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Assessment and reassessment of injured patients at non-tertiary hospitals in Ghana: A stepped-wedge cluster randomized trial

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ABSTRACT

Introduction: Frequent reassessment of injured patients is an important component of trauma and emergency care. How frequently such reassessment is done in African hospitals has been minimally addressed. We sought to address this gap, as well as to assess the effectiveness of a standardized trauma intake form (TIF) to improve assessment and reassessment rates.

Methods: We undertook a stepped-wedge cluster randomized trial with research assistants observing trauma care before and after introducing the TIF at emergency units of eight non-tertiary Ghanaian hospitals for 17.5 months. Differences in seven key performance indicators (KPIs) of assessment and reassessment were evaluated using generalized linear mixed regression. KPIs included: respiratory rate, heart rate, blood pressure, level of consciousness, mobility, temperature, and oxygen saturation.

Results: Management of 4077 patients was observed: 2067 before TIF initiation and 2010 after. In the before period, completion of KPIs of initial assessment ranged from 55% (oxygen saturation) to 88% (level of consciousness). KPIs for reassessment for patients still in the EU after 30 min ($n = 1945$, in before period) were much lower than for initial assessment, ranging from 10% (respiratory rate and oxygen saturation) to 13% (level of consciousness). The TIF did not significantly improve performance of any KPI of assessment or reassessment. Similar patterns pertained for the subgroup of seriously injured patients (Injury Severity Score ≥ 9).

Conclusion: At non-tertiary hospitals in Ghana, performance of KPIs of initial assessment were mostly adequate, but with room for improvement. Performance of KPIs for reassessment were very low, even for seriously injured patients. The intervention (trauma intake form) did not impact reassessment rates, despite previously having been shown to impact many other KPIs of trauma care. Potential avenues to pursue to improve reassessment rates include other quality improvement efforts and increased emphasis on reassessment in training courses.

African relevance

- Reassessment of injured patients during their stay in the emergency unit is important to detect deterioration and occult injuries.
- How often reassessment is done in African emergency units has been minimally addressed.
- The current study identified moderate to high rates of performance of key performance indicators (e.g. vital signs, oxygen saturation) during initial assessment.
- Reassessments during patients' stay in the emergency unit were minimally performed, thus identifying this aspect of trauma and emergency care as an important target for future work.

Introduction

A cornerstone of the management of critically ill or injured patients is a rapid initial assessment to detect and treat life threatening conditions, such as a compromised airway or shock. Periodic reassessment is likewise important, especially in patients who have evidence of

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instability on initial presentation. Such reassessment is emphasized by the World Health Organization's (WHO) Basic Emergency Care (BEC) course. The BEC course manual states: "Ideally, the ABCDE approach should be repeated at least every 15 min or with any change in condition" [1]. The BEC course manual goes on to urge extreme caution for trauma patients, who may present in stable condition, but who may have occult life threatening injuries that only manifest later. Similarly, the Advanced Trauma Life Support (ATLS) course recommends "repeat the primary survey frequently to identify any deterioration in the patient's status…" [2].

Studies in Africa and several other low- and middle-income countries (LMICs) have looked at the performance of the elements of initial assessment in injured patients. Sawe et al. [3] looked at both the performance (through observation) and documentation (in medical records) for assessment of heart rate, blood pressure, respiratory rate, and oxygen saturation for injured patients at five referral centers in Tanzania. Botelho et al. [4] prospectively observed adherence to the steps in the primary survey for injured children at a tertiary center in Brazil. Shivasabesan et al. [5] reported high levels of completeness of recording for heart rate, blood pressure, respiratory rate, and Glasgow Coma Scale (GCS) for injured patients recorded in trauma registries of four trauma centers in India.

None of the above studies reported how often reassessment was performed. In one of the few studies that reported data on reassessment, Towns et al. [6] looked at the performance of vital signs for emergency patients in a hospital in Liberia before and after training with the WHO's BEC course. Recording of a full set of vital signs increased from 3.2% to 16.2%. As regards reassessment, the study documented an increase in performance of a repeat BP for patients in shock from 6.6% to 25.4%. Otherwise, the literature on reassessment rates for injured and ill patients is sparse in Africa and other LMICs.

