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How useful are Primary Trauma Care courses in sub-Saharan Africa?

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ABSTRACT

Introduction: More than five million deaths occur each year from injury with the vast majority occurring in low and middle-income countries (LMICs). Africa bears the highest road traffic related mortality rates in the world. Despite this, formal training in trauma management is not widely adopted in these countries. We report our results of 10 consecutive Primary Trauma Care (PTC) courses delivered in seven East and Central African countries, as part of the COSECSA Oxford Orthopaedic Link (COOL) initiative.
Methods: Candidate's knowledge and clinical confidence in trauma management were assessed using a multiple-choice questionnaire and a confidence matrix rating of eight clinical scenarios. We performed descriptive statistical analysis on knowledge and clinical confidence scores of candidates before and after the course. We sub-analysed these scores, examining specifically the difference that exist between gender, job-roles and instructors versus non-instructors.
Results: We have trained 345 new PTC providers and 99 new PTC instructors over the 10 courses. Data sets were complete for 322 candidates. Just under a third of candidates were women ($n = 94$). Over two-thirds of candidates ($n = 240$) were doctors, while the remainder comprised of nurses, medical students and clinical officers. Overall, the median pre-course MCQ score was 70% which increased to 87% post course ($p < 0.05$). Men achieved a higher MCQ score both pre- and post-course compared to women ($p < 0.05$); however there was no significant difference in the degree of improvement of MCQ scores between gender. Instructors outperform non-instructors ($p < 0.05$), and similarly doctors outperform non-doctors on final MCQ scores (post-course). However, it was the non-doctors who showed a statistically significant improvement in scores before and after the course (20% non-doctors vs 16% doctors, $p < 0.05$). Candidate's clinical confidence also demonstrated significant improvement following the course ($p < 0.05$).
Conclusion: Our work demonstrates that COOL-funded PTC courses in the COSECSA region delivered to front-line health staff have helped improve their knowledge and confidence in trauma management, irrespective of their job-roles and gender. Further follow-up is needed to establish the long-term impact of PTC courses in this region.
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Introduction

Injury is a leading cause of morbidity and mortality across the world, affecting in particular the young and healthy population who are the main breadwinners. More than 5 million deaths occur each year from injury with the vast majority occurring in low and middle-income countries (LMICs) [1,2]. Africa bears a heavy burden, with more deaths occurring each year from injury (either violence or accidents) than deaths linked to HIV AIDS, tuberculosis and malaria combined.

To deliver uniformly good trauma care in developed countries, the Advanced Trauma Life Support (ATLS) protocol is well

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established and widely adopted. However, although the ATLS principles are universally applicable, the feasibility and practicality of this approach in LMICs are less evident. Barriers include the lack of organised health care infrastructure, workforce, funding and education [3]. Recognising the disparity between the need for and provision of training in trauma management in LMICs, the Primary Trauma Care Foundation (PTCF) was set-up in 1997 to run courses for front-line staff in such countries to try and reduce the human and economic effect of injury [3]. Training is based on ATLS principles but adapted to fit the limited resources in LMICs. Furthermore, PTC courses are open to all front-line staff, free of charge, run by volunteers and encourage local 'cascading', whereby key delegates who have completed the course are trained as instructors.

In 2012, the University of Oxford, in collaboration with the College of Surgeons of East Central and Southern Africa (COSECSA), set up the COSECSA Oxford Orthopaedic Link (COOL) programme [4,5]. This aims to strengthen research and training in trauma and musculoskeletal impairment care in the 10 COSECSA countries. One of the programme's main activities is to support the establishment of sustainable PTC courses in the COSECSA region.

Ten PTC courses funded by the COOL programme were run in COSECSA countries between December 2012 and June 2013. This study aims to establish the impact of these PTC courses on candidates' knowledge and confidence in trauma management and explore the factors affecting this.

Methods

The PTC 2-day course, which is open to all levels of health care practitioners, by invitation or application, involves a combination of lectures, moulages and hands-on skills stations. It requires no high-tech facilities and is delivered by experienced clinicians. The initial PTC course in each country is run by visiting faculty (usually a team of 4), whereas later courses (cascade courses) in each country are run either jointly with or entirely by local PTC faculty.

