Injury, Int. J. Care Injured 47 (2016) 1128–1134

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Delivering a sustainable trauma management training programme tailored for low-resource settings in East, Central and Southern African countries using a cascading course model

N.A. Peter [a,*], H. Pandit [a], G. Le [a], M. Nduhiu [b], E. Moro [c], C. Lavy [a]

[a] Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences (NDORMS), Nuffield Orthopaedic Centre, University of Oxford, Windmill Road, Oxford OX3 7LD, United Kingdom
[b] Nyeri County Referral Hospital, PO Box 27-10140, Nyeri, Kenya
[c] Faculty of Medicine, Gulu University, Loroo Division, Gulu Municpality, Gulu 166, Gulu, Uganda

ARTICLE INFO

Article history:
Accepted 24 November 2015

Keywords:
Trauma
Injury
Training
Education
Developing country
Sub-Saharan Africa
Doctors
Nurses

ABSTRACT

Background: Injuries cause five million deaths and 279 Disability Adjusted Life Years (DALYS) each year worldwide. The COSECSA Oxford Orthopaedic Link (COOL) is a multi-country partnership programme that has delivered training in trauma management to nine sub-Saharan countries across a wide-cadre of health-workers using a model of "primary" courses delivered by UK instructors, followed by "cascading" courses led by local faculty. This study examines the impact on knowledge and clinical confidence among health-workers, and compares the performance of "cascading" and "primary" courses delivered in low-resource settings.

Methods: Data was collated from 1030 candidates (119 Clinical Officers, 540 Doctors, 260 Nurses and 111 Medical Students) trained over 28 courses (9 "primary" and 19 "cascading" courses) in nine sub-Saharan countries between 2012 and 2013. Knowledge and clinical confidence of candidates were assessed using pre- and post-course MCQs and confidence matrix rating of clinical scenarios. Changes were measured in relation to co-variants of gender, job roles and primary versus cascading courses. Multivariate regression modelling and cost analysis was performed to examine the impact of primary versus cascading courses on candidates' performance.

Findings: There was a significant improvement in knowledge (58% to 77%, $p < 0.05$) and clinical confidence (68% to 90%, $p < 0.05$) post-course. "Non-doctors" demonstrated a greater improvement in knowledge (22%) and confidence (24%) following the course ($p < 0.05$). The degree of improvement of MCQ scores differed significantly, with the cascading courses (21%) outperforming primary courses (15%) ($p < 0.002$). This is further supported by multivariate regression modelling where cascading courses are a strong predictor for improvement in MCQ scores (Coef = 4.83, $p < 0.05$).

Interpretation: Trauma management training of health-workers plays a pivotal role in tackling the ever-growing trauma burden in Africa. Our study suggests cascading PTC courses may be an effective model in delivering trauma training in low-resource settings, however further studies are required to determine its efficacy in improving clinical competence and retention of knowledge and skills in the long term.
© 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

Traumatic injuries are a neglected epidemic in developing countries [1,2]. More than five million deaths/per year are related to injury, and 90% of this burden is borne by low and middle income countries (LMICs) [3–5]. This burden is expected to grow and current projections estimate that it will overtake HIV/AIDS and TB as a cause of world mortality by 2020 [1,6].

Although Africa is home to only 2% of the world's vehicles, it has one the highest road traffic related mortality rates, reaching unprecedented epidemic proportions at 28 per 100,000 population [6–8]. This equates to an approximately 14-fold higher risk of dying in a road traffic accident in Africa than in the United Kingdom [7]. Despite this, many frontline health workers in sub-Saharan African countries manage multiply injured patients with minimal formal training in trauma management, and often work with limited medical resources [9–13].

* Corresponding author. Tel.: +44 07988704232.
E-mail address: noel.peter@ndorms.ox.ac.uk (N.A. Peter).

http://dx.doi.org/10.1016/j.injury.2015.11.042
0020–1383/© 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

