

# Establishing Sustainable Arthroscopy Capacity in Low- and Middle-Income Countries (LMICs) through High-Income Country/LMIC Partnerships

## A Qualitative Analysis

Ericka P. von Kaeppler, BS, Nathan Coss, BS, Claire A. Donnelley, MD, Dave M. Atkin, MD, Marc Tompkins, MD, Billy Haonga, MD, Alberto M.V. Molano, MD, Saam Morshed, MD, PhD, MPH, and David W. Shearer, MD, MPH

*Investigation performed at the University of California San Francisco, San Francisco, California*

**Background:** Disparities exist in treatment modalities, including arthroscopic surgery, for orthopaedic injuries between high-income countries (HICs) and low- and middle-income countries (LMICs). Arthroscopy training is a self-identified goal of LMIC surgeons to meet the burden of musculoskeletal injury. The aim of this study was to determine the necessary “key ingredients” for establishing arthroscopy centers in LMICs in order to build capacity and expand training in arthroscopy in lower-resource settings.

**Methods:** This study utilized semi-structured interviews with orthopaedic surgeons from both HICs and LMICs who had prior experience establishing arthroscopy efforts in LMICs. Participants were recruited via referral sampling. Interviews were qualitatively analyzed in duplicate via a coding schema based on repeated themes from preliminary interview review. Subgroup analysis was conducted between HIC and LMIC respondents.

**Results:** We identified perspectives shared between HIC and LMIC stakeholders and perspectives unique to 1 group. Both groups were motivated by opportunities to improve patients’ lives; the LMIC respondents were also motivated by access to skills and equipment, and the HIC respondents were motivated by teaching opportunities. Key ingredients identified by both groups included an emphasis on teaching and the need for high-cost equipment, such as arthroscopy towers. The LMIC respondents reported single-use materials as a key ingredient, while the HIC respondents reported local champions as crucial. The LMIC respondents cited the scarcity of implants and shaver blades as a barrier to the continuity of arthroscopy efforts.

**Conclusions:** Incorporation of the identified key ingredients, along with leveraging the motivations of the host and the visiting participant, will allow future international arthroscopy partnerships to better match proposed interventions with the host-identified needs.

**Clinical Relevance:** Arthroscopy is an important tool for treatment of musculoskeletal injury. Increasing access to arthroscopy is an important goal to achieve greater equity in musculoskeletal care globally. Developing successful partnerships between HICs and LMICs to support arthroscopic surgery requires sustained relationships that address local needs.

In recent years, appreciation of the burden of traumatic musculoskeletal injury in low- and middle-income countries (LMICs) has grown<sup>1-3</sup>. Global orthopaedic efforts have historically focused on fracture care, chronic osteomyelitis, and congenital musculoskeletal conditions, while articular pathologies amenable to arthroscopic treatment have received less attention<sup>4</sup>. Arthroscopy is an adjunctive diagnostic tool for evaluating periarticular trauma<sup>3,6</sup>, which increases its utility in LMICs where the burden of traumatic injury is high<sup>1</sup>.

Arthroscopy is also a critical modality for the treatment of sports-related joint dysfunction<sup>5</sup> and can be used for excision, reconstruction, and replacement of damaged or abnormal tissue<sup>6</sup>, as well as joint irrigation in patients with septic arthritis<sup>7-9</sup>. Injuries that can be treated arthroscopically are common in LMICs<sup>10</sup>, but despite its widespread use in high-income countries (HICs), arthroscopy has not been widely implemented in LMICs and is seldom discussed as a potentially effective intervention.

**Disclosure:** The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (<http://links.lww.com/JBJSOA/A400>).

Copyright © 2022 The Authors. Published by The Journal of Bone and Joint Surgery, Incorporated. All rights reserved. This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-No Derivatives License 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/) (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

When surveyed, orthopaedic surgeons in LMICs identified arthroscopy as a desired skill<sup>11,12</sup>, highlighting the need for arthroscopy training and technology to meet global health demand. Despite the poor availability of arthroscopy resources and training for LMIC surgeons, few studies have quantified the needs and implementation strategies for arthroscopy in LMICs<sup>4,11,12</sup>. Many models exist for international partnerships (ranging from short-term mission-based initiatives to long-term cooperative partnerships<sup>13</sup>), but studies show that a “train-the-trainer” approach is more sustainable<sup>4,13</sup>. In a 2012 case study, Tibor and Hoenecke identified considerations for implementing arthroscopy in LMICs<sup>4</sup>. They emphasized the need for (1) context-appropriate interventions that suit the LMIC’s needs and capacity, (2) simple and cost-effective surgical techniques, and (3) the integration of team members for the training of local operating room staff<sup>4</sup>. Further refinement and expansion of the application of these elements are needed.

The purpose of this study was to expand on the findings from Tibor and Hoenecke by examining the experiences of individuals from HICs and LMICs who have worked in global arthroscopy partnerships. We interviewed stakeholders from LMICs and HICs to identify the “key ingredients” for estab-

lishing arthroscopy centers in LMICs. Evaluating the drivers of success for these programs may provide useful insights for future efforts to build capacity and/or expand arthroscopy training in lower-resource settings.

### Materials and Methods

The study was approved by the institutional review board of the University of California, San Francisco (institutional review board #19-29338). Respondents were informed about the purpose, methods, and potential risks of participation. They were assured of the confidentiality of the information they provided, and written informed consent was obtained.

### Study Design

This study utilized interviews with orthopaedic surgeons from both HICs and LMICs to examine prior attempts at establishing arthroscopy efforts in LMICs. Respondents included HIC and LMIC surgeons who had worked both with and without official partnerships through established nongovernmental organizations (NGOs). Respondents included surgeons who worked in public, private, and academic practice settings with varying levels of training.

