ORIGINAL RESEARCH

Analysis and recommendations based on evaluation data from AO Alliance educational events in sub-Saharan Africa and Asia

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Abstract

Background
Traumatic injuries are among the leading causes of death and permanent disability worldwide, disproportionately affecting low- and middle-income countries. The AO Alliance, a nonprofit organization, is committed to enhancing fracture care to limit the effects of trauma. They conduct courses on both operative and nonoperative trauma care in Asia and sub-Saharan Africa. This study aimed to investigate the effectiveness of 137 courses within 12 countries from January 2018 through August 2019.

Methods
An online course evaluation questionnaire was completed by participants and faculty at the end of each course. The online survey asked a mixture of multiple-choice and long-answer questions. Faculty members were asked to complete a follow-up questionnaire in addition to the course evaluation questionnaire.

Results
Participants in AO Alliance courses were mainly surgeons or operating room personnel with less than 5 years of experience. Most of the participants found the course content useful for their daily practice, that they learned something new and planned to use the new information in their practice, that the stated course objectives were met, and that faculty were effective. Having more practical exercise and discussion time and addressing the language barriers were the main areas of improvement identified. Most chairpersons have implemented the suggestions by increasing discussion time and adapting the course content to the local setting and participants. Some suggestions could not be implemented due to a lack of financial resources.

Conclusions
The overall data support the usefulness of AO Alliance courses and reaffirm that they are highly valued in low- and middle-income countries by participants and faculty. Offering more courses in Africa would allow for a smaller course setting, which could further improve overall course quality.

Keywords: fractures, surgical education, surgeons, operating room personnel, orthopaedic trauma, operative care, nonoperative care, Asia, Africa

Introduction

Injury is the sixth leading cause of death and the fifth leading cause of permanent disability worldwide.[1],[2] Injuries disproportionately affect low- and middle-income countries (LMICs), where they cause 5 million deaths each year and are estimated to cause between 50 and 250 million cases of disability annually.[3],[4]

A significant factor leading to disability and poor patient outcomes in LMICs is the lack of access to resources (e.g., trained medical and nursing staff, infrastructure, equipment, and supplies), as suggested by the lower yearly government healthcare expenditure of sub-Saharan Africa (US$1.67 billion) compared with the European Union (US$4.15 billion).[5] Several nonprofit organizations have been committed to investing in surgery-related global health initiatives, especially during conflicts and natural disasters.[6] However, this is not sufficient to improve the treatment of all injuries. A lack of proper training in the management of orthopaedic injuries is another main factor contributing to death and disability in LMICs.[7],[8] The World Health Organization has developed guidelines for essential trauma care that encourage the creation of trauma courses tailored towards settings of varying resource capacity.[9]

The AO Alliance is a nongovernmental organization that has focused on enhancing operative and nonoperative fracture care in LMICs since 2015. The AO Alliance is active in 11 countries within English-speaking Africa (The Gambia, Ghana, Ethiopia, Kenya, Malawi, Nigeria, Rwanda, Tanzania, Uganda, Zambia, and Zimbabwe), 13 countries in French-speaking Africa (Benin, Burkina Faso, Burundi, Cameroon, Chad, Congo, Democratic Republic of Congo, Gabon, Guinea, Ivory Coast, Niger, Senegal, and Togo), and 7 countries in Asia (Bangladesh, Cambodia, Laos, Myanmar, Nepal, Sri Lanka, and Vietnam).[10] Between January 2015 and August 2019, the AO Alliance delivered a total of 309 courses in these 3 regions. To gauge the impact of these courses and the possible barriers, course evaluation forms were collected on a regular basis. The evaluations were first paper-based and then web-based. This change was first implemented in January 2018 with the intent of increasing standardization and data accessibility. We electronically collected the evaluations of 137 courses administered between January 2018 and August 2019. Through the analysis of these data, we evaluated the impact of the AO Alliance courses and identified some of the key limitations faced in implementing educational interventions in LMICs.

