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Level of Readiness and Availability of Essential Emergency Critical Care (EECC) Resources in Emergency Units in Addis Abeba City - A cross-sectional observational study

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Abstract

Background: Access to healthcare remains limited in many low-middle income countries. Ethiopia has a rapidly developing healthcare system but still has areas that require improvement. Essential emergency critical care (EECC) was developed as a concept to provide available and cost-effective care in resource constrained settings. The current level of EECC resources in Ethiopia is unknown.

Purpose: The primary aim was to determine the current level of EECC resources in emergency departments in Addis Abeba, Ethiopia. The secondary aim was to determine if there was a correlation between facility-level availability of EECC resources and bedside-level readiness of EECC resources.

Method: A cross-sectional observational study was conducted in Addis Abeba, Ethiopia. Twentynine emergency departments from 19 hospitals were included. The hospitals were from different tiers to provide a representative result; eight primary, five secondary and six tertiary hospitals were included. Data was collected using a modified version of the EECC rapid healthcare facility assessment tool. Facility-level availability assessed whether staff reported EECC items as available somewhere within the hospital, while bedside-level readiness assessed whether items were functional, and available in sufficient quantity within the emergency department.

Results: Facility-level availability were similar across all hospital types, with mean scores of 87% for primary, 85% for secondary and 88% for tertiary hospitals. Bedside-level readiness showed larger variation, with mean scores of 39% for primary, 65% for secondary and 66% for tertiary hospitals. A weak correlation between facility-level availability and bedside-level readiness was found in primary hospitals.

Conclusion: Facility level-availability was similar across hospital levels. Beside-level readiness showed a larger heterogeneity, secondary and tertiary hospitals showed similar results, primary hospitals showed weaker results. There was a weak correlation between facility-level availability and bedside-level readiness in primary hospitals. The results indicates that bedside-level readiness is a more reliable predictor of preparedness for EECC than facility-level availability.

Populärvetenskaplig sammanfattning på svenska

Tillgång till grundläggande sjukvård är fortfarande otillräcklig i många låg- och medelinkomstländer. Etiopien har ett sjukvårdssystem som utvecklas snabbt men det finns fortfarande områden som är i behov av förbättring. Essential emergency critical care (EECC) har utvecklats som ett koncept för att kunna erbjuda basal och livräddande akutsjukvård i en lågresursmiljö. Den primära frågeställningen var att kartlägga den nuvarande nivån av EECC-resurser på akutmottagningar i Addis Abeba. Den sekundära frågeställningen syftade till att undersöka ifall det fanns något samband mellan nivåerna av de undersökta variablerna Facility-level availability och Bedside-level readiness.

En tvärsnittsstudie genomfördes i Addis Abeba, Etiopien. Tjugosju akutmottagningar ifrån 19 olika sjukhus inkluderades. Sjukhus ifrån alla sjukhusnivåer inkluderades för att få ett representativt urval. Åtta länsdelssjukhus, fem länssjukhus och sex universitetssjukhus inkluderades i studien. Data samlades in med en modifierad version av EECC rapid healthcare facility assessment tool. Två variabler studerades. Facility-level availability utvärderar om en resurs finns tillgänglig någonstans på sjukhuset genom att fråga personalen. Bedside-level readiness utvärderar om en resurs finns tillgänglig på akutmottagningen, i tillräckligt antal, om den fungerar och alltid är tillgänglig för personalen.

Facility-level availability visade liknande resultat för alla sjukhustyper med genomsnittliga värden på 87% för länsdelssjukhus, 85% för länsdelssjukhus och 88% för universitetssjukhus. Bedside-level readiness visade större variation med ett genomsnittligt värde på 39% för länsdelssjukhus, 65% för länssjukhus och 66% för universitetssjukhus, och det var endast på länssjukhusen som det fanns en korrelation mellan availability och readiness.

Facility-level availability var liknande för alla sjukhus. Bedside-level readiness visade mer skiljande resultat. Länssjukhus och universitetssjukhus visade liknande resultat medans länsdelssjukhus visade lägst resultat Alla sjukhus nådde högre nivåer för facility-level availablity än bedside-level readiness. Vi fann en svag korrelation mellan facility-level availability och bedside-level readiness, dock endast för primary hospitals. Resultaten visar att bedside-level readiness sannolikt är ett bättre mätvärde för att förutsäga beredskap för EECC än facility-level availability.

Background

The provision of critical care is a global issue and can affect patients in all healthcare settings across the world. Ensuring adequate access to critical care is a challenge in many settings but is especially pronounced in low- and middle-income countries (LMIC).

Essential emergency critical care (EECC) is an evidence-based approach to delivering critical care in resource restrained settings that aims at delivering critical care in a cost efficient and available manner (1). EECC was developed through a Delphi process that included 269 clinical experts from 59 different countries. The initiative agreed upon 40 clinical processes and 66 requirements for providing EECC (2). The focus of EECC is to prioritize full implementation of basic technology and interventions as well as improving human resources within for example triage and monitoring of patients, to be able to detect and treat critical illness early and in a cost-efficient manner. All items and resources included in EECC are considered to be essential and all are needed to be fully prepared to care for critically ill patients.