**TABLE 1 Participant Demographics**

	All Participants	Participants by Economic Classification		P Value
		HIC	LMIC	
No.	17	7 (41%)	10 (59%)	
Region				<0.001*
Europe	3 (18%)	1 (14%)	2 (20%)	
North America	6 (35%)	6 (86%)	0 (0%)	
Central America	7 (41%)	0 (0%)	7 (70%)	
Southeast Asia	1 (6%)	0 (0%)	1 (10%)	
Mean age (SD) (yr)	50.87 (11.80)	56.00 (12.34)	46.38 (9.93)	0.12
Gender				
Male	17 (100%)	7 (100%)	10 (100%)	
Completed fellowship	10 (67%)	5 (83%)	5 (56%)	0.58
Mean years in practice (SD)	17.79 (11.01)	22.43 (12.00)	13.14 (8.28)	0.12
Mean years doing arthroscopy (SD)	15.93 (12.29)	25.00 (10.47)	8.00 (7.33)	0.003*
Practice setting				0.019*
Academic	1 (6%)	1 (14%)	0 (0%)	
Academic/private combination	2 (12%)	2 (29%)	0 (0%)	
Private	4 (24%)	3 (43%)	1 (10%)	
Public	0 (0%)	0 (0%)	0 (0%)	
Private and public	9 (53%)	1 (14%)	8 (80%)	
Majority private	3 (33%)	0 (0%)	3 (38%)	
Majority public	5 (56%)	1 (100%)	4 (50%)	
Majority not reported	1 (11%)	0 (0%)	1 (13%)	
Setting not reported	1 (6%)	0 (0%)	1 (1%)	

\*Significant. SD = standard deviation.



Fig. 1 Map displaying the home location of each respondent. The red pins signify respondents from LMICs ( $n = 10$ , representing 7 countries), and the blue pins signify respondents from HICs ( $n = 7$ , representing 2 countries).

Individuals who were  $\geq 18$  years of age were identified by referral sampling and considered for inclusion in the study if they had experience working in international partnerships for implementing arthroscopy in an LMIC, whether the efforts were successful or not.

#### Data Collection

The lead authors (E.P.v.K. and N.C.) conducted interviews via Zoom video conferencing. Each interview was recorded with Zoom video-conference software. All of the subjects answered standardized demographic questions, followed by a semi-structured interview exploring their prior experiences with arthroscopy efforts in LMICs.

The interview questions were developed based on a review of the existing literature and subsequently were refined using serial focus group discussions with the project working group, which included individuals with experience in international arthroscopy partnerships. The key topics in the final

interview guide included (1) strategies for site initiation, (2) motivations, (3) definitions of success, (4) key ingredients for initiation and maintenance, and (5) potential impacts of international arthroscopy partnerships.

The semi-structured interviews were directed with questions from the above-identified topics but allowed for further discussion and exploration of additional respondent-identified topics as they arose. The interview instrument was prepared in English and translated into Spanish by N.C., a native and college-trained Spanish expert. Interviews were conducted either in English or in Spanish according to participant preference. All of the interviews were transcribed verbatim from the interview recordings for analysis. When applicable, the interview transcripts were translated into English before the analysis.

#### Data Analysis

Qualitative thematic content analysis of the interview transcripts was performed. After the interview recordings were

**TABLE II Motivations for Involvement in Arthroscopy in LMICs**

Theme	Definition	Examples
Improve patient care	The opportunity to improve patient care is a motivating factor for wanting to be involved in arthroscopy efforts in an LMIC.	“That has been always our main motivation: to look for better treatment for the patients.” (Ecuador, LMIC surgeon)
Make a difference	The opportunity to make a difference in the lives of others (including surgeons and patients) is a motivating factor for wanting to be involved in arthroscopy efforts in an LMIC.	“As orthopaedic surgeons, we have the ability to really make a difference in people’s lives.” (U.S., HIC surgeon) “...wanting to help out so that arthroscopy becomes a usual thing in the different hospitals in the country, beginning with the key cities first and then eventually the countryside.” (Philippines, LMIC surgeon)
Opportunity to expand clinical acumen	The opportunity to gain proficiency in arthroscopy (and as a result expand the scope of clinical practice) and engage in bidirectional learning is a motivating factor for wanting to be involved in arthroscopy efforts in an LMIC.	“I wasn’t trained for a lot of things that they were doing. For example, obviously, arthroscopy, pediatrics, and other orthopaedic surgeries. So that was exciting for me because I didn’t learn that in the residency, and obviously here in Huehuetenango, I wasn’t doing that. So, the first year I saw a lot of surgeries that they were doing, and it was really nice to learn from them. And the doctors told me that if I wanted, I can learn, for example, knee arthroscopy, and that was really good for me.” (Guatemala, LMIC surgeon)
Opportunity to teach	The opportunity to teach and indirectly affect the lives of more patients than 1 person could reasonably operate on individually is a motivating factor for wanting to be involved in arthroscopy efforts in an LMIC.	“I love and I also just enjoy teaching. And so, the goal was really just to find ways to use my time to help other people best. And I think that traveling and teaching and trying to do it in places where the potential improvement and rate of improvement is high is a good use of my time.” (U.S., HIC surgeon)

transcribed, ATLAS.ti software (version 8.4) was used for data management. Utilizing a subset of transcripts, the lead coder (E.P.v.K.) developed a codebook (an organized list of meaningful labels) based on repeated themes in the preliminary interview review. The codebook included codes that represented recurrent themes, definitions of the identified codes, and examples of the codes in context. The preliminary codebook was then reviewed with the second coder (N.C.). These 2 investigators then applied the preliminary codebook to all of the interview transcripts. The codebook was revised throughout the coding process to incorporate emerging themes into the thematic analysis. Intercoder consistency assessment was conducted through discussion of thematic overlaps and divergences between coders to ensure consistency in the application of the codebook<sup>14</sup>.

Themes were extracted from coded text to create frameworks and were subgrouped by respondent country category (HIC or LMIC). Analysis was conducted iteratively to better identify and refine emerging concepts, especially with respect to (1) motivations for engagement, (2) key ingredients for success, (3) potential impacts, (4) metrics of success, and (5) challenges. Care was taken to highlight HIC and LMIC similarities and differences. Anonymized quotations were selected to support identified themes.

### Source of Funding

The study was funded by Operation Rainbow, which did not have a role in any part of the investigation. D.M.A. serves as the director of Operation Rainbow. D.W.S. serves as Vice President of SIGN Fracture Care.