Methods

Intervention

The AO Alliance offers in-person courses for both surgeons and operating room personnel (ORP): Basic Principles of Fracture Management (both operative and nonoperative), Advanced Principles of Fracture Management, Primary Trauma Care, and subspeciality courses (operative). The course curricula were developed over several years and built on existing educational materials from the AO Foundation Socio-Economic Committee (AO SEC). These courses are adapted to meet regional and local needs (e.g., translated for French-speaking Africa), as well as specific groups of medical professionals, namely, paramedics, ORP, surgeons, and residents. The course planning starts with a request from the country to the AO Alliance, who establishes the annual schedule of events and then provides the curriculum, teaching materials, and resources to the local chairperson and faculty. These local surgeons have a good understanding of locally available resources and ensure the delivery of education tailored to local settings and participants. For example, we offer more nonoperative courses where nonoperative treat-

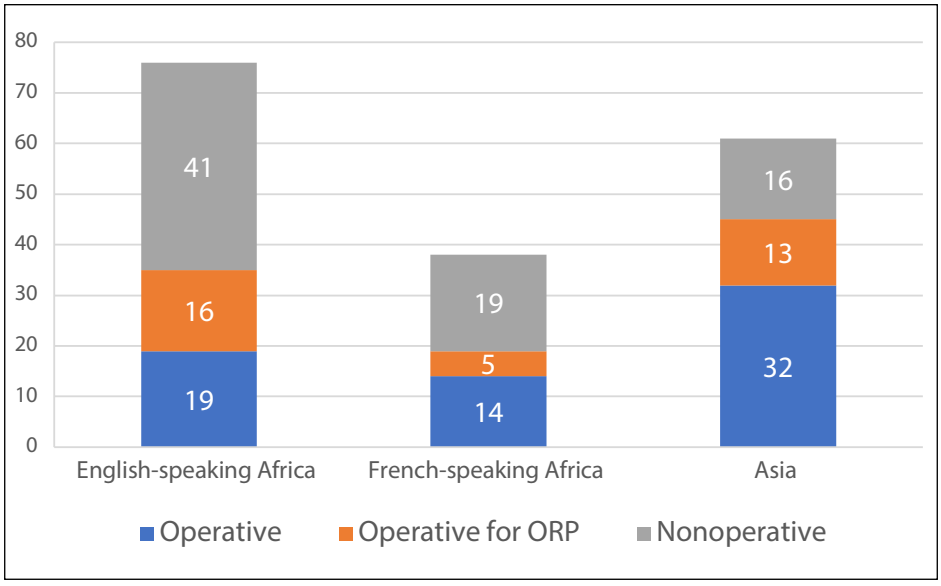

Figure 1. Number of AO Alliance operative and nonoperative courses (2018-2019)

ment is the preferred option because of poor access to resources (implants, equipment, operating rooms, inability of the patient to pay the treatment). This maximizes the application of learned knowledge and skills by participants. The local AO Alliance team organizes the venue and communication to participants. Registration is available online or on site. All expenses related to the course are covered by the AO Alliance with no additional financial support from regional governments. The event is then conducted over 2 to 3 days (depending on course type), including a precourse faculty meeting. The event is implemented using a combination of educational methods: lectures, small group discussions, and hands-on practical exercises.

Study design

This was a retrospective analysis of data collected from 137 courses administered between January 2018 and August 2019.

Data collection

At the end of each course, the course organizers or chairpersons sent—by email or instant messaging platform—a link to participants who attended the full course and to faculty. The link brought them to an online evaluation form on the SurveyMonkey (Momentive Inc., San Mateo, CA, USA) platform, where 12 multiple-choice questions and 4 open-ended questions were presented (Table 1 and Supplementary File).