Candidates were asked to complete a multiple-choice questionnaire (MCQ) at the start and end of the 2-day course. This comprised a set of 30 questions related to trauma which candidates had up to 45 min to complete. One point was awarded for every correct single best answer out of 5 options. There was no negative marking. Candidates were asked to complete the same set of questions at the end of the 2-day course and the percentage improvement was calculated. The MCQ was compiled from a list of questions within the PTC database that have been widely used in PTC courses over 60 countries. The MCQs were presented in a non-biased manner according to the best practice guidelines of writing multiple-choice questions. In addition to the MCQ, candidates were asked to rate how confident they would be in managing eight different trauma scenarios on a scale of one to five (five being very confident). This same confidence matrix was presented to candidates at the end of the 2-day course and the difference in scores were analysed. General data on patient demographics, including occupation, gender, place of work and trauma management experience, were also compiled.

A 1-day instructor course was held immediately after the end of the 2-day PTC course. Candidates for the instructor course were chosen based upon their clinical and leadership skills, either by the local course organiser at the end of the 2-day course, or put forward before the start of the course by faculty at their local hospital. These newly qualified instructors helped run the second 2-day PTC course that took place on day 4 and 5 of that same week. This 5-day schedule (2-day PTC course, 1 day PTC instructor course, 2-day PTC course run by newly qualified instructors) replicates the PTC introductory model known as 2:1:2, initially described by Wilkinson et al. [6].

Scores were collated and represented in percentages for comparative purposes. In addition to analysing the differences in overall MCQ and confidence matrix scores for candidates pre- and post-course, the impact of candidates' gender, occupation and whether they went on to become an instructor was compared.

Statistical analysis was carried out using STATA version 13.0 (Stata Corp, College Station, TX, USA) programme. A p-value of <0.05 was considered statistically significant. All candidates enrolled in this study gave written consent for their scores to be used in this analysis.

Results

General data and demographics

The first 10 COOL-funded PTC courses, from December 2012 to June 2013, have been held in seven of the COSECSA countries (Table 1). Each of these PTC courses followed the 2:1:2 model and was held over 5 consecutive days [6].

A total of 345 candidates participated in the courses, although we have complete data for 322 candidates (Table 2). Just under a third of candidates were women ($n = 94$). Four candidates had missing data on gender assignment which could not be ascertained from any other data gathered.

Over two-thirds of candidates ($n = 240$) were "doctors" which included physicians, anaesthetists, surgeons and medical officers. The remaining candidates were a combination of nurses, medical or nursing students, clinical officers and plastering technicians. A third of candidates ($n = 99$) were recruited as new instructors and delivered training during the second 2-day course.

Multiple-choice questions

Overall, the median pre-course MCQ score was 70% which increased to 87% at the end of the 2-day course ($p < 0.05$) (Fig. 1, Table 3). Thirty candidates (9%) failed to show an improvement post-course, where 14 candidates demonstrated no change, while 16 demonstrated a decline in their MCQ scores (range 0 to −5).

Of the 30 candidates that failed to show an improvement in scores, 18 had an MCQ score that was greater than 75% both pre- and post-course. The remaining candidates that scored less that 75% consisted of 2 nurses, 1 health care worker and 9 doctors (combination of anaesthetists, surgeons, physicians, paediatricians and general practitioners).