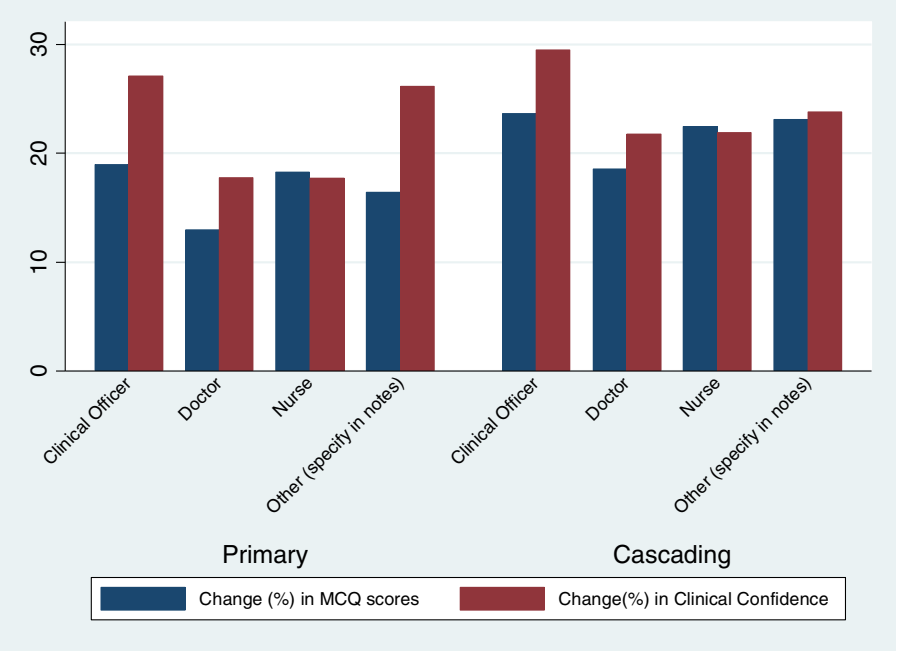

Fig. 1. Percentage of improvement in MCQ and clinical confidence scores between different job roles in primary versus cascading courses.

This remains a stark contrast to clinicians in high-income countries (HICs), where trauma management training are commonly founded on principles from the Advanced Trauma Life Support (ATLS)® system. The ATLS® system, produced by the American College of Surgeons [14], is a well-established protocol-based system for treating severely injured trauma patients. However the implementation of this system has not been as widely adopted in sub-Saharan Africa as in Europe and North America [15,16]. A relative lack of basic medical resources, limited funding and insufficient skilled staff are among the key reasons [17]. Furthermore, many of the limited resource settings in LMICs are unable to support the specialised resource-dependent and technology-driven protocols advocated by the ATLS system [18] (Fig. 1).

It was with this premise in mind that the Primary Trauma Care (PTC) course was developed in 1997 to address this challenge [19]. The PTC course aims to train doctors, nurses, paramedics and other clinical personnel in the management of severely injured patients in low-resource settings. In 2003, the PTC manual was published by the World Health Organisation (WHO) and to date the course has been delivered in over 60 countries, in at least 14 different languages [19]. Though the course was originally designed for use in low-resource settings in Africa, previous efforts to establish a sustainable programme have met limited success [20,21]. As a result, trauma training among frontline health workers in sub-Saharan Africa remains sporadic and sparse [11,20,22].

In response to this ever-growing need, the College of Surgeons of East, Central and Southern Africa (COSECSA) has collaborated with the University of Oxford in establishing a multi-country partnership programme to improve trauma management training within the region. The COSECSA-Oxford-Orthopaedic Link (COOL) [23] programme was established in 2012 through the support of the Health Partnership Scheme by the UK Department for International Development (DFID) and the Tropical Health Education Trust (THET). One of the goals of the programme is to address the critical need of training more frontline health workers in trauma management. The project seeks to achieve this by running 45 PTC courses over a three year period (2012–2015), training around 1800 new PTC providers across the ten sub-Saharan countries in the COSECSA region (Burundi, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda, Zambia and Zimbabwe) (Fig. 2).

The framework of the programme, is based on PTC courses being delivered in each of our partner countries applying a "2:1:2" format. This in simple terms, equates to a standard two day provider training course, followed by a one day instructor's course and finally ending with a further two day provider training course. The first PTC course ("primary") in each country is delivered by a team of four UK National Health Service (NHS) instructors. On completion of the first PTC course ("primary") in the country, subsequent "2:1:2" PTC ("cascading") courses are led by a team of local instructors with a UK instructor present to offer mentorship to the new instructors. This format allows for a quick and effective dissemination of trauma management training to health-workers, particularly those working in rural parts of the country, where often the need is greatest (Table 1).

Although the concept of cascading PTC courses is appealing, its efficacy is not proven. Ultimately, if cascading courses fail to deliver training to a high standard, then their introduction in LMICs will be counter-productive and costly in the long-run. We addresses the question of how effective the "cascading" training model is in delivering adequate and appropriate training to health workers in low resource settings.

Methodology

Ethics & role of the funding source

Written informed consent was obtained from all the participants. No identifiable information was collected. No personal or identifiable data has been reported in the manuscript. Ethics approval for the study was by the Medical Sciences Inter Divisional Research Ethics Committee Research Services, University of Oxford. The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication (Table 2).