## Results

### Participants

Seventeen stakeholders from 9 countries (7 from HICs and 10 from LMICs) were interviewed (Table I). The HIC respondents were primarily from North America (86%), and the LMIC respondents were primarily from Central America (70%). The average age of the HIC and LMIC respondents was 56 and 46 years, respectively. All of the respondents were men. The majority of the HIC respondents had completed some fellowship training (83%), while approximately half of the LMIC respondents had completed some fellowship training (56%,  $p = 0.58$ ). The HIC respondents reported having performed arthroscopy for an average of 25 years, while the LMIC respondents reported an average of 8 years ( $p = 0.003$ ). Respondents originated from 4 continents (Fig. 1) and had attempted partnerships in 4 continents.

### Thematic Analysis

Recurrent themes were grouped into 5 main categories: motivations, key ingredients, impacts, metrics of success, and challenges.

### Motivations

A recurring theme that was shared between the HIC and LMIC respondents was motivation for engaging in international partnerships for arthroscopy. The LMIC respondents were motivated by the opportunity to learn new clinical skills in order to develop an arthroscopy practice and to improve patient care, while the HIC respondents were motivated by the desire to make a difference in the lives of others, to learn, and to teach (Table II).

**TABLE III Key Ingredients for Successful Arthroscopy Efforts**

Theme	Definition	Examples
<b>Relationships</b>		
Referrals for identifying new sites	New sites are often identified through referrals from prior existing relationships. A prior LMIC partner might recommend a new potential LMIC partner, or an LMIC surgeon trained at an existing partnership site might want to start a new partnership at his/her new practice.	<p>“So much of [identifying new sites] is relational and connection. So much of it is having a connection somehow. Whether that’s through somebody else that has a connection to a particular site and then engages you, or whether that’s because of previous opportunities and then you meet somebody from another place who then invites you to that place. That is a key first step, you have got to have some kind of connection.” (U.S., HIC surgeon)</p> <p>“They told me that some group was going to be there in Nicaragua, and I went to Nicaragua to meet them. And at the end of the mission, they asked me if I wanted to have a mission in Honduras. And I told them, “Yes! Of course, I would like it.” That was incredible.” (Honduras, LMIC surgeon)</p>
Continuous engagement	Maintenance and growth of existing relationships as well as development of new relationships contribute to overall success and sustainability of partnerships. Engagement by both parties, local and visiting, is critical for site maintenance.	<p>“You need some kind of feedback, and you need some relationship to be able to keep on being motivated for doing your work.” (Ecuador, LMIC surgeon)</p> <p>“I’ve stayed in touch with the Cuban docs that I’ve, you know, developed a relationship with, as a resource if they want. Really, they’ve never needed it, but the offer’s there outside of, you know, when I’m actually on the ground.” (U.S., HIC surgeon)</p>
Bidirectional equal partnership	It is critical to the partnership that both sides view the relationship as a partnership in that both sides are invested, both sides respect each other, and both sides are equal partners.	<p>“I think there has to be mutual education.” (U.S., HIC surgeon)</p> <p>“So, it’s just like a 2 way: they help my patients by providing the free implants, and I help them by teaching them the way I operate on the actual patients.” (Philippines, LMIC surgeon)</p>
<b>Leadership</b>		
Local physician champion	A local “leader,” “point person,” or “champion” who is the primary site liaison and who leads the program, especially when HIC partners are not “in country,” is critical to navigating the initiation and maintenance of a successful partnership site. This individual is often dynamic and committed to the greater mission.	<p>“If you don’t have a local champion who is really fully engaged and really wants the program to succeed, it will never happen. Time and time again, we’ve come, we’ve worked with people, they show a little bit of interest, you try to teach them, but they’re really not a champion. You need at least 1 or 2 local champions who are just committed to developing [the site]. From there, they teach the others, but if you don’t have that local champion, none of this will ever work.” (U.S., HIC surgeon)</p> <p>“The key ingredient [to success] in my country is choosing the right people. You need to choose a good person so you can learn about the techniques of arthroscopy. And you need a good person to give the machines, implants, and resources to.” (Honduras, LMIC surgeon)</p>
Visiting physician champion with experience	A committed visiting champion who often has prior experience working with arthroscopy in LMICs is critical to success of the partnership.	<p>“You also have to have champions outside the environment that help get the ball rolling that have some experience.” (U.S., HIC surgeon)</p> <p>“I would have to say Cuba has been a great success with a lot of ups and downs. We made a lot of mistakes. I almost got myself thrown in jail, but it was well worth it.” (U.S., HIC surgeon)</p>
Institutional support	Institutional support, from both visiting and local institutions, is necessary to ensure the successful implementation and maintenance of lasting partnerships. Institutional involvement must be appropriately supportive, but not overly involved. Individual efforts without institutional support are often unsustainable.	<p>“Support from the institution [is a key ingredient for success], whether it’s public or private. We had this pathology undertreated, and for me it was a big opportunity to develop the practice. So, if you’re motivated and you have somebody to back you up, like either the institution or your boss or whatever, I think this is the main ingredient—like salt and pepper.” (Romania, LMIC surgeon)</p> <p>“You have to have political will within the hospital and the director or sub-director.” (U.S., HIC surgeon)</p>

*continued*

TABLE III (continued)