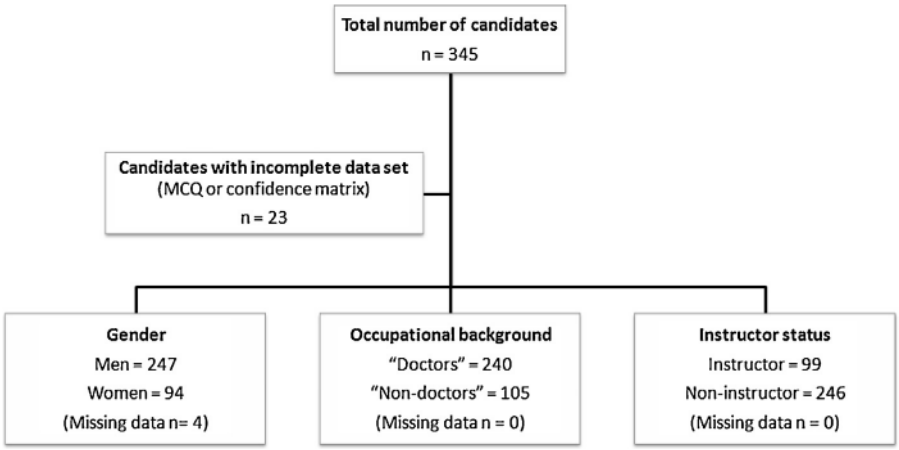
Men achieved a higher MCQ score both pre- and post-course compared to women (73% for men vs 67% for women pre-course, and 87% for men vs 83% for women post-course, $p < 0.05$, respectively), however there was no significant difference in change of scores between genders (Fig. 2).

Candidates who went on to become instructors on subsequent 2-day PTC courses obtained a higher MCQ score overall (both pre- and post-course) compared to non-instructors (73% and 90% vs 67%

Table 1
List of COOL-funded PTC courses from December 2012 to June 2013.

Course no.	COSECSA country	Course date	Location
1	Kenya 01	December 12	Nanyuki
2	Malawi 01	February 13	Blantyre
3	Uganda 01	February 13	Kampala
4	Mozambique 01	March 13	Maputo
5	Rwanda 01	April 13	Kigali
6	Kenya 02	April 13	Kitale
7	Zimbabwe 01	April 13	Harare
8	Uganda 02	May 13	Soroti
9	Malawi 02	May 13	Blantyre
10	Ethiopia 01	June 13	Addis

Table 2
Candidate information.



and 87%, respectively), however non-instructors achieved a greater change in score (18% vs 14%, $p < 0.05$).

Similarly, doctors achieved a higher MCQ score both pre- and post-course (73% and 90% vs 57% and 77% for non-doctors), however non-doctors showed a statistically significant higher change in score (20% vs 16%, $p < 0.05$) (Fig. 3).

Confidence matrix

Trainees' confidence in managing trauma patients also improved significantly (mean pre-course 73% vs mean post-course 95%, $p < 0.05$) There appears to be no direct correlation between level of knowledge (MCQ score) and level of confidence either pre or post-course (Spearman correlation pre-course $r = 0.25$, $p < 0.05$, post-course $r = 0.072$, $p < 0.05$). However it is worth noting that following the course, the association of the candidate's knowledge and confidence on a scatter plot assumed a more concentrated distribution towards greater confidence and knowledge (Fig. 4). This is a significant shift compared to the haphazard nature of candidates knowledge–confidence matrix before the course, confirming our observation that there was an improvement in both knowledge and confidence post course.

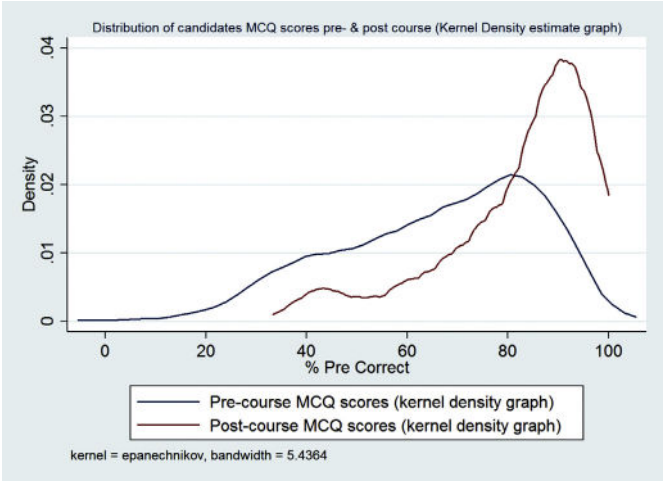


Fig. 1. Distribution of MCQ scores before and after PTC courses.

Discussion

Overall, 91% of candidates showed a significant improvement in their knowledge post PTC course with a median increase of 17% in MCQ score. Similarly, candidates' confidence improved by 20%. This is the first in-depth analysis of the impact of the PTC course on candidates' knowledge and confidence in managing trauma patients, and explores some of the factors involved.