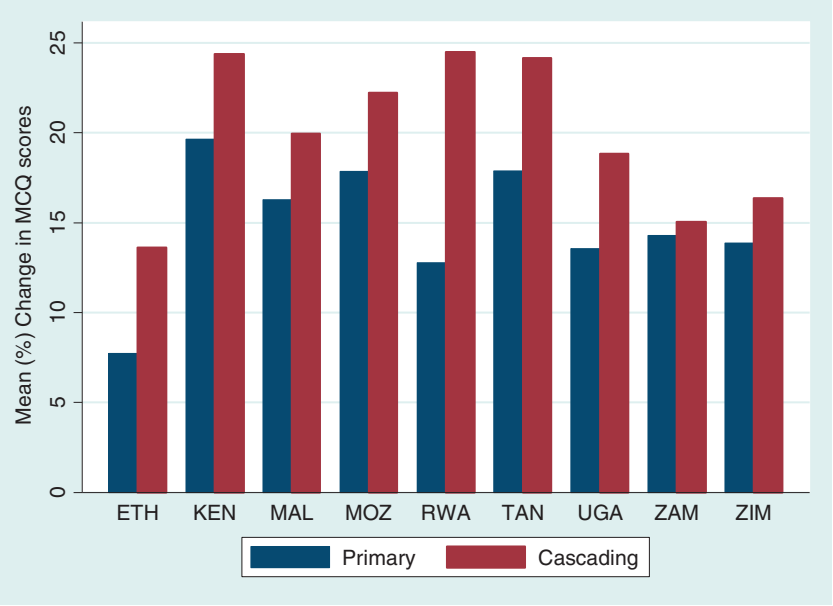

Fig. 2. Percentage of change in MCQ scores between countries in primary versus cascading courses.

Study setting and participants

All PTC courses instituted by the COOL project adopted the "2:1:2" model, which was held over 5 consecutive days. The 2-day provider course outlined the "ABCDE" approach to trauma management through a mixture of lectures and small group discussions. Practical skills and "trauma moulages" were run at stations in small groups during the course. The candidates were assessed on their knowledge of trauma management and clinical confidence which were administered using a multiple choice questionnaire (30 MCQs) and a confidence matrix of clinical scenarios (8 scenarios). Consent was obtained from all participants and individual information was anonymised. Candidates who demonstrated strong teaching attributes were invited to attend an instructor's course the next day. The instructor's course was centred on the principles of teaching and emphasis was made on giving feedback, teaching a skill, delivering a lecture and facilitating small group discussions. This new faculty of local trainers then ran a further 2-day PTC course, with the UK NHS instructors available to offer support and mentorship. This framework was designed to facilitate delivery of subsequent cascading courses by local faculty to more rural health institutions in each respective country (Table 3).

Knowledge and clinical confidence scores were collated before and after each course and standardised to percentages for purpose of comparison. Demographic data, MCQ and confidence matrix scores were entered and coded in Excel (Microsoft, Redmond, WA, USA), while further statistical analysis was performed using STATA version 13.0 (StataCorp, College Station, TX, USA). Descriptive and summary statistics were employed with an alpha level set at 0.05. Multivariate regression modelling of MCQ and clinical confidence scores was performed to examine the difference between primary and cascading courses, having adjusted for the confounders of gender, job-roles and country of origin. A cost analysis was calculated, taking into consideration expenditure on venue, operating expenses, flights, accommodation and meals per PTC course. All instructors delivered training during these courses on a voluntary basis (Table 4).

Table 1
Educational framework of provider and instructor courses.

Day/course	Content	Teaching methods
Day 1 Provider course	Pre-course assessments Primary Survey Airway and breathing Circulation and shock Secondary Survey Chest injuries Major Haemorrhage	Lectures Skill stations Workshops Small Group discussions Trauma moulages
Day 2 Provider course	Head and spinal trauma Abdominal and limb trauma Trauma in children Trauma in pregnancy Burns Transport and transfer Disaster management Post-course assessments	Lectures Skill stations Workshops Small Group discussions Trauma moulages
Day 1 Instructors course	How adults learn? Asking questions Feedback Giving a lecture/presentation Facilitating a discussion group Teaching a skill Facilitating a scenario Language issues How to run the course?	Lectures Discussion groups Workshops

Results

In the period from December 2012 to December 2013, 1030 new PTC providers were trained across nine countries in the

Table 2
Demographic data of candidates attending primary versus cascading courses.

	Primary courses	Cascading courses
Total number of candidates	330	700
Gender		
Male ♂	♂: 238 (72%)	♂: 419 (60%)
Female ♀	♀: 92 (28%)	♀: 281 (40%)
Job titles		
Clinical officers	28 (8%)	91 (13%)
Doctors	224 (68%)	316 (45%)
Nurses	40 (12%)	220 (31%)
Other HW	38 (12%)	73 (10%)
Number of new instructors	92 (28%)	189 (27%)

Table 3
MCQ and clinical Confidence matrix scores between primary and cascading courses.