Theme	Definition	Examples
Commitment		
Continuity	Sustained commitment over time of both local and visiting partners with continued engagement and continuous communication is necessary to establish rapport, develop trust, and ensure sustainability.	“The people who are going to go there have to be committed for probably 10 years. And they have to be willing to go multiple times a year, otherwise it won’t work because you have to build the trust between those local champions and the people coming. Because in the very beginning, they’re going to be thinking, ‘Well, why is this person coming here?’ They might think that they’re trying to sell something, or that you’re trying to profit from them in some way. It takes some time to develop that trust that you’re just there to help them out, and you’re not really trying to sell something.” (U.S., HIC surgeon)
Multiple visits by visiting surgeons	The return of visiting partners multiple times to the same local site is a key ingredient for the initiation and sustained success of a partnership site.	“And the third [key ingredient] is the continuous program. For example, if you have 1 doctor that is teaching you, it’s really good that this doctor keeps going to the same hospital that they already know because you kind of [develop a relationship] with the doctor that started teaching you. So, it’s really good if you want to have a really nice relationship between the teacher and the student. It’s really good if it’s the same doctor.” (Guatemala, LMIC surgeon) “I can’t tell you how important that is to keep in touch and to go back. I can give you an example that I think is really, really true. I went to [LMIC partner site] 7 or 8 years ago for our first time, and then my partner and I were committed to coming back. We kept coming back. And about the fourth time, 1 of the doctors turned to me and said, ‘Why do you keep coming back? Nobody ever comes back. They come 1 or 2 times, and then we never see them again. And that’s why we kind of lose faith. But you guys have really kept coming back.’ So that’s a really big part of all of this. If you’re going, it’s not just about going to do a little surgery and feel good about yourself. Keep in touch with them, keep coming back because I think they’ll really appreciate it. And then everybody will learn.” (U.S., HIC surgeon)
Willingness to take ownership	Both local and visiting partners need to be willing and committed to take on leadership roles and to make sacrifices for the success of the program. This could be in the form of committing to a certain number of sustained years with the partnership and/or commitment of a certain amount of work on the partnership.	“You have to have ownership. There has to be people that want to make it happen and are willing to take the leadership, the onus, and the sacrifice of time or other things to carry it out.” (U.S., HIC surgeon)
Communication and engagement	Both local and visiting partners must be committed to honest and continuous communication, especially when visiting partners are not in-country. Local partners must communicate their evolving needs and visiting partners must provide support to meet those needs. For example, local surgeons may consult visiting partners for advice on challenging cases or for requests for additional equipment.	“The key ingredient has been the friendship that you develop with some members of the team and the possibility of being in contact and discussing cases.” (Ecuador, LMIC surgeon) “I have always tried to maintain relationships via email and WhatsApp, and again, to be more direct to say, ‘Can you please tell me how many cases you’ve done? Can you take some photos of the equipment? I gave you 2 towers, were you able to share in any way with urology or any other service?’ A lot of people are direct. They’re like, ‘Yeah, here’s 1 of your towers in the urology department.’ And in fact, I got 1 of those photos on my phone right now. ‘Here’s what we’ve done.’” (U.S., HIC surgeon)
Understanding local context		
Local welcome	Visiting partnership and presence must be welcome and/or explicitly invited by the local LMIC stakeholders for success.	“Get invited, pay [for] yourself, go and see, ask what [the local surgeons] are interested to know. Check [the local] health system and be open to participate in their ‘daily life.’” (Switzerland, HIC surgeon) “If someone doesn’t really want you there, they’ll just tie you up forever in paperwork. Conversely, if someone really does want you there, then it’ll be expedited.” (U.S., HIC surgeon)

continued

TABLE III (continued)

Theme	Definition	Examples
Thorough site visit	An in-person site visit is often critical to vet a site, perform a thorough needs assessment, assess political climate (national as well as institutional), and develop relationships with local partners (if not already well-known to HIC partners).	"[A typical site visit is] 1 to 2 days. And we'll look through sterile processing. We'll look through the operating rooms. We'll meet with the director, and sometimes the sub-director of the hospital. We will physically look at the ORs [operating rooms], and nursing, and the wards. Then also get a feel for seeing what the patient dynamic is." (U.S., HIC surgeon)
Needs-driven intervention	The needs identified by the LMIC partner should inform the design of the proposed intervention. Each site is unique: while standardized processes may help streamline and ensure success, each site is unique, with different needs, capabilities, disease burdens, prior experience, and ultimate goals. As such, all partnerships should be tailored to satisfy site-specific differences. These could be differences between countries or even between institutions within the same country.	"...it really depends on the country and their need. So we try to get a needs assessment to see what their needs are. Some may have an arthroscope, but they don't have any, for example, disposable shavers or shaving equipment. Some need everything." (U.S., HIC surgeon)
Political climate	A key ingredient is understanding of the local political climate (both at the initiation of the site and during any subsequent changes). This often can be achieved by collaborating closely with the local partner. Understanding of local context (cultural, political, geographical, resources, etc.) and commitment to working within that local context is key to success.	"You've got to feel the political climate. And I think that that's a really important thing. Regimes, or whatever you want to call it, political regimes change frequently...you got to figure out what you're in for politically or someone can just block you and you just won't get anything done." (U.S., HIC surgeon)
Educational focus		
Intraoperative skill exchange	Hands-on instruction through operating together in arthroscopic cases is critical to sustainable skill transfer. Initially this is led by the visiting surgeons, but ultimately this can and should be taken on by local surgeons instructing their own trainees.	"They not only do a combination of lectures, but then also do a day or 2 of live surgery where they actually work with the local surgeons, teach them techniques, and then the local surgeons take those techniques to their cities and are able to work with them to develop." (U.S., HIC surgeon)  "We go to the operating room and we do the surgeries closely with the doctors from the United States. They teach us about the approach, techniques. They teach us about the future healing of the pathologies in patients with joint injuries. Three or 4 days after the first case, the [visiting] doctors give some cases to us so that we can do the surgeries alone. But they are supervising the procedure." (Honduras, LMIC surgeon)
Didactic instruction	Didactic instruction in which visiting surgeons give lectures on arthroscopy topics supplement the hands-on skill exchange. Initially this is led by the visiting surgeons, but ultimately this can and should be taken on by local surgeons with their own trainees.	"[The partnership] has also given us the opportunity to share difficult cases and to exchange experiences and information by talking to the surgeons that come. It's like having a training program. When they come, we even do some conferences and talks to all the rest of the orthopaedic team." (Ecuador, LMIC surgeon)  "Each time I have taught arthroscopy in a number of different ways, both didactic—in clinic in terms of seeing patients—and in the operating room—in terms of helping to perform surgeries and teach in that setting." (U.S., HIC surgeon)
Train-the-trainer model	For sustainable educational efforts, there must be an emphasis on training and empowering local surgeons to take on the role of teacher to their own trainees.	"You can't just go to do surgery. To really make any kind of footprint, you've got to be teaching surgery. And to teach surgery, you've got to have participation from the local surgeons" (U.S., HIC surgeon)  "The deal I made with [the local surgeon] was if I'm going to teach him, he's going to teach others. And so I think he's really been great about reaching out and teaching his colleagues." (U.S., HIC surgeon)

continued

TABLE III (continued)

