squared test**

Effect of ETAT+ refresher training on completeness of taking vitals during patient examination at admission

During the post-implementation period, more children had oxygen saturation measured and documented (83.3% vs 24.9%). More children had their temperature (88.8% vs 24.3%), pulse rate (78.9% vs 18.0%) and respiratory rates (15.7% vs 7.3%) taken at admission during the post implementation phase in comparison with the pre-implementation phase). Children admitted during the post implementation phase were 3.93 times as likely to have their temperature [95% Confidence Interval (CI) (3.45,4.49): p value (p)<0.001], oxygen saturation [3.56 95% CI (3.04,4.15) p<0.001], pulse rate [4.58 95% CI (3.89,5.39) p<0.001]and respiratory rate [2.47 95% CI (1.76,3.47) p<0.001] taken and documented at admission as compared to children admitted during the pre-implementation phase. Details are presented in figure 2 and Table 4.

Effect of ETAT+ refresher training on doing emergency investigations at admission

More children had a malaria test done and documented during the post-implementation period (88.5% vs 69.1%). More children had a hemoglobin estimation done at admission (91.0% vs 50.4%). Children presenting with pallor were 1.8 times as likely to have a hemoglobin estimation test done and documented at admission during the post implementation phase [adjusted prevalence ratio (APR) 1.8: 95% CI (1.56,2.12) p<0.001]. Details are presented in Figure 2, Figure 3 and Table 4.

Effect of ETAT+ refresher training on patient outcomes: mortality and duration of hospital stay

In patient mortality reduced by 61.8% during the post implementation phase (5.5% vs 2.1%) and, prolonged hospital stay reduced by 65% (29.7% vs 10.4%). The mean hospital stay during the post implementation period was shorter as compared to the pre-implementation phase [5.7 days (SD 6.33) vs 3.9 days (SD 1.78)]. Children admitted during the post-implementation were 12% less likely to stay in hospital for more than 5 days [APR 0.88: 95% CI (0.85,0.91) p<0.001 and 29% less likely to die [APR:0.71, 95% CI (0.37,1.36) p=0.300] as compared to children admitted during pre-implementation period. The proportion of children with reduced hospital stay was significant for children discharged alive, there was no significant difference in hospital stay for children who died. Details are presented in Figure 4, Figure 5 and Table 4.

Table 4. Effect of ETAT+ refresher training on taking of patient vitals, emergency investigations and patient outcomes of children ≤ 60 months of age admitted at the pediatrics emergency unit at a regional referral hospital in Eastern Uganda

	Pre-implementation phase N (%)	Post-implementation phase N (%)	CPR	95% CI	P-value	APR	95% CI
	696 (49.6%)	707 (50.4%)					
Oxygen saturation taken							
No	358 (75.1%)	118 (16.7%)					
Yes	119 (24.9%)	589 (83.3%)	3.34	(2.85,3.92)	<0.001	3.56	(3.04,4.15)
Temperature taken							
No	527 (75.7%)	79 (11.2%)					
Yes	169 (24.3%)	626 (88.8%)	3.66	(3.20,4.18)	<0.001	3.93	(3.45,4.49)
Pulse rate taken							
No	569 (82.0%)	149 (21.1%)					
Yes	125 (18.0%)	558 (78.9%)	4.38	(3.72,5.16)	<0.001	4.58	(3.89,5.39)
Respiratory rate taken							
No	645 (92.7%)	595 (84.3%)					
Yes	51 (7.3%)	111 (15.7%)	2.15	(1.57,2.94)	<0.001	2.47	(1.76,3.47)
Malaria test done							
No	215 (30.9%)	81 (11.5%)					
Yes	481 (69.1%)	626 (88.5%)	1.28	(1.21,1.36)	<0.001	1.33	(1.26,1.41)
*Hemoglobin Estimation							
No	112 (49.6%)	13 (9.0%)					
Yes	114 (50.4%)	131 (91.0%)	1.80	(1.57,2.073)	<0.001	1.81	(1.56,2.12)
*Total length of stay	5.7 days (sd 6.33)	3.9 days (sd 1.78)					
5 days or less	499 (72.0%)	633 (89.5%)					
More than 5 days	194 (28.0%)	74 (10.5%)	0.86	(0.83,0.89)	<0.001	0.88	(0.85,0.91)
Outcome at discharge							
Alive	658 (94.5%)	692 (97.9%)					
Dead	38 (5.5%)	15 (2.1%)	0.39	(0.22,0.70)	0.002	0.71	(0.37,1.36)