	Primary courses	Cascading courses
Pre-course MCQ		
Mean	69%	53%
SD	18.05	17.91
Std Error	1.00	0.686
95% CI	67.36–71.30	51.75–54.45
Post-course MCQ		
Mean	83%	74%
SD	14.13	16.87
Std Error	0.801	0.657
95% CI	81.73–84.88	72.22–74.79
% Improvement of MCQ		
Mean	15%	21%
SD	11.39	15.25
Std error	0.651	0.599
95% CI	13.23–15.80	19.73–22.08
Pre-course confidence matrix		
Mean	73%	67%
SD	15.50	17.28
Std error	1.026	0.740
95% CI	71.23–75.28	65.04–67.94
Post-course confidence matrix		
Mean	93%	89%
SD	8.47	13.59
Std error	0.556	0.570
95% CI	91.39–93.59	87.53–89.77
% Improvement confidence matrix		
Mean	19%	23%
SD	13.79	17.32
Std error	0.947	0.779
95% CI	17.53–21.26	21.47–24.53

COSECSA region over 28 courses through the COOL programme. 330 of these candidates were trained in nine ''primary courses'' versus 700 in 19 ''cascading courses''. The distribution of health worker roles among the candidates consisted 119 non-medically qualified clinical officers, 539 doctors, 261 nurses and 111 other health workers roles (e.g. occupational therapist, physiotherapist, medical students etc). 281 were trained as instructors, which comprised approximately a quarter of the new providers. The overall mean of (primary & cascading combined) pre-course MCQ scores was 58% (SD 19.5, 95% CI 57.1–59.5) and the overall mean post-course MCQ score was 77% (SD 16.7, 95% CI 75.6–77.7). Among the different health-worker groups, doctors average significantly higher pre- and post-course scores both in knowledge and clinical confidence. (Doctors PRE-MCQ = 68%, SD 17.3 95% CI 66.1–69.0, POST-MCQ = 84%, SD 13.3 95% CI 82.4–84.7). However, nurses and clinical officers demonstrated the greater degree of improvement in knowledge and clinical confidence following the course (Nurses = 22%, SD 14.1 95% CI 20.0–23.6, Clinical Officers = 23%, SD 13.1 95% CI 20.2–25.2).

Intriguingly, the degree of improvement of MCQ scores differed significantly between primary and cascading courses. Primary courses achieved a mean of 15% improvement (SD 11.4, 95% CI 13.2–15.8) compared with the cascading courses mean of 21% improvement (SD 15.3, 95% CI 19.7–22.1). The cascading effect is not universally identical across the COSECSA countries, as some countries outperformed others. In particular, cascading courses facilitated in Kenya, Malawi, Mozambique, Rwanda and Tanzania were particularly successful, achieving a mean improvement of MCQ scores >19% (Kenya = 24% SD 11.6, Malawi = 20% SD 18.5, Mozambique = 22% SD 14.22, Rwanda = 25% SD = 19.3, Tanzania = 24%, SD 16.1). Multivariate regression analysis demonstrates that a predictor to degree of improvement of MCQ scores among candidates includes: attending a cascading course (Coef = 4.83, $p < 0.05$), being a nurse (Coef = 2.67, $p = 0.05$) or clinical officer (Coef = 4.93, $p = 0.002$), and attending courses delivered in Kenya (Coef = 9.55, $p < 0.05$), Malawi (Coef = 6.00, $p < 0.05$), Mozambique (Coef = 8.52, $p < 0.05$), Rwanda (Coef = 7.22, $p = 0.001$) and Tanzania (Coef = 9.40, $p < 0.05$). Gender had no significant influence over the outcome of improvement in MCQ scores.

Table 4
Percentage of improvement of MCQ scores between health workers in primary and cascading course.

Job titles	Primary courses (Mean)	Cascading courses (Mean)
Clinical officer	19% (SD 9.71)	24% (SD 13.68)
Doctor	13% (SD 11.02)	19% (SD 15.54)
Nurse	18% (SD 11.18)	22% (SD 14.46)
Other health workers	16% (SD 12.99)	23% (SD 17.02)

The overall mean (primary & cascading combined) pre-course confidence matrix scores were 68% (SD 17.05, 95% CI 67.28–69.69) and the overall mean post-course confidence matrix scores were 90% (SD 12.45 95% CI 88.90–90.63). Analogously, when sub-analysing confidence scores between the different groups of health-workers, doctors appear more confident prior to the course compared to the rest of their colleagues (73%, SD 15.95, $p < 0.05$). However, this effect is diminished following the course with clinical officers demonstrating equally high levels of clinical confidence in managing trauma scenarios. (Clinical Officers Post = 93%, SD 7.82, Doctors Post = 91% SD 11.26). Once again, clinical officers and nurses demonstrate the largest improvements following the course (Clinical officers = 29%, Nurses = 22%).