Theme	Definition	Examples
Resources		
High-cost equipment	Initiation of new sites requires access to high-cost equipment such as arthroscopy towers, which are often donated by the visiting partners.	"So, the first year that they came, I asked them if they can bring some scopes and all the other things because we didn't have anything here at the hospital." (Guatemala, LMIC surgeon)
Equipment maintenance	Continued success of existing sites requires adequate maintenance and upkeep of equipment, including arthroscopy towers. Often this requires visiting partners to provide necessary parts for replacement.	"The problem is that when you use more the equipment, you start having problems with it because you need to repair and to change some parts of it." (Ecuador, LMIC surgeon) "I can tell you, when people tell me that things are breaking, I'm so happy because that means they're being used. If nothing's breaking, it makes me worried that something's gathering dust somewhere." (U.S., HIC surgeon)
Disposable equipment	Continued success of existing sites requires sustainable supply of disposable equipment such as implants and shavers that are often hard to access or prohibitively expensive in LMICs.	"We do a lot of surgeries, arthroscopic surgeries, between the times [visiting partners] come. The problem is sometimes the budget of my hospital is very low and the implants that you need to do arthroscopy, for shoulder for instance, they are quite expensive, so that limits the possibilities of doing arthroscopy in-between [visits]. That's the good thing I would say when [the visiting partners] come, also they bring a lot of equipment and implants that allowed us to keep working even after they are gone." (Ecuador, LMIC surgeon) "If you don't have access to those implants and single-use equipment, then you cannot perform the surgery." (Romania, LMIC surgeon)
Virtual tools	Virtual tools and technology (e.g., WhatsApp, email, augmented reality tools) augment efforts to initiate new partnerships and sustain existing partnerships.	"Before we didn't have the chance—like now we are talking by internet. So when [our visiting partners] left, sometimes we had little contact. Right now, thanks to the internet, I believe it's a key ingredient to be in contact in some ways: to share patients, to share special cases, to do some consultation about a difficult case and things like that. That helps to maintain the program, I would say." (Ecuador, LMIC surgeon)

### Key Ingredients

Distinct ingredients were identified for the initiation (creating a partnership) and maintenance (sustaining established sites) of arthroscopy efforts in LMICs (Table III). Relationships were critical for initiating new sites. Frequently, sites were identified based on existing relationships or referrals. Local champions, described as local leaders who served as the primary liaison for the in-country partnerships, were also identified as a critical element to site initiation.

A thorough understanding of local context was identified as critical to success, including familiarity with local politics as well as geographic and resource constraints. Often, this understanding was achieved by  $\geq 1$  site visit. Understanding the local context helped drive targeted intervention. For example, if a site had existing capability for certain procedures but needed training for new procedures, the focus was skill transfer rather than equipment donation.

For the maintenance of existing sites, recurring site visits were critical; they helped HIC partners establish rapport, develop trust, and ensure sustainability. Continuous engagement between in-person visits, by telephone, email, or other communication methods, helped with longitudinal success. Respondents discussed using virtual communication tools, such as

WhatsApp and Zoom, to maintain a continuous connection with partners. These connections enabled ongoing training, skill transfer, and continuous needs assessments.

Nearly all of the respondents identified teaching and education of the LMIC physicians and other health-care providers as necessary for building a pipeline of future clinician-educators, ensuring eventual independence of the LMIC arthroscopy programs. In at least 1 respondent's experience in building a sustainable training program, what started with support via international partnership developed into a program that now independently trains local specialists in arthroscopy.

Finally, resources were identified as a key ingredient for initiation and maintenance. The provision of high-cost items (e.g., an arthroscopy tower) was critical for site initiation, while the supply of single-use materials (e.g., shaver blades and implants) was critical for site sustainability. LMIC respondents highlighted the need for the replenishment of single-use materials and the maintenance of arthroscopy equipment as barriers to sustained success.

### Impacts

Respondents identified the positive and negative impacts of international partnerships (Table IV). The LMIC respondents



TABLE IV Impacts of International Partnership

Theme	Definition	Examples
Positive impacts		
Bidirectional teaching and learning	Both visiting and local surgeons have the opportunity to learn and teach surgical skills and context-specific patient care.	<p>“If it is possible to be able to operate in multiple environments, whether that’s for the LMIC surgeon or whether that’s for the HIC surgeon, I think it’s good all the way around. The more experience [you get], the more chances you have to see how things are done differently. It expands your perspective, skills, and breadth.” (U.S., HIC surgeon)</p> <p>“I learned how to create from nothing, a way to do things. You kind of become a little bit innovative. And then you use a shaver that you’re supposed to throw after each case, you use it for like maybe 4 or 5 years until you get the next one.” (U.S., HIC surgeon)</p>
Expansion of clinical skills and practice	Exposure of both local and visiting surgeons to new skills, techniques, and ideas leads to overall broadening and improvement of clinical skills (both operative and nonoperative).	“It has impacted [our hospital] a lot because there was no one who did arthroscopy before and [the partnership] generated interest for clinicians to pursue arthroscopy. Now we do arthroscopy in the hospital. This was a field we did not offer before, so it had a positive impact.” (Nicaragua, LMIC surgeon)
Improved patient care	Improved clinical outcomes for patients in LMICs.	<p>“I had this year, 2 months ago, I had a little child, 5 years old, with a synovitis in the knee. And 8 years ago, I could do nothing. But now I have a tower and I can use it without doing an open surgery in a small child. That’s crazy. That’s amazing to me.” (Honduras, LMIC surgeon)</p> <p>“So, with the collaboration, we could suddenly do more things in the arthroscopic way that we hadn’t done before. So, definitely the patients were getting benefits, of course. Shorter period of hospitalization, less traumatization of the patient, minimally invasive surgeries.” (Armenia, LMIC surgeon)</p>
Indirect improvement of other surgical services	Positive impacts on other, non-arthroscopy, clinical services as a result of equipment and knowledge exchange from visiting partners.	<p>“They gave us an Arthrex tower and some of them, general surgeons and gynecologists, can use the tower too.” (Honduras, LMIC surgeon)</p> <p>“I donated [1 of the towers I received] to another urology department in our hospital, which was 1 of the advanced ones, so they started to work at that period of time.” (Armenia, LMIC surgeon)</p>
Development of lasting relationships	Sustained partnership results in the development of lasting personal and professional relationships between visiting and local surgeons.	<p>“I got tremendous satisfaction. I got tremendous friendships.” (U.S., HIC surgeon)</p> <p>“I’m sending, on WhatsApp, x-rays, MRIs, patients, saying ‘Look here, what is this? This is a more difficult situation.’ So, it’s a relationship that’s extremely important in our practice to have good friends, relationships, and get advice.” (Romania, LMIC surgeon)</p>
Negative impacts		
Dependence on visiting partner	Host partners can become dependent on visiting partners.	<p>“Unfortunately, some years [visiting HIC partner] couldn’t come, and I think that has cut some of the possibilities and the improvement of the program” (Ecuador, LMIC surgeon)</p> <p>“No one would use the arthroscopy towers due to lack of training.” (Nicaragua, LMIC surgeon)</p>
Perception of competition between local and visiting surgeons	Local surgeons not involved in the partnership may view both the visiting surgeons and the newly trained local surgeons as competition for cases. Further, newly trained local surgeons may refuse to share knowledge and equipment in order to avoid competition.	<p>“[The surgeons] at the private practice, they see a really big competition with the doctors that come from the U.S. Because every time that you say there is a mission, for example here at the public hospital, all the people, even the people that have money, come here because they think that they are bringing the best doctors from other countries...[The surgeons at the private practice] say, ‘Oh, they’re not going to come here to my practice and pay for me for whatever they want to do.’ And so that’s why a lot of doctors, even from here in the public hospital, they see it as a competition.” (Guatemala, LMIC surgeon)</p> <p>“It is a problem because some people are only purely private, and they don’t share their skills because they’re worried about the competition, and they don’t want to share the equipment.” (U.S., HIC surgeon)</p>