We sought to address this gap by examining how often elements of initial assessment (vital signs, mobility, level of consciousness, temperature, and oxygen saturation) were repeated on injured patients presenting to emergency units in non-tertiary hospitals in Ghana. We also sought to determine whether a standardized trauma intake form with built-in decision support prompts could improve the performance of both initial assessment and reassessment. An initial trial showed significant overall improvement in achievement of trauma care key performance indicators for all injured patients and reduced mortality for the more seriously injured with introduction of the trauma intake form [7]. The current study focuses on reassessment rates for patients who remained in the emergency unit for half an hour or longer.

Methods

Setting

This study was set in six district and two regional hospitals in southern Ghana. District (first-level) hospitals provide basic trauma care and are staffed by nurses, medical officers, physician assistants, and occasionally by specialists. Regional (second-level or referral) hospitals usually have at least some specialists [8]. Of the eight hospitals in this study, only one (a district hospital) had an emergency physician. Both regional hospitals and five of six district hospitals had one or more nurses with additional training in emergency nursing. Supplies and equipment for trauma care (such as chest tubes) and diagnostic services (such as x-ray and ultrasonography) are often lacking at district hospitals, with some improvement in availability at regional hospitals. However, items for triaging patients (blood pressure measuring devices, pulse oximeters, and thermometers) were available at the emergency units of our study hospitals during the study period. There are very few trauma-related quality improvement activities in any district or regional hospital [9]. Some hospitals do utilize standardized forms for triage decisions and all of our study hospitals had and maintained a triaging form based on the South African Triage Scale (SATS) [10]. Otherwise, most hospitals do not utilize standardized forms for patient clerking/intake. Instead, they tend to document information for trauma and other emergency patients in blank records (paper or electronic). These blank records usually do not have any clinical decision support prompts or reminders.

Study design

We performed a stepped-wedge, randomized clinical trial, [11] utilizing a standardized trauma intake form (TIF) to improve initial trauma care by emergency unit (EU) health service providers (EHSPs; nurses, physician assistants, and doctors). While the TIF includes all the elements of the SATS-based triage form, it was intended to function as a checklist with real-time clinical decision support prompts to promote adherence to the ABCDE approach to trauma care [12]. The TIF was created in Ghana and was adapted from the World Health Organization's Trauma Care Checklist [13]. Selection of the key performance indicators (KPI) to incorporate into the TIF was also informed by a Delphi process that addressed audit filters appropriate for LMIC non-tertiary hospitals [14]. The TIF had a specific section to prompt reassessment every 30 min while the patient was still in the EU. The two regional and six district hospitals (as noted above) chosen for this study were selected purposively for their sufficient flow of injured patients ($\geq$75 per month).

Study procedures

Previous publications have reported the study procedures, including data collection, sampling, and power estimation [7,15]. These study procedures are summarized briefly herein. Trained research assistants (RAs) observed and documented initial assessment and management of injured patients in the EUs of study hospitals for 3.5 months. Any type of injury and any mechanism of injury (except for poisoning) were included. Two nearby hospitals were then randomly selected for introduction of the TIF using STATA'S random number generator. At these two hospitals training was conducted by the principal investigator to orient EHSPs as to how to use the TIF in their initial management of patients. The TIF was then used by EHSPs, starting the day after the training. Nearby hospitals were randomized together for ease of study management as regards logistics. The TIF was then introduced sequentially to randomly selected groups of two hospitals every 3.5 months until study completion at 17.5 months (October 2020 to March 2022). RAs were posted at EUs in rotating 8-hour shifts to record completion of KPIs (e.g., vital signs taken, chest examination performed, assessment for intraabdominal bleeding performed), or otherwise, using an observation form derived from the TIF. RAs made their observations without interacting with patients or EHSPs. RAs also reviewed patient records for supplemental information. KPIs were considered as performed if they were directly observed by the RA as being performed or if they were documented in the patient record or both. KPIs not required (e.g., chest examination in minor laceration), were recorded as performed if the EHPS had noted in the patient record that it was not required.