There was a significant difference in the degree of confidence improvement between primary (19%, SD = 13.79, 95% CI 17.53–21.27) versus cascading courses (23%, SD = 17.32, 95% CI 21.48–24.53, $p < 0.05$). However, multivariate regression analysis of independent co-variants demonstrated that the only strong predictor towards improvement of clinical confidence in our study was attending courses delivered in the following countries: Kenya, Malawi, Zambia and Zimbabwe. Neither the independent variables of gender, different job roles, nor primary or cascading courses, demonstrated any significant predictive influence on improvement of clinical confidence.

Value for money

From a cost perspective, a 2:1:2 courses (taking into consideration expenditure on venue, operating expenses, flights, accommodation and meals) demonstrated a significant saving of £2000 in favour of cascading courses compared with primary courses. Assuming 30 candidates are trained during the course of the week, this equates to roughly a saving of £66.86 per candidate attending a cascading course. The main reason the cascading courses are cheaper than primary courses are the lower faculty travel and accommodation expenses for local faculty versus external overseas faculty costs.

Discussion

The magnitude of the global trauma burden is staggering. Given the scale of the problem confronted by LMICs, there is a need to ensure that front-line health workers are trained and equipped to deal with life-threatening injuries effectively [24]. Our findings indicate an improvement in knowledge and clinical confidence of trauma management among health-workers across the nine COSECSA countries. Both nurses and clinical officers demonstrate the most significant improvement in these areas. Furthermore, cascading courses delivered by local instructors achieved excellent training outcomes, and represent a cost-effective method in delivering trauma training in LMICs.

Considering that 95% of disaster-related deaths occur in the developing world, it is astounding that less than 1% of all

trauma-related publications relate to LMICs [25]. The lack of tangible data and accurate estimates of mortality and morbidity rates in the region have been amongst the challenges of implementing policy-making and public-health initiatives in this area [26]. For this reason, it is unsurprising there is limited evidence in the literature demonstrating whether ATLS® or similar training programs impact the outcomes for trauma victims in LMICs [27]. However, there is evidence that these educational initiatives improve knowledge and clinical confidence among health-workers. Other medical training initiatives suggest that an increase in knowledge and confidence does impact positively on patient outcomes, such as that seen in cardiac resuscitation and obstetric emergency [28–30]. However, not all models of trauma management training developed in HICs are appropriate for low-resource settings. Training programmes should be assessed for appropriateness on the basis of effectiveness, affordability, available local resources, and likelihood of sustainability before implementation in LMICs [16].

Cost-effectiveness

From an affordability perspective, the cost of a three day ATLS® course is £600 per participant, which is indeed a substantial amount for medical staff in sub-Saharan African countries to afford [20]. The PTC Foundation has ensured that its material is freely accessible to all, as both the manual and instructor packs are available online at no cost [19]. However, there is some expenditure incurred in organising these courses, although all candidates as part of the COOL project attended the courses free of charge. The average cost for a primary five day PTC course was £7115, while the average cost for a five day cascading course was £5109. Our cost estimation for a candidate attending a 2:1:2 primary PTC course was £237, versus the average cost per 2:1:2 cascading course of £170. We believe, the relative affordability of the PTC programme offers an attractive case for its integration into the wider post-graduate medical curricula in LMICs, with minimal financial support needed from local health ministries. Furthermore, this is a move away from training programmes which are dependent on frequent visits by clinicians from high income countries to deliver training in low-middle income countries, to a model which harnesses and develops local instructors and resources.

Improving knowledge and clinical confidence in managing the multiply injured patient

Knowledge components of trauma training courses are typically assessed through written examinations. Measuring the candidates' baseline level of knowledge prior to the course, helps to identify areas of weakness and also serves as a measure to evaluate their improvement and effectiveness of the course. The overall mean pre-course MCQ score was 58% and the overall mean post-course MCQ score was 77%. The overall gain of knowledge seen among participants attending the PTC courses overall (primary and cascading courses combined) is a mean of 19%. This compares favourably with the literature that reports increase in knowledge ranging from 8% to 14% in other trauma training courses instituted in LMICs [31–33]. The overall mean pre-course confidence matrix score was 68% and the overall mean post-course confidence matrix score was 90%. The overall mean gain in clinical confidence among the candidates was 22%. Intriguingly, candidates attending cascading courses appear to have a greater improvement in knowledge (MCQ scores) compared with primary course (21% versus 15%, $p < 0.05$). A similar effect is seen when analysing increase in clinical confidence among candidates in managing a variety of trauma scenarios (Primary 19% versus Cascading 23%, $p = 0.079$). Although clinical confidence scores are "self-perception" scores by each individual candidate, we believe it serves as a gross measure of a candidate's self-efficacy. Nevertheless, these measures of "confidence" should not be mistaken as a measure of clinical competence, nor is it a measure of clinical performance. Previous studies have demonstrated that confidence levels have poor predictive value in clinical performance [34–40]. However, as per Albert Bandura's work, we can only assume the greater a candidates self-efficacy/confidence, the greater their likelihood of applying what they have learned in practice [41]. However, it is worth noting this may not translate to an improvement in clinical performance.