*continued*

TABLE IV (continued)

Theme	Definition	Examples
Misuse of equipment	Donated equipment and supplies may be used for purposes other than originally intended by the partnership.	"In another hospital not so far from here, another doctor from another program brought a couple of arthroscopy towers, and [the local surgeons] only stole the parts from the equipment and they didn't perform any surgery." (Guatemala, LMIC surgeon)
Brain drain	Exposure to international resources and opportunities within the field of arthroscopy, especially when LMIC surgeons travel to HIC partner sites for training, may cause LMIC surgeons to leave their countries of origin in pursuit of additional opportunity.	"Avoid brain drain!" (Switzerland, HIC surgeon)  "I think some people are concerned about the idea of brain drain. That having an opportunity to go and see a practice in a different environment makes people potentially want that over theirs and then increases the desire and or willingness to leave their environment, which is likely to be an environment that really needs them." (U.S., HIC surgeon)

identified arthroscopic skill training and access to arthroscopy equipment as positive impacts. The HIC respondents identified the opportunity to "give back." Both the HIC and LMIC surgeons described the development of new relationships that facilitated long-term knowledge exchange.

The potential negative impacts included the overdependence of LMIC hosts on visiting partners, competition for surgical cases, and the monopolizing or misuse of equipment, including sales of donated equipment for a profit. The LMIC respondents highlighted how arthroscopy efforts could stall while the visiting partners were not in the country, with some donated equipment falling into disuse.

#### Metrics of Success

Nearly all of the respondents reported growth as an indicator of success, including the total number of trained surgeons and the clinical skill sets of individual surgeons (Table V). Increases in case volume and case complexity and the establishment of national societies with associated meetings were additional metrics of success. Additionally, the HIC and LMIC respondents identified performing complex cases independently as well as the independence of locally led training programs as markers of success. Although the ultimate goal often was clinical independence of the LMIC partners, the respondents noted other benefits of continued engagement, including bidirectional learning with ongoing opportunities for the exchange of ideas and technologies.

#### Challenges

Transporting equipment was one of the challenges identified by HIC respondents, which was often complicated by volatile political climates and international regulations (Table VI). Some described experiences of transporting equipment in personal luggage on commercial flights, while others reported using couriers. Both methods encountered barriers, with equipment often being detained by customs officials.

The LMIC respondents cited the lack of reliable access to single-use materials as a substantial challenge for longitudinal success. Despite the utility of donated arthroscopy towers, the LMIC surgeons often lacked the resources to purchase the required implants and disposable supplies for arthroscopic

procedures. These challenges limited the sustainability of the arthroscopy efforts of the LMIC respondents.

Both the HIC and LMIC respondents described the challenge of ensuring reciprocity in relationships between partners. While some respondents expressed the desire for LMIC surgeons to visit HIC partners for additional training, the logistics of securing operating privileges in HICs were often cited as a substantial barrier.

#### Shared and Unique HIC and LMIC Perspectives

We identified shared and unique perspectives of the HIC and LMIC stakeholders, which spanned the categories of (1) motivations, (2) key ingredients, (3) impacts, (4) metrics of success, and (5) challenges (Fig. 2). Both groups were motivated by the opportunity to improve patients' lives, while the LMIC respondents were also motivated by access to skills and equipment, and the HIC respondents were motivated by teaching opportunities. Key ingredients identified by both groups included an emphasis on teaching and the need for high-cost equipment, such as arthroscopy towers. The LMIC respondents reported single-use materials as a key ingredient, while the HIC respondents reported local champions as crucial. The LMIC respondents cited the lack of implants and shaver blades as barriers to continuity of the arthroscopy efforts, although this was not often cited by the HIC respondents.

#### Discussion

In this study, interviews with HIC and LMIC stakeholders with both successful and failed experiences introducing arthroscopy efforts in LMICs identified motivations, key ingredients, impacts, and metrics of success and challenges for arthroscopy partnerships. Respondents highlighted the importance of site visits for understanding the local context before initiating an international arthroscopy partnership. Knowledge of a potential site's clinical capacity and political climate helped tailor the partnership to the local context. Nearly all of the respondents identified relationships as critical for partnership initiation, and continuous engagement was necessary for the sustainability of established programs.