Data analysis

Analyses were performed with Stata 17 (StataCorp, USA). Primary outcomes were performance of KPIs. The overall study assessed performance of 23 KPIs [7,15]. For the analysis in this paper, we focus on seven KPIs related to initial assessment and reassessment, specifically respiratory rate, heart rate, blood pressure, level of consciousness, mobility, temperature, and oxygen saturation as these represent items on the South African Triage Scale that is utilized by most EUs in Ghana. We especially focus on whether these were reassessed in patients spending 30 min or more in the EU. A given KPI was considered reassessed if it was repeated at least once at any point during the patient's stay in the EU. Serious injury was defined as Injury Severity Score (ISS)

≥9 [16]. A secondary outcome assessed was in-hospital mortality. Patients who were admitted were followed until discharge.

Chi-squared was used to compare characteristics of patients managed before vs. after TIF introduction. Differences in KPI performance between patients managed before vs. after TIF introduction were estimated in standard fashion for stepped-wedge study designs, using generalized linear mixed regression models with TIF introduction (intervention) considered as the fixed effect with adjustment for time periods as fixed effects and hospitals (cluster) and time periods as random effects [17,18]. Data analysis was carried out on an intention-to-treat basis. All patients managed after TIF introduction were considered in the intervention arm whether or not the TIF was utilized in their management.

Ethics

This study was approved by the Committee for Human Research and Publication Ethics of Kwame Nkrumah University of Science and Technology (CHRPE/AP/142/20). EHSPs provided written informed consent to be observed. The study was pre-registered at clinicaltrials.gov (NCT04547192).