Formal trauma training courses have been in practice for about 30 years with ATLS courses taking the lead in trauma education in the late 1970s [7]. ATLS has been effective in improving trauma resuscitation skills for medical students and doctors as assessed by improved scores in theoretical knowledge, clinical examinations as well as through hands-on trauma simulation scenarios [8–11]. These courses have been shown to increase confidence and lead to a change in practice. Encouragingly, the benefits of ATLS have also been translated to clinical practice and some have linked it to improved trauma patient outcome in the first hour of admission and mortality rates for major trauma patients [12,13].

In comparison, PTC courses have been in place for a shorter duration of time and, to date, published information on its benefits and outcomes are limited. Amiri et al. showed a 26% improvement in written test scores post PTC course in a group of 64 candidates [14]. The analysis of the impact of a PTC course in Pakistan suggested a similar trend and reported improved outcomes on both written test scores and management of simulated trauma scenarios [15].

Although the results of this study are encouraging, they are in line with expectations that both knowledge and confidence would improve when tested upon immediate completion of a course. Of the 30 candidates (9%) who failed to improve, the majority (60%) already had a "good" score (defined arbitrarily at 75% correct answers) in both pre- and post-course, so the lack of improvement could be due to a ceiling effect. Of those candidates who scored less highly, only 3 were non-doctors, which suggests that having a medical degree/more extensive medical background is not essential to benefit from the PTC course learning experience.

Table 3
Median MCQ scores of candidates' pre-post scores.

	Median score (%)
Pre-course	70
Post-course	87
Mann–Whitney *U* test	$p < 0.05$

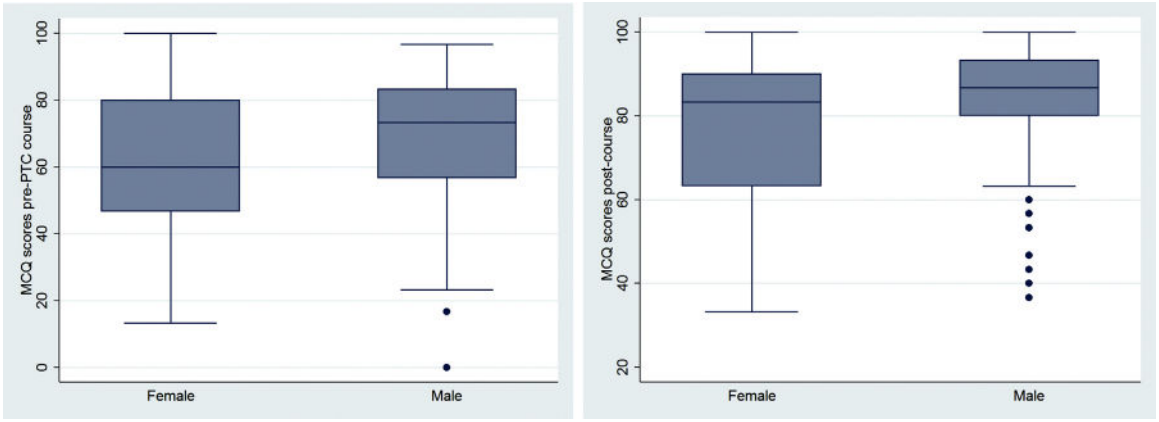


Fig. 2. Distribution of MCQ scores before and after the course, by gender.

Overall, men achieved higher MCQ scores throughout but there was no statistical difference in score improvement between genders. As expected, "doctors" fared better overall, and non-doctors showed a greater improvement in knowledge, possibly secondary to a ceiling effect. Similarly, candidates recruited as PTC course instructors had better overall knowledge, and non-instructors had scope for greater change in MCQ score.