Teaching and educational infrastructure were also reported by both the HIC and LMIC respondents to be critical for the

TABLE V Metrics of Success

Theme	Definition	Examples
<b>Growth</b>		
Increased number of trained surgeons	Increasing the number of trained surgeons in a region can be an indicator of success.	<p>“One proxy for success is that year over year, there are more people who have been trained as arthroscopists. There are more people who are doing arthroscopy.” (U.S., HIC surgeon)</p> <p>“We've seen in all the countries that we really have committed to, 2 surgeons lead to 4 surgeons, lead to 5 surgeons, and all of a sudden you really are a core group that is very committed to moving forward with this.” (U.S., HIC surgeon)</p>
Increased clinical expertise	Increasing expertise and clinical ability to take on more challenging and complex cases is an indicator of success.	<p>“You see growth in terms of the type and capacity of surgeries and pathologies that can be handled.” (U.S., HIC surgeon)</p> <p>“If you, at the end of the program, you start doing these procedures or improving your knowledge and going forward, then it's probably going to grow on its own from that point.” (Romania, LMIC surgeon)</p>
Increased case volume	Increased case volume is an indicator of success.	<p>“Ways of measuring [success] obviously include patient volume. So how many surgeries are being done, how many patients are being seen in an arthroscopy or sports related clinic, or whether you go to other subspecialties.” (U.S., HIC surgeon)</p> <p>“Now we have much more arthroscopy surgeries, I would say. A lot more than before. Right now we are doing many meniscectomies only by arthroscopy and also ACLs and some of the surgeries for shoulder only by arthroscopy. Before we couldn't do it, so it's a big improvement for us.” (Ecuador, LMIC surgeon)</p>
Establishment of national meetings and societies	The establishment of a professional society and/or recurring conferences (for discussion of cases, teaching, and research presentations) is a marker of success. This is especially true if the society/conference was established by the local partners or if the society/conference is run by the local partners.	<p>“There is enough of a nucleus that they eventually started a society that has been a growing and a viable society that has innovated in terms of having meetings and making sure that everybody's getting a good education.” (U.S., HIC surgeon)</p>
<b>Sustainability</b>		
Multigenerational continuity	Sustainability of a program over many years, especially beyond the involvement of any 1 individual contributor, is an indicator of success. If operating, teaching, or other activities stop when the visiting partners leave, that is a failure.	<p>“I think developing a self-sustaining program is key. I think that is 1 of the measures of success” (U.S., HIC surgeon)</p>
<b>Independence</b>		
Ability to handle cases	Developing clinical independence without continued reliance on HIC partners (for resources, training, and handling of complex cases) is an indicator of success.	<p>“I think independence is key. The whole point here is sustainability and not having a system that relies on me, or anybody like me.” (U.S., HIC surgeon)</p> <p>“Success is if we see that eventually those who attend trainings or workshops will eventually harness their own skills and their own practices in their respective hospitals.” (Philippines, LMIC surgeon)</p>
Locally led training programs	The independence of local programs in training their own trainees and developing training programs is an indicator of success.	<p>“That's what would eventually make the program successful: when I see that eventually, my resident graduates would put up their own practice and skills training in their respective places far from Manila, far from the city.” (Philippines, LMIC surgeon)</p> <p>“[Local partner] has been very, very rewarding. It's in year 6, but now they've developed their own course, they have their own faculty, they're able to do these things, and it's quite rewarding to see that develop.” (U.S., HIC surgeon)</p>

TABLE VI Challenges		
Theme	Definition	Examples
Transporting equipment	Transporting arthroscopy equipment to local partner sites is challenging due to international restrictions and the large amount of equipment required for arthroscopy.	“I had secured an arthroscopy tower that had been refurbished by Stryker. The problem was getting it [to local partner site] is exceedingly challenging.” (U.S., HIC surgeon)
Establishing sustainable supply of disposable materials	Lack of access to disposable resources such as implants and shavers is often the limiting factor for longitudinal success. Furthermore, the maintenance of towers often presents a similar challenge.	<p>“Equipment is the biggest limiting factor. A light bulb burns out, where are you going to get the light bulb? Or, when the scope gets scratched, how are you going to get it fixed? So, equipment is definitely the biggest issue.” (U.S., HIC surgeon)</p> <p>“Access to implants is also extremely important in arthroscopy. Not just equipment, but implants like anchors and screws...that is also something that may at some point affect your ability to perform arthroscopy because they’re expensive. And if you don’t have access to implants, then regardless if you know how to perform the surgery, then you cannot perform the surgery.” (Romania, LMIC surgeon)</p>