Critical illness is common in Sub-Saharan Africa, one study concluded that 12.5% of all hospitalized patients across 22 countries were critically ill as well as that 50% did not receive timely critical care (4). The availability of intensive care is generally limited, one study estimated the availability in Ethiopia to 0.3 intensive care beds per 100.000 population (3). It is there for common that critically ill patients receive care outside of intensive care units, an issue that is not isolated to LMICs but also in occurs in high income countries, emphasizing the need of EECC at all health care levels (5, 6).

Ethiopia is an example of a low-income country with a developing healthcare system that could benefit from implementation of EECC. It is the second most populous country in Africa, with an estimated population of approximately 132 million (7). Rapid population growth and urbanization, particularly in the capital Addis Ababa with over 5.7 million residents, creates a large demand for hospital-based emergency care.

In Ethiopia, emergency departments face shortages of trained personnel and insufficient equipment nationwide (8). These limitations in resources reduce the capacity of hospitals to provide timely and adequate care for potentially critically ill patients. Overcrowding is a common issue in emergency departments, highlighting the large strain put on emergency services (9, 10).

A common challenge for the provision of critical care is a lack of equipment. Even relatively simple medical devices such as pulse oximeters or equipment for monitoring blood pressure can be unavailable. The cause of this is usually difficulties with supply or maintenance (11-14). Access to drugs that are essential for the care of critically ill patients are also often limited (15). Human resources and staff training is an essential part of the care of critically ill patients, particularly the ability to detect and treat the early stages of critical illness, and studies have shown that nurses in Africa have insufficient knowledge in triaging patients (16-18).

The Ethiopian healthcare system is organized in a three-tiered system designed to provide efficient care to patients with different levels of complexity. *Primary hospitals* are the most widespread type of hospital and are found all over Ethiopia, they have a usual catchment area of 60,000-100,000 people and are focused on preventative healthcare, maternal health and basic outpatient services, they also offer inpatient care of uncomplicated cases and perform minor surgery. One major task is to serve as a referral service to secondary and tertiary hospitals, and often they constitute the first level of care that a patient usually encounters (19).

Secondary hospitals, often referred to as general hospitals, usually have a catchment area of 1.0 – 1.5 million people, they cover a larger population and provide a wider range of more advanced clinical services such as more advanced diagnostics and more advanced surgical interventions (19).
Tertiary hospitals are the highest level of healthcare in the Ethiopian healthcare system and usually have a catchment area of 3.5 million – 5 million people and serve as referral centres for both secondary and primary hospitals. Tertiary hospitals often function as nationwide referral hospitals for subspecialized types of healthcare that usually is not available in other hospitals (19).

The availability of EECC resources on a facility-level and the readiness for use of EECC resources at the bedside-level has not been assessed in many parts of Africa. One study from a similar setting in Dar es-Salaam, Tanzania showed on average 84% availability of EECC resources and on average 56% readiness of EECC resources (20). One mixed-method study including 5 tertiary hospitals in Addis Abeba found that the most common barrier to care was absence of equipment and being out of supplies (8). Hence the level of facility-level availability and bedside-level readiness for EECC in most of Africa is largely unknown, and

in Ethiopia, little previous research on EECC resources has been performed. Further studies are therefore required to address the lack of knowledge in this area. The information gained from this study will be useful to provide policy makers within the Addis Abeba healthcare system with an evidence base that can be used to guide allocation of resources to improve the quality of the healthcare system in Addis Abeba.

Aim

The main aim of this study was to determine the current level of availability of EECC resources within healthcare facilities and the level of readiness for the use of EECC resources at bedside-level in emergency departments in Addis Abeba. The secondary aim of this study was to determine if the level of facility-level availability correlates with the level of EECC readiness.

Method

The study was carried out as a cross-sectional observational study. The study was conducted in Addis Ababa, which has an estimated population of at least 5.7 million. The city covers approximately 540 square kilometres and is the political, cultural, and economic centre of Ethiopia. Healthcare in the city is provided through a mix of public and private facilities, including primary, secondary, and tertiary hospitals. These hospitals do not only serve the population of Addis Ababa but also surrounding regions and to some extent the entire nation, managing a wide range of medical conditions and a high patient volume across both emergency and elective services.

In Addis Abeba there is in total 54 hospitals where of 22 are private (21). Data was collected from emergency departments at 19 different hospitals in Addis Abeba, eight primary, five secondary and six tertiary. If a hospital had more than one emergency department, they were studied separately. In total 29 emergency departments were included, 11 were dedicated adult emergency departments, 10 were dedicated paediatric emergency departments and 8 were mixed emergency departments.

Selection was performed by the Ethiopian ministry of health using purposive sampling and only public hospitals were included. The hospitals were selected to represent all levels of care within the Ethiopian healthcare system to produce a representative result.

The data was collected using a standardized questionnaire in combination with site visits. The questionnaire used was a modified version of the EECC rapid healthcare facility assessment tool. The EECC rapid healthcare facility assessment tool was modified to accommodate assessment of dedicated adult and dedicated paediatric emergency units separately. In its original form the assessment tool requires that both adult and paediatric items should be provided to score a point. For example, to score a point for carrying oxygen face masks the requirement is to carry both adult and paediatric oxygen face masks. To compensate for this dedicated adult emergency departments and dedicated paediatric emergency departments were allowed to score points whilst only carrying items relevant for their intended age group. Mixed emergency departments were expected to carry both adult and paediatric items.