In analysing the effect of gender, the first notable difference is the high proportion of men compared to women who have participated in the PTC course with a ratio of 3:1. This follows similar trends to the higher percentage of boys compared to girls who are enrolled in secondary education in sub-Saharan countries (Gender Parity Index for Sub Saharan Africa 0.82 vs 1.06 for the world) [16]. However, variations per country within the sub-Saharan region are notable. For example, the female to male ratio enrolment in secondary education in 2013 in Malawi was 0.97, compared to 0.66 in Ethiopia [17]. This trend was apparent in sub-analysis of gender participation with the female to male ratio in Ethiopia being 0.14 compared to 0.42 in Malawi. Over the past 20 years women have become an increasing part of the medical profession in Europe and North-America, however there remains unequal gender gap in most sub-African medical schools [18,19]. The disparity observed between the genders in MCQ performance could be explained by the greater number of male doctors in our cohort. This is substantiated when sub-analysing post-course MCQ scores between men and women in each job-role, which demonstrated no significant difference between their performances ($p > 0.05$). Further analysis confirms no statistical difference in degree of improvement between men and women in our cohort of candidates, proving that the course content and style of delivery is similarly applicable and beneficial to both.

Analysis of scores based on occupational background shows that "doctors" (which regroups candidates with more extensive medical knowledge and exposure, including physicians, surgeons, anaesthetists and medical officers) achieve a higher pre- and post-course score compared to "non-doctors". However, importantly, both groups show a significant improvement in score. This validates the need for ongoing training of doctors, as despite holding a higher medical degree these candidates appear to benefit from participating in the course. Secondly, it supports the view that the PTC course is applicable and useful to all health care workers. This is of prime importance especially in regions of the world where there is a great shortage of medical personnel. For example, Malawi, with a population of 14 million has only 10 orthopaedic surgeons. Furthermore, training non-health care workers such as bus and lorry drivers, and agricultural workers, who are likely to be among the first-responders to trauma patients, may be beneficial in improving trauma patient outcomes especially in countries where pre-hospital services are scarce.

Most of the instructors for these 10 COOL-funded PTC courses in each of the COSECSA countries have come from UK. These have been a combination of anaesthetists and surgeons who have had previous experience in delivering PTC courses. In most cases, the first PTC course in each COSECSA country was run in one of the main teaching hospitals in the capital city, with the aim of later cascading PTC courses to district hospitals and rural areas. The average cost for running these 10 PTC 5-day courses was approximately £6000 per course, which included venue hire,

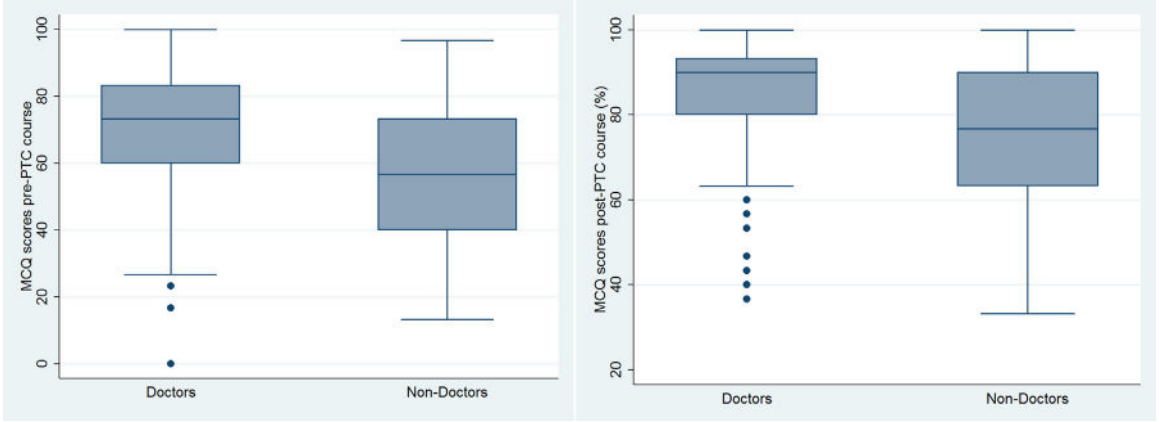


Fig. 3. Distribution of MCQ scores before and after the course for doctors vs non-doctors.