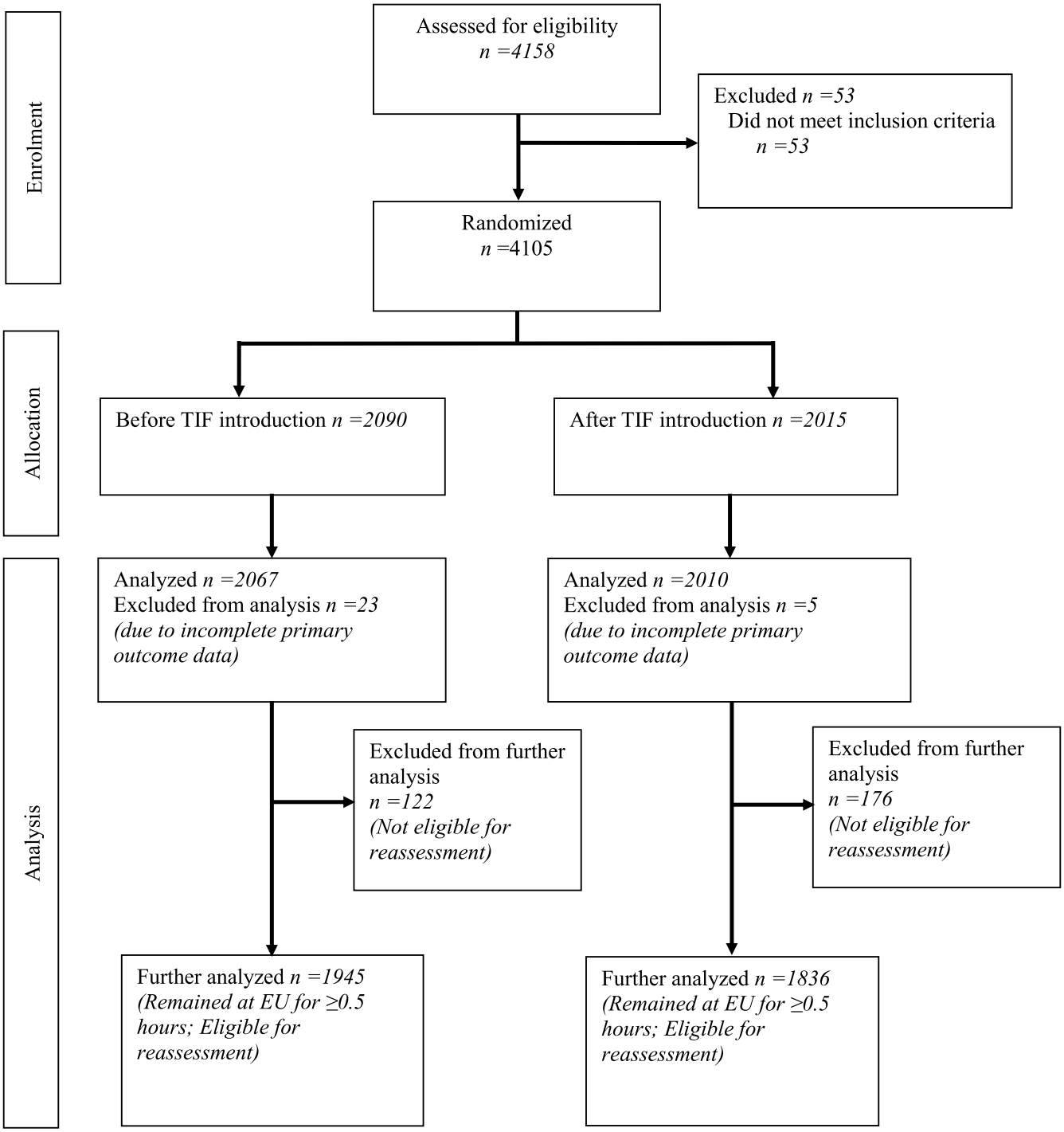

Fig. 1. Trial CONSORT flow diagram EU – emergency unit.

Table 1
Demographics of injured patients presenting to emergency units of select Ghanaian non-tertiary hospitals ($N = 4077$).

	Before TIF Introduction ($n = 2067$)		After TIF Introduction ($n = 2010$)		
	N	(%)	N	(%)	p-value*
Sex					
Male	1530	(74)	1480	(74)	0.482
Female	517	(25)	526	(26)	
Missing	20	(1)	4	(0.2)	
Age, Median (IQR), Years	26	(19)	28	(19)	0.124
Mechanism of injury					
Blunt	1583	(77)	1544	(77)	0.241
Penetrating	440	(21)	410	(20)	
Burns	41	(2)	55	(3)	
Missing	3	(0.2)	1	(0.1)	
Intent					
Unintentional	1854	(90)	1,61	(88)	0.699
Assault	199	(10)	204	(10)	
Self-harm	4	(0.2)	6	(0.3)	
Unknown/Missing	10	(0.4)	7	(0.4)	
Injury Severity Score ≥9	175	(8)	186	(9)	0.387
Referred to higher levels of care	232	(11)	213	(11)	0.521

Statistical tests done excluding missing data;.
* p-values in bold denotes statistical significance
TIF – Trauma Intake Form.

Results

A total of 4158 patients were screened for eligibility. We excluded non-trauma patients ($n = 53$) and patients without complete primary outcome data ($n = 28$). This left 4077 patients in the analytic sample (Fig. 1). There were no significant differences in the before ($n = 2067$) and after periods ($n = 2010$) as regards sex, age, mechanism of injury, intent of injury, or percent of patients with serious injury (ISS≥9) (Table 1).

Key performance indicators of assessment and reassessment: all patients

In the before period, the KPIs of initial assessment ranged from 55% (oxygen saturation) to 88% (level of consciousness) in terms of percent completion (Table 2). KPIs for reassessment for patients still in the EU after 30 min were much lower than for initial assessment, ranging from 10% (respiratory rate and oxygen saturation) to 13% (level of consciousness).