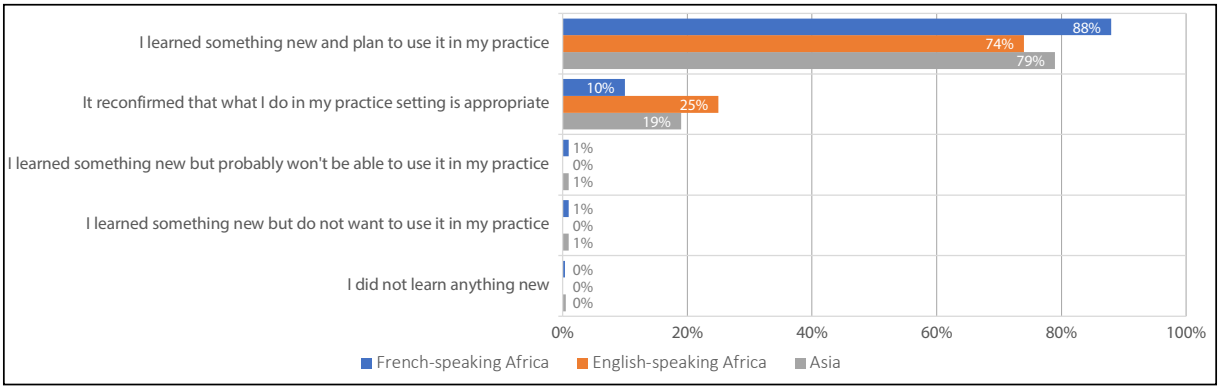

Figure 2. **Responses to the question, "What was the overall impact of this educational event?"**

Table 1. **Postcourse evaluation questions**

Postcourse online questionnaire
1. Which event did you attend (which event are you evaluating now)?
2. What is your current position (surgeon, operating room personnel, general practitioner, etc.)?
3. When did you graduate from medical school or other healthcare professional school?
4. What is your main practice location?
5. How many cases do you treat in an average month?
6. What was the overall impact of this educational event?
7. To what degree were the stated objectives met?
8. How useful was the content to your daily practice?
9. How effective were all faculty in the role they played?
10. Would you recommend this event to your colleagues?
11. Please describe 1 to 3 improvements you intend to make in your daily practice after this educational event.
12. Please rate the venue/location.
13. Did you perceive this event to be commercially biased?
14. Do you have any suggestions for improvements regarding content or faculty?
15. Did you experience any obstacles in terms of logistics, communication, and venue?
16. If you have suggestions regarding our future educational offerings, please enter these below.

Table 2. Follow-up questions for regional/national chairs

Follow-up questions
1. How many AO Alliance courses have you attended/organized in the last year?
2. How did you find the post-course evaluations?
3. Was it too long?
4. Were the questions clear?
5. Were there any words you didn't understand?
6. Are there any improvements/changes that can be made to the evaluation?
7. What changes did you implement due to comments from the previous evaluations provided to you?

All of the analysed data from the online evaluations were collected and sent out to each course chairperson, who were responsible for recommending improvements and changes to be implemented for upcoming AO Alliance courses. Surveys were administered in either English or French.

The evaluation survey questions were developed with the guidance of medical educationalists at the AO Foundation and adapted to be suitable for LMICs. To assure equivalence of the survey questions in both English and French and to generate functionally equivalent survey instruments in both languages, translation into French was done by a French-speaking trauma and orthopaedic surgeon with translation experience.

A set of follow-up questions was sent via email to all 65 course chairpersons between June and August 2019 (Table 2).

Data analysis

The 2350 responses to open-ended questions from participants and the 597 from faculty were grouped based on the occurrence of keywords using MAXQDA 2020 (VERBI Software, Berlin, Germany) and previously described methods.[11] We omitted comments with the following characteristics from the analysis of open-text responses: positive comments, those that were infrequently submitted, and those that were specific to a single event or course topic already shared with the course chairpersons and course organizers. All multiple-choice questions were grouped by respondent role (i.e., faculty, participant, chairperson/co-chairperson) and by region. Responses to the follow-up questions were grouped by region.