The EECC rapid healthcare facility assessment tool was developed using previous research in the area, and in total 40 variables were chosen to be included based on their feasibility for data collection and their value for providing critical care. The assessment tool was divided

into two different parts, one that assesses facility-level availability of EECC resources, and one that assesses bedside-level readiness for use of EECC resources.

Facility-level availability of EECC resources was assessed during a 10-minute site-visit with the person in charge of the facility or another person with good knowledge of the facility. The data collector asked the responder the question “Does this health facility have this item available anywhere in the facility” for each item listed in the form, with yes or no available as answers. For each question answered with yes, a point was awarded. After finishing the form, the result was calculated into a percentage-based score ranging from 0-100%.

Bedside-level readiness of EECC resources was assessed during a 30-minute visit to the emergency department. Data collectors followed the person in charge of the emergency department and asked the person in charge if the items listed in the questionnaire would be accessible to a nurse during the night without having to go elsewhere or requesting assistance.

The possible answers for each item were that the items was *Always*, *Usually*, *Rarely* or *Never* available. To score a point, the data collector needed to see the item, ensure that the item was available in the specified amount, be shown that it was functional and available for immediate use in the care for a critically ill patient and receive the answer that the item *always* was available. Any answer that was not "*Always"* resulted in a score of zero points. After finishing the form, the result was calculated into a percentage-based score ranging from 0-100% based on the number of points scored compared to the maximum number of points possible.

The tool is intended to examine entire hospitals with all wards and units included. In this study only emergency departments were included, the purpose of this decision was to be able to include more hospitals. Emergency departments were chosen since they likely see the largest amount of potentially critically ill patients and therefore the impact in patient outcome of being well prepared for critical illness is greatest there.

In preparation for data collection, data collectors and representatives from the local health bureau received a 1-day training in the use of the EECC rapid healthcare facility assessment tool (Appendix) and had to perform a pre-test before being deployed for data collection. Data collectors were not allowed to collect data from their usual workplace and study coordinators travelled to selected study sites to supervise data collection.

Ethical considerations

Ethical approval was obtained from the institutional review board of Asrat Weldeyes Health Science College, Debre Birhan University. Ethical approval was also obtained from the Ethiopian Ministry of Health. The study was an observational study of hospitals and health care facilities and therefore didn't affect direct patient care. No actual patients were studied and therefore potential ethical issues with patient consent and patient confidentiality were avoided. There was a potential risk for disruption of patient care and distraction of the healthcare workers away from their usual work to answer the data collectors' questions, this was taken into consideration in the design of the assessment tool, and it was intended to be easy and quick to answer by a single respondent. The collected data was stored securely, and all researchers who needed to take part in the data were required to sign a form to be allowed to handle data to ensure confidentiality.

Statistical analysis

Data was analysed using STATA v19. Data for the descriptive statistics were presented as percentages of the total score as well as mean, sample size (n), standard deviation (SD) and range. The data was checked for normality using a Shapiro-Wilk test and was found to be approximately normally distributed. A post-hoc ANOVA was performed to determine how similar the data from different hospital levels was to each other, the result was presented as p-value. A p-value <0.05 was considered statistically significant.

Correlation between facility-wide availability of EECC resources and bedside-level readiness of EECC resources was investigated using Pearson correlation analysis. The data from the correlation analysis is presented as correlation coefficient, p-value, sample size and 95% confidence interval (CI). Regression analysis using linear regression was performed to investigate if facility-level availability of EECC resources predicted bedside-level readiness of EECC resources. The data from the regression analysis was presented as regression coefficient (b), sample size (n), p-value, 95% CI, and R^2.

The results from the statistical analysis were presented in the form of tables and a scatter plot. No data was missing.

Results

Facility-level availability of EECC resources

In emergency departments (n=29) across all hospital's facility-level availability of EECC resources ranged from 72% to 96% with a mean score of 87% (SD 7). In primary hospitals (n= 8) facility-level availability of EECC resources ranged from 76% to 92% with a mean score of 87% (SD 4), in secondary hospitals (n= 10) from 72% to 96% with a mean score of 85% (SD 8) and in tertiary hospitals (n=11) from 84% to 96% with a mean score of 88% (SD 6). There was no difference in facility level availability of EECC between primary, secondary and tertiary hospitals (p=0.542). (Figure 1, Table 1)

Table 1. Facility-level availability of EECC resources

Facility level	n	Mean score (%)	SD	ANOVA p-value
Primary	8	87	4	0.542
Secondary	10	85	8	
Tertiary	11	88	6	
All hospitals	29	87	7	-

Table showing number of included emergency departments (n), mean score in %, standard deviation (SD), and ANOVA p-value, organized by facility level.