In the after period, the TIF was used in the management of 1720 out of 2010 patients (86% usage). In this after period, the KPIs of initial assessment ranged from 84% (blood pressure) to 94% (mobility). Although four of seven KPIs were above 90% completion, none of the increases in individual KPI completion were significant (Table 2). KPIs for reassessment for patients still in the EU after 30 min remained low, ranging from 5% (oxygen saturation) to 7% (blood pressure). Although all of the seven KPIs were nominally lower in the after period, none of the changes were significant.

Key performance indicators of assessment and reassessment: seriously injured patients

In the before period, KPI completion rates for initial assessment were higher in the seriously injured group than for the group of all patients, ranging from oxygen saturation assessed (78%) to consciousness level assessed (97%) (Table 3). KPI completion rates for reassessment were also higher in the seriously injured group, but still very low, ranging from 17% (mobility) to 26% (blood pressure).

In the after period, KPI completion rates for initial assessment ranged from 89% (blood pressure) to 99% (level of consciousness). Although six of seven KPIs were above 90% completion, only the increase in oxygen saturation (77% completion before vs. 96% completion after) was significant (Table 3). Reassessment rates ranged from 6% (mobility) to 12% (blood pressure). All KPIs were nominally lower, but not significantly different, than in the before period.

Mortality

For all patients, in-hospital mortality was 2% and was not significantly different (1%) after TIF (adjusted odds ratio 0.42; 95% CI 0.12–1.43; $p = 0.17$). For seriously injured patients (ISS ≥9), mortality decreased significantly from 19% in the before period to 8% in the after period (adjusted odds ratio 0.12; 95% CI 0.03–0.52; $p = 0.004$). Among these patients, mortality was not different for those who were reassessed for any of the triage elements (18% reassessed vs 12% not reassessed; adjusted odds ratio 1.54; 95% CI 0.69–3.45; $p = 0.290$).

Discussion

This study sought to understand how often key performance indicators (KPIs) of initial assessment were performed on injured patients presenting to emergency units (EU) in non-tertiary hospitals in Ghana, and especially how often these KPIs were reassessed for patients remaining in the EU 30 min or longer. The study found high, but not

Table 2
Assessment of injured patients presenting to emergency units of select Ghanaian non-tertiary hospitals ($N = 4077$).

	Before TIF Introduction ($n = 2067$)		After TIF Introduction ($n = 2010$)				
	N	(%)	N	(%)	AOR	95% C.I	p-value
Initial assessment and monitoring							
Respiratory rate at EU arrival assessed	1194	(58)	1787	(89)	2.31	0.70 - 7.64	0.169
Heart rate at EU arrival assessed	1483	(72)	1850	(92)	1.40	0.56 - 3.47	0.467
Blood pressure at EU arrival assessed	1431	(69)	1682	(84)	1.21	0.67 - 2.21	0.522
Consciousness level at EU arrival assessed	1819	(88)	1947	(97)	2.20	0.90 - 5.36	0.084
Mobility at EU arrival assessed	1807	(87)	1894	(94)	1.53	0.43 - 5.45	0.504
Temperature at EU arrival assessed	1644	(80)	1873	(93)	1.21	0.46 - 3.18	0.694
Oxygen saturation level at EU assessed	1128	(55)	1785	(89)	2.63	0.94 - 7.33	0.065
Reassessment and monitoring for patients who stayed ≥0.5 hr at EU	Before TIF ($n = 1945$)		After TIF ($n = 1836$)				
Respiratory rate re-assessed	192	(10)	112	(6)	0.73	0.19 - 2.85	0.650
Heart rate re-assessed	221	(11)	117	(6)	0.89	0.17 - 4.54	0.887
Blood pressure re-assessed	243	(12)	125	(7)	0.64	0.15 - 2.65	0.533
Consciousness level re-assessed	253	(13)	108	(6)	3.27	0.62 - 17.15	0.162
Mobility re-assessed	243	(12)	82	(4)	2.45	0.30 - 0.45	0.301
Temperature re-assessed	234	(12)	106	(6)	0.47	0.13 - 1.63	0.232
Oxygen saturation level re-assessed	188	(10)	98	(5)	0.78	0.20 - 3.02	0.719

EU– Emergency Unit; AOR – Adjusted Odds Ratio (adjusted for time period and hospital (cluster)).