Ethical considerations

According to the Ethics Committee of the Canton of Zurich, this study did not require ethical committee authorization (Req-2020-00985). On the survey, we included the following statement of purpose, which disclosed our intended use of the data: "The information you provide will be anonymized and made available to the faculty and education planning groups in aggregate form. Data may be used for research purposes."

Results

The AO Alliance provided 171 courses on orthopaedic procedures between January 2018 and August 2019 in Asia and sub-Saharan Africa for a total of 7418 participants. Seventy-six courses were conducted in English-speaking Africa, 37 were conducted in French-speaking Africa, and 58 were in Asia (Table 3). The proportions of operative vs nonoperative courses varied by region, with a slight preponderance of operative courses in Asia and nonoperative courses in English-speaking Africa and French-speaking Africa (Figure 1).

The mean numbers of participants for each type of course and the evaluation response rates are shown in Table 4. English-speaking Africa had a mean of 40 participants per course (range, 14-85), French-speaking Africa had a mean of 45 participants (range, 28-88), and Asia had a mean of 42 participants (range, 23-74). We did not observe major differences in response rates between the regions.

Surgeons accounted for largest number of both course participants and faculty respondents, followed by ORP (Table 5). Twenty-five per cent of the attendees worked in local or community hospitals, 20% in level I trauma centres, 20% in level II trauma centres, 20% in university hospitals, and 10% in private practice. Additionally, 5% of respondents indicated practising in "other" settings. Sixty per cent of the attendees graduated in the 5 years before attending an AO Alliance course, and 59% reported treating more than 20 orthopaedic trauma cases per month.

Faculty respondents reported practising primarily at level I or II trauma centres (52%), with 61% treating over 20 cases per month related to the course content. They were more experienced than the course participants, with over 40% having graduated from medical school more than 15 years before completing the survey and 37% having graduated between 6 and 15 years prior. The remaining 20% graduated between 0 and 5 years prior.

Eighty-eight per cent of the participants responded that they had "learned something new and plan[ned] to use it in their practice" (Figure 2), and 85% responded that the content was either very or extremely useful to their daily practice. Ninety-one per cent of the course participants felt that the stated objectives of the course were either mostly met (52%) or fully met (39%). Eighty-two per cent of the par-

Table 3. Number of courses per country and by type

Country	Total number	Nonoperative	Operative	Operative for ORP
Asia				
Nepal	22	8	11	3
Bangladesh	9	3	4	2
Cambodia	6	1	4	1
Laos	6	0	4	2
Vietnam	6	3	4	2
Sri Lanka	5	1	2	2
Myanmar	4	0	3	1
French-speaking Africa				
Burkina Faso	5	1	4	0
Guinea	4	2	1	1
Chad	3	3	0	0
Gabon	3	2	1	
Ivory Coast	3	2	1	1
Niger	3	2	1	0
Togo	3	2	0	1
Benin	3	1	2	0
Burundi	3	1	1	1
Cameroon	3	1	2	0
Central African Republic	2	0	1	1
Democratic Republic of Congo	2	2	0	0
English-speaking Africa				
Malawi	21	9	6	6
Ghana	14	6	4	4
Ethiopia	7	2	2	3
Nigeria	7	4	2	1
Kenya	5	4	0	1
Tanzania	5	4	0	1
Rwanda	4	2	1	1
Uganda	4	4	0	0
Zambia	4	2	1	1
Zimbabwe	3	2	0	1
The Gambia	2	2	0	0

ORP, operating room personnel

Table 4. Mean number of participants and mean response rate by course type

Course type	Mean number of participants per course	Mean participant response rate, %
Operative course	38	53.5
Operative course for ORP	49	37
Nonoperative course	41	75.5

ORP, operating room personnel

ticipants rated faculty as either very or extremely effective, and 74% reported that AO Alliance teaching events are not commercially biased. Overall, 98% of participants would recommend the course to their colleagues: 96% for operative courses, 98% for operative ORP courses, and 98% for nonoperative courses.