Bedside-level readiness of EECC resources

In emergency departments (n=29) across all hospitals bedside-level readiness of EECC resources ranged from 34% to 72% with a mean score of 58% (SD 13). In primary hospitals (n=8) bedside-level readiness of EECC ranged from 34% to 41% with a mean of 39% (SD 3), in secondary hospitals (n=10) from 57% to 71% with a mean value of 65% (SD 4), and in tertiary hospitals (n=11) from 57% to 72% with a mean value of 65% (SD 4). There were no differences in bedside-level readiness between tertiary and secondary hospitals, but primary hospitals showed significantly lower results ($p<0.001$). Secondary hospitals and tertiary hospitals showed no statistically significant differences (p=1.000), (Figure 1, Table 2).

Table 2. Bedside-level readiness of EECC resources

Facility level	Post-hoc analysis	n	Mean score (%)	SD	ANOVA p-value
Primary	-	8	39	3	-
Secondary	-	10	65	4	-
Tertiary	-	11	65	4	-
All hospitals	-	29	58	13	-
-	Primary vs secondary	-	-	-	< 0.001
-	Primary vs tertiary	-	-	-	<0.001
-	Secondary vs tertiary	-	-	-	1.000

Table showing number of included emergency departments (n), mean score in %, standard deviation (SD) and ANOVA p-value, organized by facility level.

Correlation and regression analysis between facility-level availability of EECC resources and bedside-level readiness of EECC resources

There was no significant correlation between facility-level availability of EECC resources and bedside-level readiness of EECC resources except for primary hospitals. Primary hospitals demonstrated a statistically significant correlation (r=0.750, CI 0.03-0.96, *p*=0.032) (Table 3) and in the regression analysis again primary hospitals were the only hospital level with a significant regression value (b=0.326, *p*=0.032) (Table 4).

Table 3. Correlation analysis between facility-level availability of EECC resources and bedside-level readiness of EECC resources.

Hospital level	p-value	r	n	95% CI	r^2
Primary	0.032	0.750	8	(0.03,0.96)	0.56
Secondary	0.271	0.385	10	(-0.32,0.82)	0.14
Tertiary	0.106	0.513	11	(-0.09,0.84)	0.27
All hospitals	0.384	0.028	29	(-0.30,0.35)	0.001

Table showing p-value, correlation coefficient (r), number of included hospitals (n), 95% CI and r^2 for correlation analysis between facility-level availability of EECC resources and bedside-level readiness of EECC resources organized by level of healthcare facility.

Table 4. Regression analysis between facility-level availability of EECC resources and bedside-level readiness of EECC resources.

Hospital level	p-value	b	n	95% CI	R^2
Primary	0.032	0.326	8	(0.04,0.61)	0.56
Secondary	0.271	0.190	10	(-0.18,0.56)	0.15
Tertiary	0.107	0.453	11	(-0.12,1.02)	0.26
All hospitals	0.384	0.302	29	(-0.4,1.00)	0.03

Table showing p-value, regression coefficient (b), number of included hospitals (n), 95% CI and R^2 for regression analysis between facility-level of availability of EECC resources and bedside-level readiness of EECC resources organized by level of healthcare facility

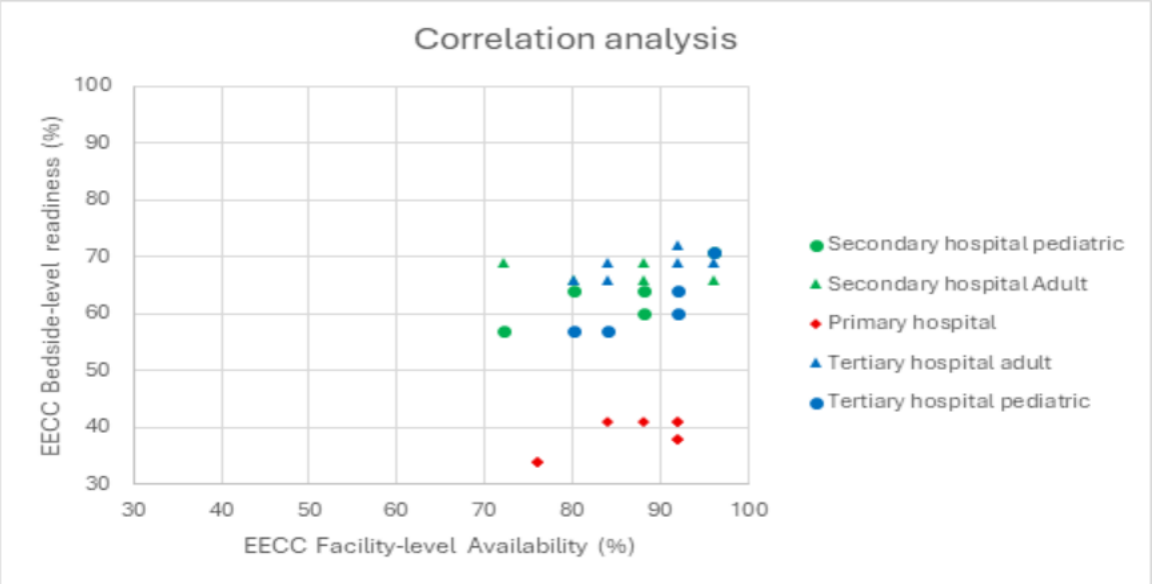


Figure 1. Scatterplot showing correlation between facility-level availability of EECC resources and bedside-level readiness of EECC resources.