Table 3
Assessment of patients with injury severity score ≥9 presenting to emergency units of select Ghanaian non-tertiary hospitals ($N = 361$).

	Before TIF Introduction ($n = 175$)		After TIF Introduction ($n = 186$)				
	N	(%)	N	(%)	AOR	95% C.I	p-value*
Initial assessment and monitoring							
Respiratory rate at EU arrival assessed	136	(78)	176	(95)	4.22	0.74 - 24.15	0.106
Heart rate at EU arrival assessed	153	(87)	180	(97)	2.77	0.44 - 17.37	0.277
Blood pressure at EU arrival assessed	148	(85)	166	(89)	1.56	0.44 - 5.64	0.490
Consciousness level at EU arrival assessed	169	(97)	185	(99)	40.97	0.98 - 1720.49	0.052
Mobility at EU arrival assessed	164	(94)	177	(95)	4.47	0.17 - 117.45	0.370
Temperature at EU arrival assessed	158	(90)	177	(95)	1.16	0.13 - 10.57	0.897
Oxygen saturation level at EU assessed	134	(77)	178	(96)	15.56	2.18 - 110.93	**0.006**
Reassessment and monitoring for patients who stayed ≥0.5 hr at the EU	Before TIF ($n = 166$)		After TIF ($n = 166$)				
Respiratory rate re-assessed	32	(19)	17	(10)	0.81	0.14 - 4.68	0.818
Heart rate re-assessed	37	(22)	17	(10)	0.82	0.21 - 3.15	0.774
Blood pressure re-assessed	43	(26)	20	(12)	0.83	0.25 - 2.83	0.769
Consciousness level re-assessed	33	(20)	14	(8)	0.70	0.16 - 3.21	0.649
Mobility re-assessed	29	(17)	10	(6)	0.61	0.12 - 3.07	0.545
Temperature re-assessed	39	(23)	15	(9)	0.54	0.13 - 2.18	0.391
Oxygen saturation level re-assessed	42	(25)	13	(9)	0.51	0.10 - 2.54	0.413

* p-values in bold denotes statistical significance
EU– Emergency Unit; AOR – Adjusted Odds Ratio (adjusted for time period and hospital (cluster)).

optimal, rates of completion of KPIs of initial assessment. KPIs for reassessment were very low, ranging from 10 to 12%. Reassessment rates were only marginally better for seriously injured patients (ISS≥9), with KPIs ranging from 17 to 26%. Ideally these KPIs should be repeated at least every 15 to 30 min for this seriously injured group of patients. Moreover, reassessment rates were recalcitrant to a quality improvement program (the trauma intake form - TIF), with no significant improvements in response to the TIF.

Several other studies in other LMICs (Brazil, India, Iran, Tanzania) have looked at the performance of initial assessment for injured patients, through either direct observation or documentation in medical records and trauma registries [3-5,19,20]. None of these studies, including two systematic reviews on registry data completeness [19,21], addressed reassessment or repeat of the elements of primary survey. In one of the few studies reporting reassessment, Towns et al. [6] reported that documentation of a repeat BP for patients in shock increased from 6.6% to 25.4% after training using the WHO's Basic Emergency care (BEC) course in Liberia, as mentioned above in the introduction.

In the current study, the least frequently performed KPI of initial assessment was measurement of oxygen saturation, at 55% baseline performance for the entire cohort. It was also minimally reassessed, at 10% performance for patients in the EU for 30 min or more. One potential explanation could be lack of equipment. However, in the after period, compliance did rise to 89% for everyone on initial assessment and to 96% for the seriously injured group. Hence, equipment scarcity is not likely the only explanation. Also, the study was initiated in October 2020, 7 months after COVID-19 arrival in Ghana and ended in April 2022, when COVID was still present. In general, as in much of sub-Saharan Africa, COVID's impact in Ghana was fairly small, compared to other regions of the world. Hence, although the study did take place during COVID, it is unlikely that this accounted for low usage of equipment such as SpO2 monitors. In similar fashion, in the above-noted study from Tanzania, the KPI of initial assessment with the lowest level of performance (23%) was measuring oxygen saturation [3]. In the above-noted study on registry completeness in India, recording of oxygen saturation was one of the least frequently recorded (84%) of the main variables from initial assessment [5].