Why is there a difference between primary and cascading courses?

Some of the key differences between primary and cascading courses are worth noting. As part of the strategy of introducing the PTC programme to a country, the first course tended to be centrally based (i.e. in a major city) and was generally held at a large academic institution. The first course was taught and led by UK NHS instructors with the aim of introducing local senior doctors, academics and educationalists to the concept of the PTC programme and increasing a sense of local ownership. This was a crucial first step in a transferable cascade of training other health workers within the country. In general, subsequent cascade courses were run in more rural settings, and organised and led by local faculty, with a single UK mentor present for the duration of the course.

Candidates attending the PTC courses within the COOL project were not limited to doctors only. Where possible, other frontline medical staff involved in the care of severely injured patients including nurses, clinical officers, physiotherapists and medical students were included. Clinical officers are mid-level practitioners of medicine in East Africa who are not medically qualified, but are licensed to perform general medical duties and perform routine surgical procedures. Often, they are the key clinical workforce in rural health centres and district general hospitals, and based on our results appear to demonstrate significant benefit from the training.

Naturally, the primary courses in each country had a much higher distribution of doctors versus other health workers compared with the cascading courses. This is unsurprising as a majority of primary courses involved medical staff from teaching hospitals localised in urban centres. However, it is notable that within the cascading courses there is a much more diverse interprofessional distribution of health workers among candidates. Nevertheless, it is interesting that our analysis demonstrates that across all job-roles, health-workers attending cascading courses demonstrated a greater improvement in knowledge compared to primary courses ($p < 0.05$).

The reason for this is observation is likely multifactorial, and may be explained by the different teaching styles of instructors, fluency of the local language, greater appreciation of cultural differences, and knowledge of effective teaching strategies. It also stands to reason that local instructors may have a greater advantage in the delivery of the material through greater understanding of pertinent issues related to their practices. The findings of this study suggest that participants who attended a cascading course received an equal or better quality of training as those who attended a primary course.

However, this observation may also be explained by the difference in pre-course MCQ scores between the primary and cascading courses. The mean of the pre-course MCQ scores for primary courses was 69% versus the mean of cascading courses of 53%. It is plausible, that candidates in the primary courses started at a much higher baseline of knowledge, resulting in a "ceiling effect" to the degree of improvement seen in their scores, explaining the observed differences between the two groups.

Table 5
Cost analysis between primary and cascading courses.

Courses	Total cost per course (including flights, accommodation, meals and course venue)	Total cost per participant over a "2:1:2" PTC course
Primary	£7115.73	£237.19
Cascading	£5109.92	£170.33

The difference seen in the improvement in MCQ and confidence matrix scores among candidates in different countries is also an interesting observation. Tanzania demonstrated an impressive performance in their cascading courses. It may be that this is due in part to a higher distribution of clinical officers and nurses in their cohort of candidates, and the strong and dynamic local leadership seen in these countries. As Burundi joined COSECSA after the COOL programme commenced, PTC courses have yet to be delivered in the country. However, it is hoped that a course will be run in Burundi in the coming year led by newly qualified instructors from neighbouring Rwanda.

What is the difference between the COOL project and previous efforts?

The COOL programme sought to learn from lessons from previous efforts to develop sustainable trauma training programmes in sub-Saharan Africa [20]. By collaborating with the COSECSA and PTC Foundation, we have improved partnership with local representatives and succeeded in achieving greater surgical involvement within the programme. For historical reasons, previous efforts to run PTC courses in Africa had little involvement from local surgeons, who play a pivotal role in trauma management in most African healthcare systems. Engaging with local surgeons has significantly strengthened the leadership of PTC country teams and developed institutional support for further trauma training.

The relative affordability of the PTC programme and the grant provided by the Health Partnership Scheme has provided sufficient funding to allow the running of the initial set of courses. There has been positive engagement with local health ministries and some progress with integrating the programme into postgraduate surgical training in some countries. In Rwanda, Kenya and Uganda, cascading PTC courses have been funded locally by their respective Health Ministries (Table 5).

Our results suggest that, in contrast to past approaches to training in LMICs the cascading approach adopted in the COOL programme has shown success in building local training capacity and establishing a sustainable model of trauma training. This is a move away from dependency on brief visits from Western-based external trainers, and rather towards establishing a programme empowered and driven by local clinicians.