Participants were asked to describe "1 to 3 improvements you intend to make in your daily practice after this educational event". An analysis of all open-text responses from course participants found that the 3 most frequently mentioned categories of intended changes were related to fracture fixation techniques, the 4 AO Principles, and patient safety.

Course participants from all regions proposed having longer courses and more time for practical exercises (Table 6). They also suggested increasing the number of courses to allow more people to participate and dedicate more time to practical exercises and case discussion (Table 6). In a few courses, participants experienced problems with communication before the event. For the Asian ORP courses, there were 24 comments asking to address language barriers by adding more local faculty.

Table 5. Current position of respondents (2018-2019)

Position	n (%)	
	Participants	Faculty
Surgeon	561 (16.7)	543 (65.5)
Surgical resident	673 (20)	34 (4.1)
ORP	586 (17.5)	162 (19.5)
Nurse	362 (10.8)	41 (4.9)
Physiotherapist	74 (2.2)	5 (0.6)
Orthopaedic surgeon	50 (1.5)	32 (3.9)
Emergency physician	26 (0.8)	0 (0)
Paramedic	78 (2.3)	0 (0)
Casting technician	27 (0.8)	1 (0.1)
General practitioner	412 (12.3)	5 (0.6)
Medical student	184 (5.5)	0 (0)
Other	322 (9.6)	6 (0.7)
Total	3355 (100)	829 (100)

ORP, operating room personnel

Faculty suggested having more time allocated to practical sessions (Table 7). Several faculty suggested that additional faculty development be provided to improve teaching skills (Table 7). They also mentioned the large number of participants and the unequal experience levels among participants as challenges in some events. Some English- and French-speaking African faculty would like to have had fewer participants per course, while faculty in the courses in Asia felt that their courses would benefit from having more participants. Up to 12% of participants and faculty suggested that improvements were needed regarding the venues or locations (Figure 3).

For the follow-up questions, we received 26 chairperson responses (40%). We first addressed the quality of the post-course online evaluation. Chairpersons reported that the questions were valid; however, several chairpersons from all regions stated that the definition of "commercial bias" was not clear to them. Second, we enquired about changes made to courses due to feedback from the previous online evaluations. Most regional and national chairpersons stated that recurring suggestions were considered and that many courses had had more discussion time than previously available. Another change implemented by faculty was adaptation of the course content to local settings and participants (e.g., using local terminology and adapting to resources available to participants in their practice). Faculty in English-speaking Africa noted that there were limitations in implementing suggestions from the previous online evaluations due to a lack of financial resources.

Discussion

Our analysis of open-text responses revealed a high demand for more courses. This suggests that the number of fracture management courses offered in LMICs still does not match the needs of these countries. The overall data suggest that the AO Alliance courses are highly valued by most course participants and faculty in LMICs in all 3 participating regions.

The online evaluation forms used in this study were effective at highlighting areas to improve the quality of our future events. Compared with the previously available paper-

Table 6. Course participant comments for improvement and frequencies related to each main category

Category	n (%)		
	Asia	French-speaking Africa	English-speaking Africa
Overall			
Operative course	343 (100)	126 (100)	235 (100)
Operative course for Operating Room Personnel (ORP)	157 (100)	66 (100)	333 (100)
Nonoperative course	143 (100)	326 (100)	621 (100)
Offer longer courses			
Operative course	38 (11)	12 (9)	150 (63)
Operative course for ORP	26 (16)	7 (10)	104 (31)
Nonoperative course	25 (17)	42 (12)	178 (28)
Offer courses more frequently			
Operative course	40 (12)	17 (13)	86 (37)
Operative course for ORP	15 (10)	11 (17)	46 (14)
Nonoperative course	19 (13)	56 (17)	88 (14)
More time for practical exercises			
Operative course	45 (13)	43 (34)	75 (32)
Operative course for ORP	25 (16)	3 (5)	49 (15)
Nonoperative course	21 (15)	54 (17)	97 (16)
Faculty improvements (improve engagement, increase number, have more international or local faculty)			
Operative course	21 (6)	3 (2)	27 (11)
Operative course for ORP	16 (10)	4 (6)	16 (5)
Nonoperative course	16 (11)	13 (4)	26 (4)
Venue improvements (facilities, accommodation, Wi-Fi)			
Operative course	15 (4)	5 (4)	11 (5)
Operative course for ORP	6 (4)	2 (3)	4 (1)
Nonoperative course	6 (4)	5 (2)	24 (4)
Provide more educational resources (PowerPoint presentations, printed slides, videos)			
Operative course	5 (1)	10 (8)	25 (11)
Operative course for ORP	2 (1)	4 (6)	5 (1)
Nonoperative course	15 (10)	6 (2)	29 (5)