Bedside-level readiness of EECC resources (Y-axis) plotted against Facility-level availability of EECC resources (X-axis). Values are divided into categories based on type of emergency department and level of healthcare facility.

Table 5. Most commonly missing items for facility-level availability of EECC resources

Item	Primary	Secondary	Tertiary	All hospitals
Intraosseous canula - Paediatric	25%	33%	20%	26%
Intraosseous canula - Adult	25%	50%	40%	38%
Oxytocin	50%	50%	40%	47%
Dedicated space for the critically ill	0%	100%	100%	66%
Guedel airway - Adult	50%	100%	100%	83%

Table showing the five most commonly missing EECC items for facility-level availability, expressed as the percentage (%) of hospitals in which the item was available, organized by hospital level.

The five most commonly missing items for facility-level availability of EECC resources was intraosseous cannula of paediatric size, intraosseous cannula of adult size, oxytocin, designated space for the critically ill and guedel airway of adult size. (Table 5)

Table 6. Most commonly missing items for bedside-level readiness of EECC resources

Item	Primary	Secondary	Tertiary	All hospitals
Oxytocin	0%	0%	34%	11%
Intraosseous canula - paediatric	0%	0%	34%	11%
Intraosseous canula - Adult	0%	34%	64%	33%
Suction catheter	0%	86%	86%	57%
Ringers lactate	0%	100%	100%	66%

Table showing the five most commonly missing EECC items for bedside-level readiness, expressed as the percentage (%) of hospitals in which the item was available, organized by hospital level.

The five most commonly missing items was oxytocin, intraosseous cannula of paediatric size, intraosseous cannula of adult size, suction catheter, ringers lactate. Primary hospitals was missing all the five most commonly missing items. (Table 6)

Discussion

The results show that emergency departments in all included hospitals, on average scored 87% facility-level availability of EECC resources and 58% bedside-level readiness of EECC resources. Across hospital types, the mean facility-level availability of EECC resources was relatively similar; tertiary hospitals scored 88%, secondary hospitals 87%, and primary hospitals 85%. In contrast to facility-level availability of EECC resources, bedside-level readiness of EECC resources showed a greater variation. Tertiary and secondary hospitals had similar values for mean bedside-level readiness of EECC resources with scores of 66% and 65%, whereas primary hospitals scored considerably lower, with a mean score of 39%.

The post-hoc analysis for bedside-level readiness of EECC resources showed that there was a statistically significant difference between primary hospitals and both secondary and tertiary ($p<0.001$), and no statistically significant difference between secondary and tertiary hospitals ($p=1.000$).

The only hospital level that had a statistically significant correlation between facility-level availability of EECC resources and bedside-level readiness of EECC resources was primary hospitals ($r=0.750$, $p=0.032$).

Comparison to previous research

The findings in this study are consistent with previous research on EECC and emergency care in sub-Saharan Africa. A study conducted in Dar es Salaam, Tanzania using the same assessment tool as in our study, reported a mean facility-level availability of 84% and a mean bedside-level readiness of EECC resources of 56% (20). The result from this study is very similar to our results for both facility-level availability of EECC resources and bedside-level readiness of EECC resources. A recent mixed-methods study including five hospitals in Addis Abeba, Ethiopia identified lack of equipment and frequent shortages of supplies as the most common barriers to providing emergency care (8). These findings correspond with our findings of gaps in availability and readiness of emergency equipment. The similarity of the findings suggests gaps in availability and readiness for EECC could be a common challenge for hospitals in urban areas in sub-Saharan Africa.

Facility-level availability of EECC resources

All included hospitals scored high results for facility-level availability of EECC resources, and that implies that most of the items considered essential for critical care by EECC are available somewhere within the healthcare facilities included in the study. All hospital types had similar levels of facility-level availability, with no statistically significant differences between them (p=0.542). The mean facility-level availability of EECC resources differed by only 4.5% between tertiary hospitals, which had the highest scores, and primary hospitals, which had the lowest.

All EECC resources were chosen with potential resource scarcity in mind and the relatively high levels of facility-level availability of EECC resources in all hospitals suggests that most EECC resources are relatively easy to make available. This indicates that EECC is a practical concept that can be useful in a low-resource setting, and that other hospitals in low-resource settings also could achieve high availability of these items.

The most commonly missing items when assessing facility-level availability of EECC resources across all hospital levels was intraosseous cannulas of both adult and paediatric sizes. One explanation could be that the use of intraosseous cannulas isn't well established or that they are relatively expensive and that the hospitals prioritize other items that are perceived to be more cost-effective and useful. Oxytocin was the drug that had the lowest facility-level availability of EECC resources on all hospital levels. One explanation could be that some of the hospitals included have dedicated obstetric units and because of this are not expecting to see obstetric patients in their emergency department and therefore doesn't have a supply of it.

None of the primary hospitals had a dedicated space for the care of the critically ill patients, whereas all the secondary and tertiary hospitals had such spaces. The absence of spaces for the care of the critically ill in primary hospitals suggest that none of them were planned with the intention of providing care for critically ill patients and instead are intended to refer them to secondary and tertiary hospitals. However, these facilities must still be prepared to always provide initial resuscitation and stabilization, since patients may present with ongoing critical illness, or they could deteriorate during their stay at a primary hospital.