Limitations

There are several limitations to appreciate in our study. First, the improvement in knowledge and clinical confidence amongst candidates was assessed immediately on completion of the course and does not measure the long-term retention of these principles. We are currently running a follow-up study to monitor variations of knowledge and confidence among candidates in the long-term. Second, it was beyond the scope of this study to assess the application of the candidates' gain in knowledge and clinical confidence translating to an improvement in their day-to-day clinical performance. This is mainly due to the vast distribution of candidates across the nine countries involving more than 150 health institutions. We can only assume a more "knowledgeable" and more "confident" work-force in trauma management principles will possess the potential to deliver better care to trauma victims in their respective countries. Further work is required to determine its impact on clinical performance and competency, and ultimately if it leads to a beneficial outcome for patients. Third, there was certainly a degree of variation with regards to the mentorship provided in each cascading course. On the whole for the cascading courses, the UK mentors encouraged the newly trained local faculty to deliver all the lectures and teach the skill stations. Their role was primarily to provide dedicated feedback at various points of the course, particularly during the faculty meeting held at the end of each training day. However, we were unable to control for the varying degree of mentorship for each course, and appreciate this may have an influence on the performances of the "new instructors", as well as on the candidates in their respective cascading courses.

Conclusion

In conclusion, our analysis demonstrates that "cascading PTC courses" may be a suitable alternative to current trauma training model for health-workers in resource-limited settings. In view of the strong existing investment of Western-based capacity building training programs of various specialities that exist across Africa, this training model harnesses the experience and expertise of UK NHS health-workers to train and empower local African instructors. We believe it has significantly strengthened the sustainability and capacity of trauma training in the region. Useful lessons can be learned from this approach to support the development of global health partnerships and to improve the effectiveness and sustainability of other medical training programmes.

Conflict of interest statement

Professor Christopher Lavy, Miss Grace Le and Mr Noel Peter all report grants from Health Partnership Scheme (HPS) Multi-Country Health Partnerships for Global Health through the Tropical Health Education Trust (THET) during the course of this study. Professor Pandit reports grants from Health Partnership Scheme (HPS) Multi-Country Partnership–Partnerships for Global Health through the Tropical Health Education Trust (THET), during the conduct of the study. He also reports grants from UKIERI and personal fees from Biomet outside the submitted work. Dr Mathenge Nduhiu and Prof Moro declare no conflicts of interest.

References

[1] Stelfox HT, Joshipura M, Chadbunchachai W, et al. Trauma quality improvement in low and middle income countries of the Asia-Pacific region: a mixed methods study. World J Surg 2012;36(8):1978–92.
[2] Krug E. Injury: a leading cause of the global burden of disease 1999. ⟨www.who.int/violence_injury_prevention/index.html⟩ (accessed 1st August 2014).
[3] Bergman S, Deckelbaum D, Lett R, et al. Assessing the impact of the trauma team training program in Tanzania. J Trauma 2008;65(4):879–83.
[4] Ozgediz D, Jamison D, Cherian M, McQueen K. The burden of surgical conditions and access to surgical care in low- and middle-income countries. Bull World Health Organ 2008;86(8):646–7.
[5] Peden M, Krug MKEG. Injury: a leading cause of the global burden of disease. Geneva: World Health Organisation; 2000. 2002.
[6] Murray CJ, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2012;380(9859):2197–223.
[7] WHO. Global status report on road safety 2013 2013. ⟨http://www.who.int/violence_injury_prevention/road_safety_status/2013/en/⟩.
[8] Krug EG, Sharma GK, Lozano R. The global burden of injuries. Am J Public Health 2000;90(4):523–6.
[9] Mock C, Kobusingye O, Joshipura M, Nguyen S, Arreola-Risa C. Strengthening trauma and critical care globally. Curr Opin Crit Care 2005;11(6):568–75.
[10] Mock C, Joshipura M, Arreola-Risa C, Quansah R. An estimate of the number of lives that could be saved through improvements in trauma care globally. World J Surg 2012;36(5):959–63.