The response to the intervention (trauma intake form - TIF) in the current study was disappointing, with only one KPI of initial assessment increasingly significantly (in the seriously injured group) and with no significant improvements for any aspect of reassessment. Rates of assessment were mostly above 90% after TIF but significant improvements were minimal (compared to baseline), likely because of the high baseline rate in the before period. However, reassessment rates were minimal and stayed minimal after TIF. Conversely, the TIF was strongly associated with decreased mortality among seriously injured patients. It should be noted that the TIF did improve the performance of many other KPIs of care, such as chest auscultation, evaluation to rule out intra-abdominal bleeding, splinting of fractures (among others), as reported in other publications [7,22]. The mortality reduction observed among seriously injured patients could be a culmination of improvements in the many other KPIs of care, even though reassessment rates were not improved.

Given that the intervention (TIF) resulted in improvements in many other KPIs of care, it is difficult to understand why reassessment rates remained so low. One can conjecture that low emphasis on re-assessment is part of the medical culture in Ghana. If so, this pertains to both doctors and nurses, as both were involved in using the TIF. As noted above, the literature has scarcely addressed this important issue, and there is little to which to compare our findings making this an important topic for future research.

Given the appropriate emphasis placed on frequent reassessments in courses such as WHO's BEC course and ATLS [1,2], the current study demonstrates that these low reassessment rates are an important problem to address. The lack of responsiveness to the TIF, which was very effective at improving other KPIs of trauma care, indicates that other methods are needed to improve reassessment rates. This could include increased emphasis during courses such as BEC and ATLS and frequent in-service training of EHSP on these important concepts. Such continuing education courses, especially ATLS, have been extensively evaluated and shown to consistently improve knowledge and skills [23]. Nonetheless, it is important to emphasize that it is very difficult to change behavior. Hence, other methods to improve re-assessment rates need to be considered, such as incorporation in quality improvement programs and better monitoring and supervision.

Limitations

First, there may have been a Hawthorne effect due to the presence of observers. This would tend to be more pronounced in the first few months of the study, prior to introduction of the TIF. Hence, KPIs in the before period may have been artificially high. This would tend to bias the study towards under-assessment of the effect of the TIF. This may have obscured some of the potential effectiveness of the TIF. Second, some hospitals experienced change in EHSP, which necessitated extra training on use of the TIF. However, we did not encounter any important

change in service provision at the study hospitals during the study. Third, we only have in-hospital mortality data. We do not have mortality data on patients who were referred to other facilities. However, the percentage of referred patients was the same in the before and after periods and, thus, this limitation is unlikely to bias the study conclusions.

Conclusions

At non-tertiary hospitals in Ghana, rates of performance of key performance indicators of initial assessment are mostly adequate, but with some room for improvement. However, performance of key performance indicators for reassessment of patients remaining in the EU 30 min or longer are very low, most below 20%, even for seriously injured patients. This is a major concern. The intervention tested in this trial (trauma intake form) did not impact reassessment rates, despite impacting many other key performance indicators of trauma care. Other potential avenues to pursue include other quality improvement efforts and increased emphasis in training courses.

Authors' contribution

Authors contributed as follows to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: AG 50%, AI 13%, PD 12%, CM 25%. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

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Dissemination

Results of this clinical trial have been shared with staff of all eight hospitals. This has been done through in-person visits by the PI and through presentations and discussions at network meetings.

Declaration of competing interest

The authors declared no conflicts of interest.

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Supplementary materials

Appendix 1: The trauma intake form

Appendix 2: Key Performance Indicators

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.afjem.2024.05.001.

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