Bedside-level readiness of EECC resources

The level of bedside-readiness of EECC resources was very similar between the tertiary hospitals and the secondary hospitals whereas primary hospitals had considerably lower results. All hospitals showed a lower bedside-level readiness of EECC resources compared to the facility-wide availability level of EECC resources, suggesting that resources that are available somewhere within the hospital are not always available in the emergency departments.

Low bedside-readiness of EECC resources has important practical implications. In emergency situations, delays caused by having to leave a patient to access essential equipment or medications can affect the timeliness of interventions and potentially patient outcomes. This may be more pronounced in primary hospitals where there are fewer trained healthcare professionals available compared to larger hospitals (22).

One possible explanation to why primary hospitals showed such a marked difference in facility-level availability of EECC resources and bedside-level readiness of EECC resources compared to secondary and tertiary hospitals could be a lower level of funding and therefore a less developed hospital infrastructure. Primary hospitals likely have a less developed supply chain, and less developed maintenance organization for medical equipment and devices, this would reduce their capability to keep consumable products supplied and equipment functioning. Another contribution factor can be that hospitals don't prioritize limited resources to be placed in the emergency departments.

Correlation between facility-level of EECC resources and bedside-level readiness of EECC resources

The correlation analysis between facility-level availability of EECC resources and bedside-level readiness of EECC resources showed a positive statistically significant correlation in primary hospitals, but in absolute terms primary hospitals score considerably lower on bedside-level readiness of EECC resources compared to secondary and tertiary hospitals.

This finding was unexpected since the facility-level availability of EECC resources was similar across all hospital levels but primary hospitals showed markedly lower levels of bedside-level readiness of EECC resources.

Limitations and strengths

One strength of the study is that it is focused on emergency departments. This allowed a larger number of hospitals to be included and the results may be representative for a wider range of emergency departments..
Emergency departments was considered to be the most significant units since they are most likely to see critically ill patients. The motivation behind choosing only emergency departments was that the benefits of a well-equipped emergency department likely have a greater impact than a well-equipped hospital ward. It would be possible perform a more comprehensive examination of the included hospitals that also includes all hospital wards, this would have increased resource consumption which would result in fewer included hospitals for the same cost.

Facility-level availability of EECC resources score higher than bedside-level readiness of EECC resources across all hospitals. One possible explanation for this could be the data collection method. When data for facility-level availability of EECC resources was collected the data collector only asked the respondent if the items were available somewhere within the healthcare facility, and if the item was usable or not without asking for the item to be presented. This approach may have caused recall bias or social desirability bias, potentially leading to overestimation of facility-level availability.

Bedside-level readiness of EECC resources scores consistently lower than facility-level availability of EECC resources and primary hospitals scored considerably lower. One possible explanation for this could be how to assessment tool is constructed. If the assessment tool as an alternative was modified and allowed the answer *Usually* instead of *Always* as the answer required to score a point for bedside-level readiness of EECC resources scores would increase, in all hospital types. Primary hospitals would show a large increase in score. The scores would increase from a mean value of 39% to 89% for primary hospitals, 65% to 92% for secondary hospitals and 65% to 91% for tertiary hospitals. On possible explanation for this could be that determining how often an item is available can be subjective and it can be difficult for an individual to determine if an item is available *Always*, *Usually*, *Often* or *Never*. Different individuals in the same setting can provide different answers based on their individual experience, familiarity with the items or different understanding of the healthcare facility. Having an item *Usually* available can still indicate a relatively high level of

readiness. This finding suggests that a low score for bedside-level readiness of EECC resources could be misleading.

The findings observed in the correlation and regression analysis could be affected by the small sample size (n=8), since it limits the statistical power of the analysis. With such a small number of observations, the analysis becomes more susceptible to random variation within the data set. Because of this the result likely is not generalizable and the result should be interpreted carefully because of this.

Conclusion

All hospitals scored higher for facility-level availability of EECC resources than bedside-level of EECC readiness with only a weak correlation between facility-level availability of EECC resources and bedside-level readiness of EECC resources among primary hospitals. This indicates that available resources might be present but are not ready to be used when needed at the bedside, with potentially adverse outcomes for patients in need of critical care. EECC resources is likely to be most accurately assessed by bedside-level readiness instead of facility-level availability and efforts are needed to increase availability of EECC resources at emergency departments in Addis Abeba.

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APPENDIX

EECC Global

EECC Rapid Health Facility Assessment Tool

Part 1: Health facility EECC Resource Availability G Readiness

Purpose: To rapidly assess the *availability* and *readiness* of EECC resources in a health facility

Note: Part 2 for health facility EECC Care Provision can be used if an assessment of care provision is planned.