ORP, operating room personnel

based evaluations, the online version offered the advantage of being centralized and simplifying data analysis for general reporting. However, this system had some challenges and limitations. The main limitations of this study were the technical challenges of collecting data evenly from all courses; not all participants responded, and we cannot be sure that there was not selection bias in favour of some characteristics of those who chose to respond to our survey. Based on feedback from the local course organizers, some participants did not respond due to a lack of Internet access. Moreover, especially for ORPs, the language barriers presented an obstacle to answering the survey questions. For this reason, we

Table 7. Faculty comments for improvement and frequencies related to each main category

Category	n (%)		
	Asia	French-speaking Africa	English-speaking Africa
Overall			
Operative course	111 (100)	23 (100)	38 (100)
Operative course for ORP	88 (100)	2 (100)	96(100)
Nonoperative course	70 (100)	38 (100)	131(100)
Offer longer courses			
Operative course	12 (10)	0 (0)	10 (26)
Operative course for ORP	19 (22)	0 (0)	33 (34)
Nonoperative course	11 (16)	1 (3)	25 (19)
Offer courses more frequently			
Operative course	15 (13)	5 (22)	3 (8)
Operative course for ORP	7 (8)	0 (0)	16 (17)
Nonoperative course	14 (2)	8 (21)	18 (14)
More time for practical exercise			
Operative course	16 (14)	2 (9)	6 (16)
Operative course for ORP	10 (11)	0 (0)	6 (7)
Nonoperative course	5 (7)	3 (8)	13 (10)
Faculty improvements (faculty development program, Pre-course faculty training)			
Operative course	17 (15)	2 (9)	4 (10)
Operative course for ORP	14 (16)	0 (0)	10 (10)
Nonoperative course	13 (18)	1 (3)	20 (15)

ORP, operating room personnel

eventually decided to provide Internet access at most of our courses and made the evaluation mandatory during the last day of the course; we even included the course evaluation in the course agenda. This increased the response rate in 2019. Another limitation was the difficulty associated with accurately categorizing thousands of open-text responses from different regions. We also did not include a precourse vs postcourse comparison for knowledge improvement or long term follow-up.

An important but unavoidable limitation was the qualitative nature of the data obtained. By this, we mean that our findings were not arrived at by statistical procedures or other means of quantification. Our findings convey the study participants' experiences, behaviours, emotions, and feelings, as well as information about the organizational functioning of the educational events. This means that this qualitative research was not statistical, and it incorporated multiple realities.

There have been several initiatives from different organizations trying to answer the call from the World Health Organization to create courses to improve trauma care in LMICs.[9] These programmes can cover the overall spectrum of life-saving procedures or specific topics. Some of them use approaches similar to that of the AO Alliance by offering 2-day courses that combine lectures and hands-on practical skills teaching. For example, the Primary Trauma Care (PTC) Foundation offers PTC courses in 80 LMICs. A study analysing PTC courses delivered in 10 sub-Saharan African countries showed improved short-term knowledge and confidence in trauma management.[12] Another study demonstrated long-term knowledge retention following a PTC course in Congo.[13] An analysis of feedback on the impact of single PTC courses revealed that the time allowed for hands-on practice was not adequate for 25% of the respondents.[14] This finding was in line with the numerous comments asking for more time for practical exercises in our analysis. There are also local initiatives, such as the develop-