Outcomes adjusted for age of child, presenting complaint and referral status CPR: Crude Prevalence Ratio APR: Adjusted Prevalence Ratio

*Hemoglobin estimation analyzed for patients who presented with pallor (N=370) *Total length of stay 3 missing

Discussion

The ETAT+ training and implementation was associated with improved patient care and in-hospital patient outcomes during the post implementation period. During the implementation, we used a multifaced approach by addressing the gaps in knowledge, skills, resources, and organization of care to ensure successful implementation of ETAT+ guidelines. There was an associated increase in proportion of patients who had emergency vitals and investigations done and documented. There was also an associated reduction prolonged hospital stay. The difference in in-hospital mortality was not significant.

Effect of ETAT+ refresher training and implementation on patient care: doing emergency vitals and investigations done

The ETAT+ training and implementation was associated with a higher proportion of children had emergency vitals and investigations done during the post implementation period. This can be attributed to improved knowledge and skills among the front-line health workers after the ETAT+ training. The training emphasized the need and importance of doing emergency signs and vitals for children admitted to the emergency department. During the implementation period, the research assistants ensured availability of supplies to do emergency vitals (pulse oximeter, thermometer) and investigations (malaria rapid diagnostic tests, hemocue). The availability of tools, enabled the health workers take emergency vitals and do emergency investigations. We recommend for increased vigilance in ensuring availability of hospital equipment as well as drafting budget lines to replace any equipment that breaks down or supplies that run out of stock. This will ensure sustainability of improved patient care. Our findings are similar to a study in Kenya which found improved patient care after supervised implementation of World Health Organization clinical guidelines (18). Other studies in Sierra Leone have also reported improved patient care following implementation of ETAT+ guidelines (19). This can be attributed to the similar health care systems in Africa, facing similar needs that are addressed by effective implementation of lifesaving guidelines.

Effect of ETAT+ refresher training and implementation on in patient outcomes: mortality and hospital stay

Improved in-patient outcomes marked by a 62.5% decline in prolonged hospital stay was associated with the post implementation phase. The better patient outcomes can be attributed to the fact that following ETAT+ refresher training, frontline health workers were equipped with knowledge and also understood the need for emergency triage which they implemented. Improved knowledge and availability of supplies also enabled prompt diagnosis and appropriate management of very sick children hence reduced in-hospital stay. Our findings are similar to other studies in low resource settings which have also reported associated decreased mortality and duration of hospital stay following implementation of ETAT+ guidelines (10, 20). Similar findings have also been reported in Sierra Leone (19), Malawi (8) and Mozambique (21). Our findings support the need for continuous medical education inform of trainings followed up with supervised implementation. These are low cost but high impact solutions to some of the poor in patient outcomes in our setting.

The observed reduction in mortality between phases was not significant. This is likely attributable to the relatively small number of deaths recorded during both study periods, which limited the statistical power of our analysis to detect a true difference in mortality between phases. Consequently, while our findings suggest a potential trend toward lower mortality in Phase 2, larger studies with greater numbers of outcome events would be needed to confirm whether this represents a genuine effect.

Strengths and limitations

To the best of our knowledge, this is the first study conducted in Uganda, to assess the effect of training and implementation of ETAT+ guidelines on pediatric patient care and outcomes. A key limitation was that ensuring the availability of supplies needed to perform emergency vital sign assessments and investigations may have influenced our findings, as improvements in documented care could partly reflect changes in resource availability rather than the training intervention alone. Due to limited funding, we were not able ensure sustainability of the supervised implementation of ETAT+ guidelines after the study. Additionally, since data were collected immediately after the refresher training, our results can neither reflect sustainability nor long term impact of the refresher training. Finally, this was a single site study, so our findings may not be generalizable to the wider paediatric population in Uganda.

Risk of bias assessment

As a quasi-experimental before-and-after study without a concurrent control group, our findings are susceptible to several sources of bias inherent to this design, which must be considered when interpreting the observed improvements in patient care and outcomes.

Observer bias

We cannot rule out observer bias (22), since the research assistants who collected the data were fully aware of the study protocol and the respective study periods. Knowledge of which phase a patient file belonged to may have unconsciously influenced how research assistants recorded or interpreted documentation of vital sign assessments and clinical management, potentially inflating the apparent improvement in the post-implementation phase.