Method:

Facility-level Availability: 10 minutes of questions for the facility in-charge (or other knowledgeable person in the facility)

1. Fill in information on Page 1
2. Ask the questions on Page 2, circling "Y" for Yes or "N" for No
3. Fill in a point for each "Yes" response in the "Analysis" box
    - Note some questions have specific instructions for points written in the "Analysis" box
4. Add up points and divide by 25 (the total possible points) and multiply by 100 to get the score in percent
5. Write the Score in the Box on Page 2

Ward/Bedside-level Readiness: 35 items to observe in each ward/unit of the facility together with the ward in-charge *(30 minutes per ward/unit)*

1. Fill in information on Page 3
2. Observe each item on Page 4. (Must see the item, and if the question requires it, count the items and check if it/they are functioning)
3. Fill in a point for each "Yes" response in the "Analysis" box
    - Note some questions have specific scoring instructions written in the "Analysis" box
4. Add up points and divide by 28 (the total possible points) and multiply by 100 to get the score in percent
5. Write the Score in the Box on Page 4
6. REPEAT Assessment for each ward/unit in the facility
7. Calculate the facility readiness score by adding up each ward/unit score and dividing by number of wards/units assessed

Note: a "critically ill patient" is any patient with an acute, life-threatening condition, wherever they are receiving care

Sources

- Schell CO, et al. Essential Emergency and Critical Care: a consensus among global clinical experts. BMJ Global Health. 2021
- Khalid K, et al. Hospital readiness for the provision of care to critically ill patients in Tanzania- an in-depth cross-sectional study. BMC Health Services Research. 2024
- EECC in Tanzania (EECCiT) assessment tools www.poetictz.org

Method for selecting variables from the sources

- The resources were chosen using the following criteria: i) most feasible for data collection; ii) most clinically relevant (greatest likely impact on population health) iii) representative for the total 66 EECC resources. The tool has been piloted and validated in Tanzania.

EECC Global

FACILITY-LEVEL AVAILABILITY

Date for data collection	
Data collector name	
Country	
Region	
District	
Health facility	
Level of health facility	[ ] Dispensary [ ] Health Centre [ ] District Hospital [ ] Regional Hospital [ ] National/University Hospital [ ] Other .....
Designation of Respondent (To be responded by facility-in-charge)	
Name of Respondent	
Respondent's Telephone (for possible follow-up questions)	
Respondent's Email (for possible follow-up questions)	
Number of wards in the facility	
List of wards in the facility	
Total number of beds in the facility	
Catchment Area (population)	
Notes / Comments	

EECC Global

Does this health facility have the following resource available anywhere in the facility?

	Item	Available (circle Yes or No)	Comments	Analysis (yes = 1 point)
1	ICU	Y N		If yes to 1,2 OR 3 = 1 point
2	HDU	Y N		
3	Designated space in any ward for critically ill patients	Y N		
4	In the Out-Patient Department or Emergency Unit (area of the hospital where patients arrive), there is a designated triage area (area for the identification of critical illness)	Y N		
5	If a critically ill patient arrives to the facility, are they treated before paying	Y N		
6	Blood pressure measuring equipment (eg. sphygmomanometer with a stethoscope)	Y N		
7	Pulse oximeter & probe	Y N		
8	Bag Valve Mask (Ambu-bag or resuscitator) adult size	Y N		If yes to 8 AND 9 = 1 point
9	Bag Valve Mask (Ambu-bag or resuscitator) paediatric size	Y N		
10	Oxygen supply (piped, concentrator or cylinder)	Y N		
11	Flowmeter	Y N		
12	Oxygen tubing	Y N		
13	Suction machine (manual or electronic)	Y N		
14	Suction catheters paediatric size	Y N		If yes to 14 AND 15 = 1 point
15	Suction catheter adult size	Y N		
16	Oxygen face masks of adult size	Y N		If yes to 16 AND 17 = 1 point
17	Oxygen face masks *of paediatric* size	Y N		
18	Oxygen face masks *with reservoir bags* (non-rebreather mask) of adult size	Y N		If yes to 18 AND 19 = 1 point
19	Oxygen face masks *with reservoir bags* (non-rebreather mask) of paediatric size	Y N		
20	Guedel (oro-pharyngeal) airways of adult size	Y N		If yes to 20 AND 21 = 1 point
21	Guedel (oro-pharyngeal) airways of paediatric size	Y N		
22	Intravenous cannulas of adult size	Y N		If yes to 22 AND 23 = 1 point
23	Intravenous cannulas of paediatric size	Y N		
24	Intraosseous cannulas of adult size	Y N		If yes to 24 AND 25 = 1 point
25	Intraosseous cannulas of paediatric size	Y N		
26	Adrenaline	Y N		
27	Oxytocin	Y N		
28	Diazepam (rectal or intravenous) (or other benzodiazepine)	Y N		
29	Ringers lactate or normal saline	Y N		
30	IV Dextrose	Y N		
31	IV giving sets	Y N		
32	Any nurse attended any acute medical training in the past 12 months	Y N	Total nurses in all wards: ..... Total nurses attended training ..... Proportion: ____%	If yes = 1 point
33	Guidelines for the identification of critical illness (triage)	Y N		
34	Guidelines for managing critically ill patients or medical emergencies	Y N		
			Points	

(Total possible points = 25). Points divided by 25 multiplied by 100 = AVAILABILITY SCORE: .....%