[11] Hogan MP, Boone DC. Trauma education and assessment. Injury 2008;39(6):681–5.
[12] Hashmi ZG, Haider AH, Zafar SN, et al. Hospital-based trauma quality improvement initiatives: first step toward improving trauma outcomes in the developing world. J Trauma Acute Care Surg 2013;75(1):60–68-L. discussion 8.
[13] Mock C. WHO releases Guidelines for trauma quality improvement programmes. Inj Prev 2009;15(5):359. journal of the International Society for Child and Adolescent Injury Prevention.
[14] Advanced Trauma Life Support (ATLS(R)). Advanced Trauma Life Support (ATLS(R)): the ninth edition. J Trauma Acute Care Surg 2013;74(5):1363–6.
[15] Ali J, Adam R, Stedman M, Howard M, Williams J. Cognitive and attitudinal impact of the Advanced Trauma Life Support program in a developing country. J Trauma 1994;36(5):695–702.
[16] Sethi D, Aljunid S, Sulong SB, Zwi A. Injury care in low and middle-income countries: identifying potential for change. Inj Control Saf Promot 2000;7(3):153–64.
[17] Schuurman N, Cinnamon J, Matzopoulos R, Fawcett V, Nicol A, Hameed SM. Collecting injury surveillance data in low- and middle-income countries: the Cape Town Trauma Registry pilot. Global Public Health 2011;6(8):874–89.
[18] Pemberton J, Rambaran M, Cameron BH. Evaluating the long-term impact of the Trauma Team Training course in Guyana: an explanatory mixed-methods approach. Am J Surg 2013;205(2):119–24.
[19] PTC. Primary Trauma Care Foundation 2014. ⟨http://www.primarytraumacare.org/⟩ (accessed 3th April 2014).
[20] Wilkinson D, McDougall R. Primary trauma care. Anaesthesia 2007;62(Suppl. 1):61–4.
[21] PTC. Primary Trauma Care Foundation; 2014, ⟨http://www.primarytraumacare.org⟩ (accessed 9th July 2014).
[22] MacLeod JB, Gravelin S, Jones T, et al. Assessment of acute trauma care training in Kenya. Am Surg 2009;75(11):1118–23.
[23] COOL. COSECSA Oxford Orthopaedic Link (COOL) project. COOL; 2014, ⟨www.ndorms.ox.ac.uk/cool.php⟩ (accessed 1st of August 2014).
[24] Amiri H, Gholipour C, Mokhtarpour M, Shams Vahdati S, Hashemi Aghdam Y, Bakhshayeshi M. Two-day primary trauma care workshop: early and late evaluation of knowledge and practice. Eur J Emerg Med 2013;20(2):130–2. official journal of the European Society for Emergency Medicine.
[25] Roy N, Thakkar P, Shah H. Developing-world disaster research: present evidence and future priorities. Disaster Med Public Health Prep 2011;5(2):112–6.
[26] Etyang AO, Munge K, Bunyasi EW, et al. Burden of disease in adults admitted to hospital in a rural region of coastal Kenya: an analysis of data from linked clinical and demographic surveillance systems. Lancet Global Health 2014;2(4):e216–24.
[27] Jayaraman S, Sethi D. Advanced trauma life support training for hospital staff. Cochrane Database Syst Rev 2009;2:CD004173.
[28] Aune S, Eldh M, Engdahl J, et al. Improvement in the hospital organisation of CPR training and outcome after cardiac arrest in Sweden during a 10-year period. Resuscitation 2011;82(4):431–5.
[29] Draycott T, Sibanda T, Owen L, et al. Does training in obstetric emergencies improve neonatal outcome? BJOG: Int J Obstet Gynaecol 2006;113(2):177–82.
[30] Pottle A, Brant S. Does resuscitation training affect outcome from cardiac arrest? Accid Emerg Nurs 2000;8(1):46–51.
[31] Aboutanos MB, Rodas EB, Aboutanos SZ, et al. Trauma education and care in the jungle of Ecuador: where there is no advanced trauma life support. J Trauma 2007;62(3):714–9.
[32] Jawaid M, Ahmed Memon A, Masood Z, Nadeem Alam S. Effectiveness of the Primary Trauma Care Course: is the outcome satisfactory? Pak J Med Sci 2013;29(5):1265–8.
[33] Tiska MA, Adu-Ampofo M, Boakye G, Tuuli L, Mock CN. A model of prehospital trauma training for lay persons devised in Africa. Emerg Med J 2004;21(2):237–9.
[34] Morgan PJ, Cleave-Hogg D. Comparison between medical students' experience: confidence and competence. Med Educ 2002;36(6):534–9.
[35] Eva KW, Regehr G. Effective feedback for maintenance of competence: from data delivery to trusting dialogues. CMAJ: Can Med Assoc J journal de l'Association medicale canadienne2013;185(6):463–4.
[36] Miller PA, Nayer M, Eva KW. Psychometric properties of a peer-assessment program to assess continuing competence in physical therapy. Phys Ther 2010;90(7):1026–38.
[37] Miller PA, Cooper MA, Eva KW. Factors predicting competence as assessed with the written component of the Canadian Physiotherapy Competency Examination. Physiother Theory Pract 2010;26(1):12–21.
[38] Miller MD. Simulations in medical education: a review. Med Teach 1987;9(1):35–41.
[39] Tavares W, Eva KW. Impact of rating demands on rater-based assessments of clinical competence. Educ Prim Care 2014;25(6):308–18.
[40] Tavares W, Boet S, Theriault R, Mallette T, Eva KW. Global rating scale for the assessment of paramedic clinical competence. Prehosp Emerg Care 2013;17(1):57–67. official journal of the National Association of EMS Physicians and the National Association of State EMS Directors.
[41] Bandura A. Self-efficacy: toward a unifying theory of behavioral change. Psychol Rev 1977;84(2):191–215.