Hawthorne effect

Our findings may also be partly explained by the Hawthorne effect (23), as staff on the wards were aware, following the training, that patient files would subsequently be reviewed to assess improvements in patient care and management. This awareness may have prompted clinicians to more consistently document or perform vital sign assessments simply

Concurrent intervention

There was no formal, planned concurrent intervention targeting under-five mortality at the pediatric emergency unit during the study period. However, we cannot rule out other interventions that may have been ongoing concurrently in the community, at pre-referral health centers, or elsewhere within the hospital, which could have independently contributed to the observed improvements in patient outcomes.

Maturation

Improvements observed in the post-implementation phase may partly reflect maturation effects rather than a true intervention effect. Specifically, our findings could be attributed to interns and other clinical staff acquiring greater clinical skill, confidence, and familiarity with emergency pediatric care over time, independent of the ETAT+ training itself. Since data were collected immediately after the refresher training, we are unable to disentangle the effect of the intervention from this natural progression of clinical experience.

Regression to the mean

If the pre-implementation phase happened to capture a period of unusually poor performance in vital sign assessment or patient outcomes, the subsequent improvement observed in the post-implementation phase could partly reflect a statistical regression toward the mean, rather than a genuine and sustained effect of the ETAT+ training.

Differences in measurement tools/methods

We did not identify any changes in the equipment or tools used to assess vital signs (e.g., thermometers, pulse oximeters) between the two phases; however, any undocumented changes in equipment availability, calibration, or measurement technique between phases could have contributed to differences in the frequency or accuracy of vital sign documentation, independent of the training intervention.

Seasonality

The pre- and post-implementation phases occurred in immediate succession, during which weather patterns were similar; we therefore consider it unlikely that seasonal variation in disease patterns (e.g., malaria, respiratory illness) meaningfully influenced our results.

Case-mix differences

The patient populations in the pre- and post-implementation periods were not identical. Several markers of illness severity, including coma, pallor, respiratory distress, and urgent referral status, differed significantly between the two groups. This raises the possibility that patients in the post-implementation period were, on average, less critically ill than those in the pre-implementation period, which could account for some of the observed improvement in outcomes independent of the ETAT+ intervention. Consequently, our results should be interpreted with caution, and the adjusted analyses accounting for these differences in case-mix should be considered more reliable than crude, unadjusted comparisons.

All in all, these potential sources of bias mean that while our findings are suggestive of an association between ETAT+ implementation and improved pediatric emergency care processes, a causal effect on mortality cannot be firmly established given the absence of a concurrent control group and the presence of these competing explanations.

Conclusion

This study demonstrates that training and ensuring implementation of ETAT+ guidelines is associated with improved clinical care and results in better patient outcomes. We recommend regular refresher training and supervised implementation of ETAT+ guidelines at similar pediatrics emergency units. We also recommend further studies with more robust study designs to assess the impact of implementing ETAT+ guidelines in our setting.

Abbreviations

APR: Adjusted Prevalence Ratio

CI: Confidence Interval

ETAT+: Emergency Triage Assessment and Treatment Plus admission care

MRRHREC: Mbale Regional Referral Hospital Research and Ethics Committee

SD: Standard Deviation

WHO: World Health Organization

Declarations

Human Ethics and Consent to Participate

Ethical approval was obtained from Mbale regional referral hospital research and ethics committee, approval number MRRHREC-OUT-011/2020. We obtained a waiver of consent from the research and ethics committee to review patient records during the study period.

All study methods were performed in accordance with the relevant guidelines and regulations as stated in the Declaration of Helsinki.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

JW and OF conceived the idea, drafted part of the manuscript, and interpreted the results. FO, RN, JO, and DM performed the analysis, and interpreted the results. JA, MC, AN, JO, EN, MN, AN, MWM, POO, SK drafted part of the manuscript, and reviewed and drafted the subsequent versions. All authors have read and agreed to the final version of the manuscript.