EECC Global

WARD/BEDSIDE-LEVEL READINESS (Visit a ward/unit physically). One of these forms to be filled in for *each* ward/unit **Designation of respondent** (Data to be collected by observing every item on the unit, led by the in-charge of the unit)	
Ward/unit name	
Ward/unit type (circle)	Male Female Mixed
Specialty (circle)	Paediatric ObsCGyn Surgical Medical General Emergency Unit OPD HDU ICU Other.....
Number of beds on ward/unit	
Number of patients in the beds on this day	
Do you ever admit the following patients in your ward?	Adults and those 12 years and above ☐ Children below 12yrs ☐ Both ☐
Notes / Comments	

EECC Global

In this ward or unit, observe these items:

	Item	Count number of items observed	Count number of items that are functioning (check them)	Is this item available for the nurse in the ward during the night without needing assistance or to go anywhere else (circle the response)	Comments	Analysis
1	Blood pressure measuring equipment (eg. sphygmomanometer with a stethoscope)			Always Usually Rarely Never		If "always" and equal or more than 1 item per 20 beds = 1 point
2	Pulse oximeter C probe			Always Usually Rarely Never		If "always" and equal or more than 1 item per 20 beds = 1 point
3	Bag Valve Mask (Ambu-bag or resuscitator) adult size			Always Usually Rarely Never		If "always" and equal or more than 1 item per 20 beds for 3 AND 4 = 1 point
4	Bag Valve Mask (Ambu-bag or resuscitator) paediatric size			Always Usually Rarely Never		
5	Suction machine(manual or electronic)			Always Usually Rarely Never		If "always" and equal or more than 1 item per 20 beds = 1 point

	Item	Observed	Is this item available for the nurse in the ward during the night without needing assistance or to go anywhere else (circle the response)	Comments	Analysis (Yes and Always = 1 point)
6	Oxygen supply (piped, concentrator or cylinder)	Y N	Always Usually Rarely Never		
7	Flow meter	Y N	Always Usually Rarely Never		
8	Oxygen tubing	Y N	Always Usually Rarely Never		
9	Suction catheters paediatric size	Y N	Always Usually Rarely Never		If yes and 'Always' for 9 AND 10 = 1 point
10	Suction catheter adult size	Y N	Always Usually Rarely Never		
11	Oxygen nasal prongs	Y N	Always Usually Rarely Never		
12	Oxygen face masks of adult size	Y N	Always Usually Rarely Never		If yes and 'Always' for 12 AND 13 = 1 point
13	Oxygen face masks of paediatric size	Y N	Always Usually Rarely Never		
14	Oxygen face masks *with reservoir bags* (non-rebreather mask) of adult size	Y N	Always Usually Rarely Never		If yes and 'Always' for 14 AND 15 = 1 point
15	Oxygen face masks *with reservoir bags* (non-rebreather mask) of paediatric size	Y N	Always Usually Rarely Never		
16	Guedel (oro-pharyngeal) airways of adult size	Y N	Always Usually Rarely Never		If yes and 'Always' for 16 AND 17 = 1 point
17	Guedel (oro-pharyngeal) airways of paediatric size	Y N	Always Usually Rarely Never		
18	Intravenous cannulas of adult size	Y N	Always Usually Rarely Never		If yes and 'Always' for 18 AND 19 = 1 point
19	Intravenous cannulas of paediatric size	Y N	Always Usually Rarely Never		
20	Intraosseous cannulas of adult size	Y N	Always Usually Rarely Never		If yes and 'Always' for 20 AND 21 = 1 point
21	Intraosseous cannulas of paediatric size	Y N	Always Usually Rarely Never		
22	Ringers lactate or normal saline	Y N	Always Usually Rarely Never		
23	IV Dextrose	Y N	Always Usually Rarely Never		
24	IV giving sets	Y N	Always Usually Rarely Never		
25	Diazepam (rectal or intravenous) (or other benzodiazepine)	Y N	Always Usually Rarely Never		
26	Adrenaline	Y N	Always Usually Rarely Never		
27	Oxytocin	Y N	Always Usually Rarely Never	Note down if not relevant for this ward and do not score (and total possible score will be one less)	
28	Do you have a routine/policy that vital signs are checked on all inpatients at least once every 24 hours	Y N	Always Usually Rarely Never		
29	When you check vital signs do you always include checking all of PR, RR, BP, SpO2, conscious level, airway sounds (eg snoring, gurgling, stridor), temperature	Y N	Always Usually Rarely Never	Note down which ones they include in their vital signs and which ones not	If ALL vital signs included "Always" = 1 point
30	Guidelines for the identification of critical illness (triage)?	Y N	[redacted]		
31	Guidelines for treating critically ill patients or medical emergencies?	Y N			
32	Do you have a system of seeking senior help when a critical patient is identified?	Y N	Briefly describe the system reported to be used.		
33	How many nurses are on duty in this shift?		Number		If >1 nurse per 10 patients = 1
34	How many nurses in this shift have attended any acute medical training in the past 12 months?		Number		If 1 or more nurse has been trained = 1
35	If a patient deteriorates and becomes critically ill, they are treated before paying	Y N	Always Usually Rarely Never		
				Points	

(Total possible points = 28). Points divided by 28 multiplied by 100 = READINESS SCORE: .....%

Page 5 of the assessment tool is currently not in use and is not available.