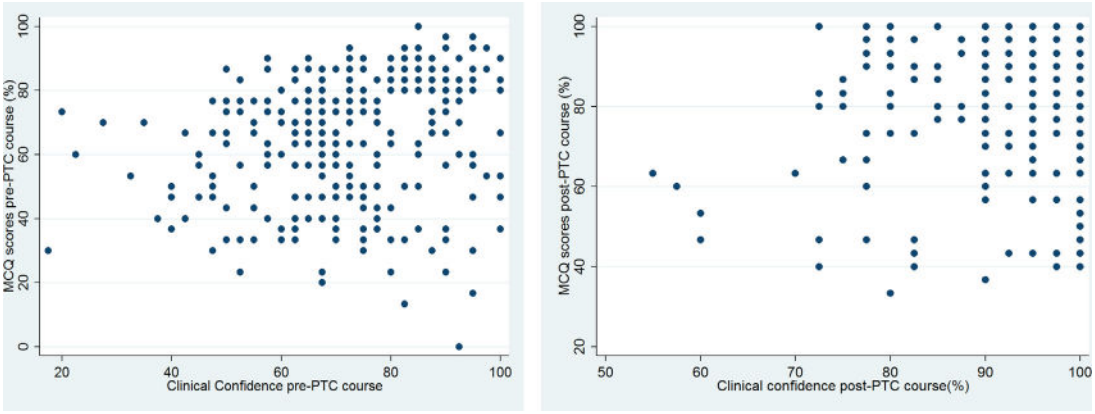


Fig. 4. Scatter plot of knowledge and confidence of candidates before and after PTC courses.

course materials, refreshments, and faculty travel and accommodation costs (on average 4 UK faculty per course). This cost excludes equipment, administrative and other overhead costs. During each of these 5-day '2:1:2' courses, on average 35 candidates attended a 2-day PTC course, and on average 10 candidates were trained to be PTC instructors. Although the training was initially provided by visiting overseas instructors, one of the key values of the Primary Trauma Care course is to encourage the cascading of PTC courses through training new local instructors, thereby empowering local health care workers to take ownership of PTC training, rapidly increasing manpower to deliver these courses, and reducing course costs.

Candidates who went on to become instructors had a higher pre- and post-course MCQ score compared to non-instructors. This suggests that, despite the lack of formal recruitment process assessing knowledge, new instructors appear to be selected wisely. However, similar to ATLS, there is no formal measure of a candidate's teaching potential apart from observation of their leadership skills and group dynamic. Training good instructors is key to the successful outcome of local cascading of PTC courses. As local cascading continues to unfold, further analysis will be needed to ensure cascading remains effective and that there is no loss in overall quality of training.

Despite our best efforts to ensure a complete data set, this was not possible in 23 cases primarily because the confidence matrix was not filled out by candidates or because the hand written answer sheets were illegible. The implementation of an electronic answer sheet is being considered. A further limitation is that this study does not examine whether an improvement in knowledge is reflected in better clinical outcomes. Crude outcome measures such as morbidity and mortality data need to be compared, although the accuracy, completeness and availability of these registries in LMICs are likely to be limited. Furthermore, it is difficult to establish the link (if any) between knowledge and confidence, as knowledge assessment using MCQs is theory-based whilst confidence is what the health care worker actually does when faced with a real life situation. It is reassuring to note that the PTC course did help in improving the confidence levels of candidates with an average improvement of 20%.

This paper has focused on MCQ scores and confidence levels immediately post-course. Analysis of these same measures several months on would be invaluable to ensure knowledge acquired is retained. It is important to establish whether the increase in knowledge is reflected in improved confidence and competence of the ground workers.

In conclusion, this study has shown that COOL-funded PTC courses in the COSECSA region have helped to improve knowledge and confidence in trauma management, irrespective of occupational background and gender. Further follow-up is needed to establish the long-term impact of PTC courses in this region.

Conflict of interests

The authors declare that they have no conflict of interests.

Ethics

According to IDREC guidelines, this study involves collected anonymised data where authors involved in the study are unable to trace back to the individuals who provided them. As such this research does not constitute a study involving human participants for review purposes.

Authors' contributions

MCN and NP – data collection and analysis, draft of manuscript. GL – data collection and revision of manuscript. HP, DO, GM, CL – developing the concept, critique of analysed data and revision of manuscript.

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