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Figures

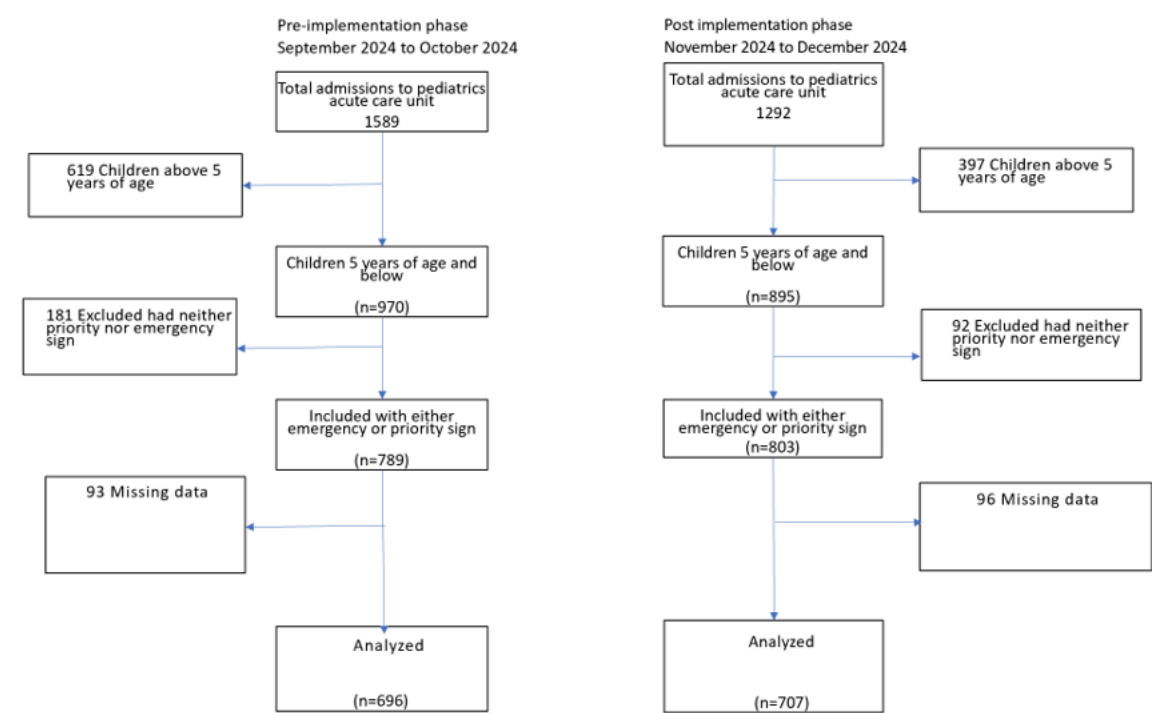


Figure 1

Flow diagram of the study participants admitted at the pediatrics acute care unit at a regional referral hospital in Eastern Uganda

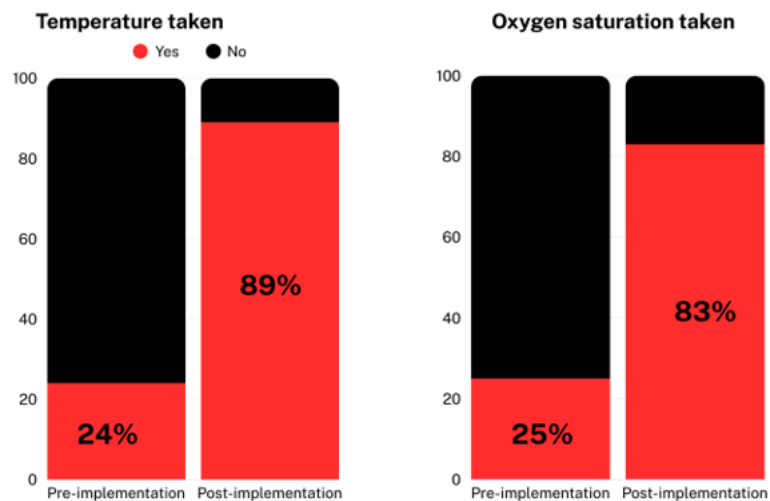


Figure 2

A Stacked box plot showing proportion of children ≤ 60 months of age who had emergency vitals taken at admission before and after ETAT+ refresher training at a regional referral hospital in Eastern Uganda

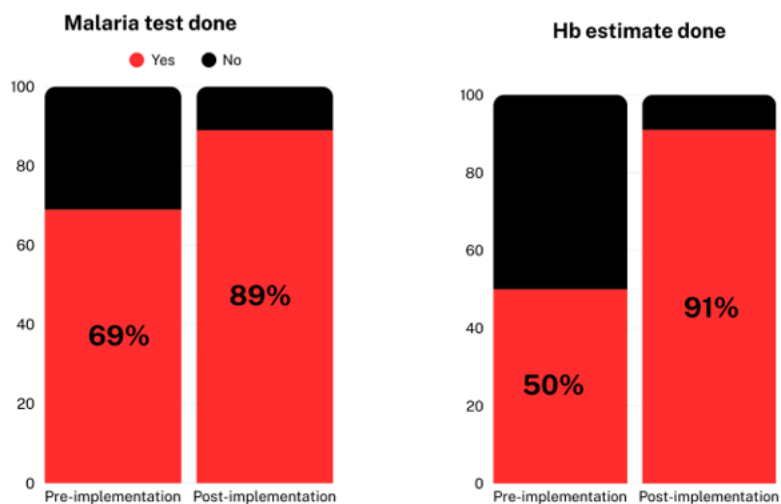


Figure 3

A Stacked box plot showing proportion of children ≤ 60 months of age who had emergency investigations done at admission before and after ETAT+ refresher training at a regional referral hospital in Eastern Uganda