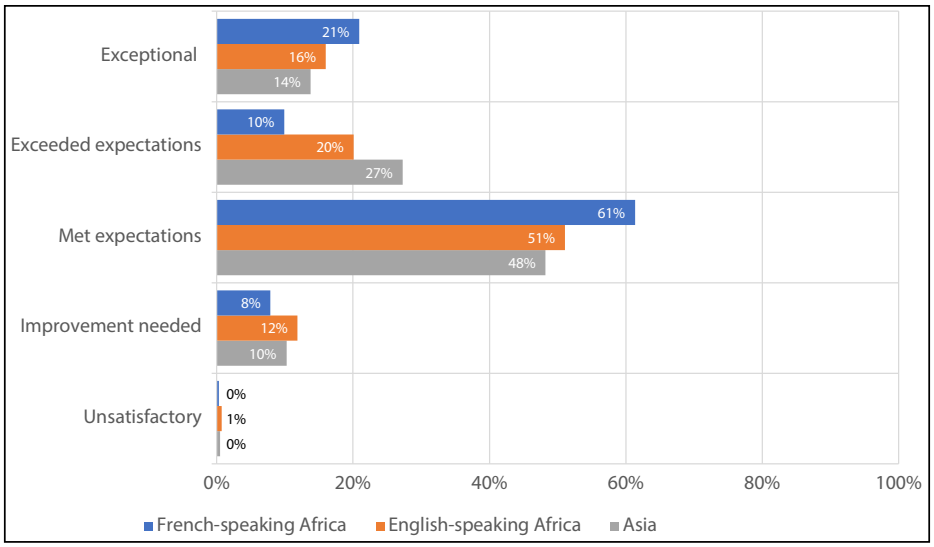

Figure 3. **Responses to "Please rate the venue/location"**

ment, by Kwame Nkrumah University in Ghana, of a trauma continuing medical education (CME) course for trauma management for general practitioners working in rural hospitals. This course included training for both operative and nonoperative procedures for managing fractures in adults and children (e.g., debridement of open fractures, recognition and treatment of vascular injury and compartment syndrome, and amputations).[15] This CME course increased short-term knowledge, and follow-up interviews suggested the application of the learned skills in clinical settings.[15]

All the studies described above suggest that skills-based courses improve the management of trauma patients. However, all the efforts to improve trauma care in LMICs must complement existing national policies and, when possible, be part of a broader national health agenda. For this reason, the AO Alliance started a project in Myanmar and Nepal to identify potential strategies for the future development of trauma care and injury prevention in a broader "National Trauma Care Plan".

Based on our analysis of the participants' responses, the AO Alliance has identified the following ways to improve its educational events. The first intended change is to offer supporting materials (e.g., slides) to participants so that they can review them later. However, we have observed that many course participants do not own personal computers but can view presentations on their smartphones.

To address the language barrier issues, especially in the ORP courses in Asia, the AO Alliance faculty sometimes creates dual-language slides. Additionally, local languages have been incorporated into small group discussions, although this requires adaptation for visiting faculty. Although many participants requested that the AO Alliance lengthen its courses, this is currently difficult to do because of financial constraints.

The AO Alliance has started to implement a faculty development programme to train new faculty members to prepare them to administer its educational materials and to improve course quality. The AO Alliance is working to create an online space where faculty can find educational resources, including pre-prepared PowerPoint (Microsoft Corp., Redmond, WA, USA) presentations or other recommended formats. This will be in addition to access to the AO Alliance faculty education programmes. The new AO Alliance Fracture Solutions Program aims to fill the remaining gaps in CME, including higher-level fracture care education and tailored, shorter topic-specific courses and seminars. The AO Alliance also plans to review the current curricula for its major courses, evaluating if they still meet local educational needs. Finally, the AO Alliance is looking forward to developing collaborative projects with AO Foundation clinical divisions to help fill existing educational gaps that would need topic-specific approaches, including spine and craniomaxillofacial surgical topics.

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