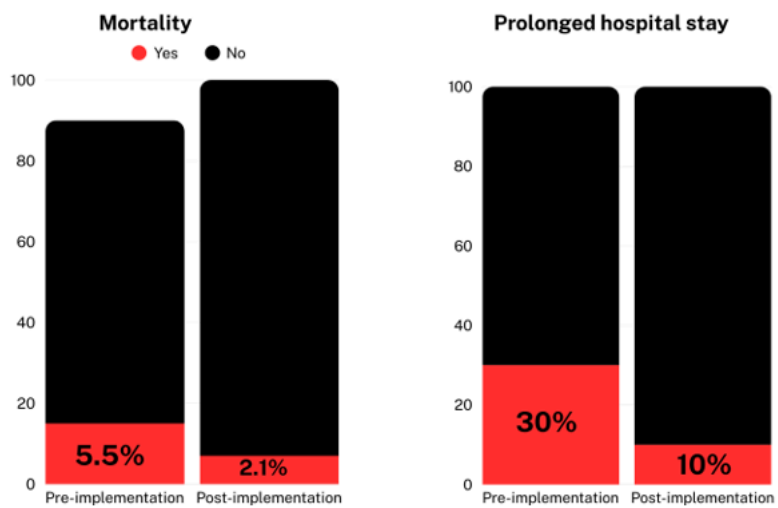


Figure 4

A stacked box plot showing proportion of children ≤ 60 months of age who died or had prolonged hospital stay before and after ETAT+ refresher training at a regional referral hospital in Eastern Uganda

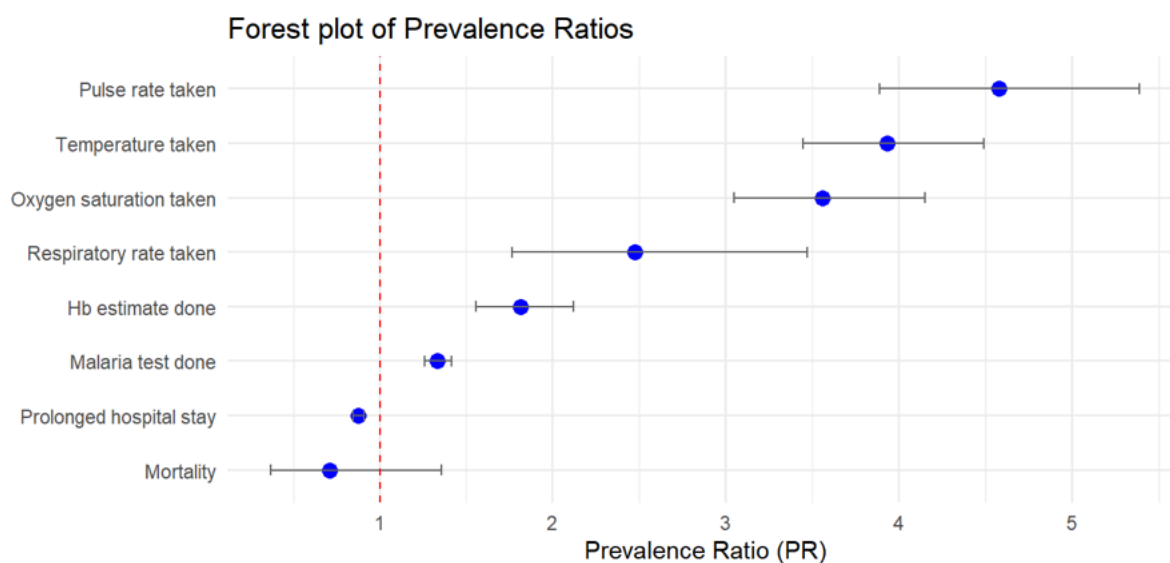


Figure 5

A forest plot showing likelihood of having emergency vitals taken and investigations done as well as poor outcomes among children ≤ 60 months of age at a regional referral hospital in Eastern Uganda before and after ETAT+ refresher training