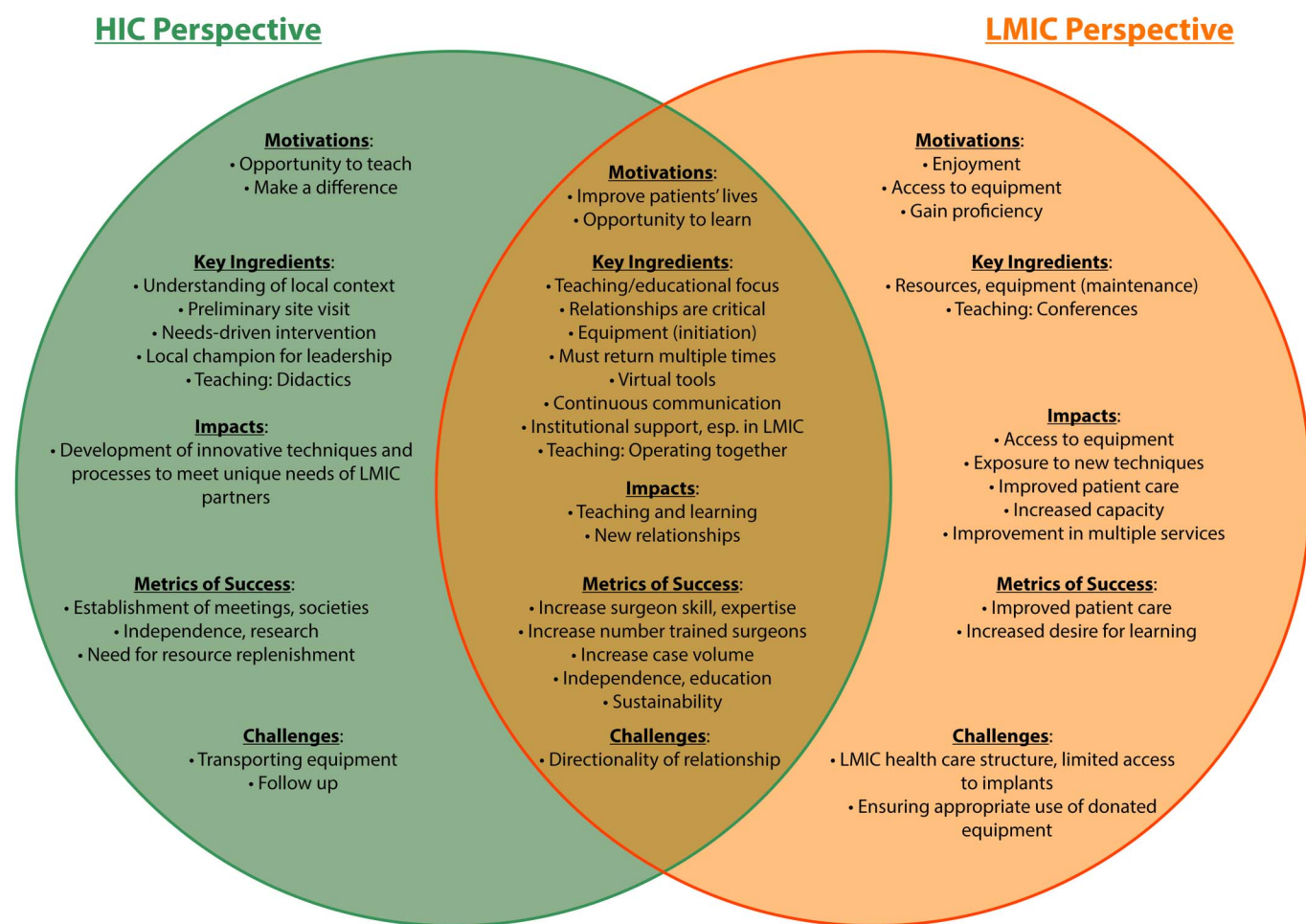


Fig. 2 Comparison of key themes identified by the HIC and LMIC respondents, including the motivations, key ingredients, impacts, metrics of success, and challenges. Unique HIC responses are reported in the green area; unique LMIC responses are reported in the orange area. Shared responses are reported in the overlapping portion.

sustainability of programs. This reflects a shift from mission-based models of international volunteerism toward the development of self-sustaining local sites through a “train-the-trainer” model. Creating educator pipelines where local surgeons are involved in teaching and training efforts is critical for ensuring that locally led training programs meet the arthroscopy needs in LMICs without reliance on outside partners<sup>15</sup>. Although this approach has been successful in other surgical specialties<sup>16–19</sup>, arthroscopy faces unique sustainability barriers (e.g., high upfront equipment costs) and the need for a sustainable supply of single-use materials. This study found that education and provision of resources are critical to improving sustainable arthroscopic care in LMICs. These findings are consistent with the “diagonal approach” to health-care provision, which combines short-term disease-specific “vertical approaches” that traditionally operate outside local health-care structures with long-term broad “horizontal approaches” to improve overall health-care infrastructure<sup>20,21</sup>. The integration of vertical and horizontal approaches, as described by our respondents, improves overall surgical capacity. This involves both the “vertical approach” of treating articular pathology through donated equipment and the “horizontal approach” of providing didactic sessions on treating articular pathology, resulting in a “diagonal” multimodal solution<sup>16,20,21</sup>.

While this study incorporated broad perspectives to add to the literature examining arthroscopy efforts in LMICs, it did have limitations. Referral sampling is subject to selection bias; thus, our findings may not be fully representative. The LMIC respondents were younger than the HIC respondents, potentially identifying this group as an outreach target for new LMIC partnerships. Our sample, although geographically diverse, included exclusively male surgeons. Non-surgeon stakeholders, including anesthesiologists, surgical scrub staff, administrators, and patients, could further inform strategies for international arthroscopy partnerships. Finally, our cohort only included English- and Spanish-language speakers, limiting the generalizability of the study. Future studies including non-surgeon stakeholders from other regions would address these limitations. Despite these limitations, by including HIC and LMIC respondents from several countries, this study provided more perspectives than have previously been described, to our knowledge.

The strength of this study lies in the inclusion of the LMIC perspectives alongside the HIC perspectives and the application of qualitative research methodologies. A recent systematic review of ethical considerations for global surgery described the substantial need for literature that incorporates LMIC perspectives<sup>19</sup>. To date, the limited body of literature examining the efforts to introduce and maintain arthroscopy efforts in LMICs has consisted largely of descriptive commentaries from HICs and has not incorporated LMIC perspectives. As we strive for global equity in all orthopaedic subspecialties, the dominance of HIC perspectives and the lack of incorporation of LMIC perspectives represent a fundamental divide that likely has limited our ability to create appropriate and effective international partnerships. The incorporation of LMIC host perspectives has been described as critical to informing effective practices for international health-care partnerships<sup>15</sup>. Additionally, the application of qualitative research methodologies to both HIC and LMIC perspectives can assess the

experiences of these target groups, which, in turn, can lead to the development of more appropriate and effective interventions<sup>22</sup>.

### Conclusions

This study incorporated the perspectives of both LMIC and HIC surgeons on international collaborative arthroscopy efforts to determine the “key ingredients” of successful and sustainable partnerships. Participants from both groups were motivated by opportunities to improve patients’ lives; the LMIC respondents were also motivated by access to skills and equipment, and the HIC respondents were motivated by teaching opportunities. Appropriately leveraging these motivating factors will incentivize sustained participation and engagement from both HIC and LMIC partners. The key ingredients identified by both groups included established relationships, site visits, an educational focus, and high-cost equipment, such as arthroscopy towers. The LMIC respondents reported sustainable provision of single-use materials as a key ingredient, while the HIC respondents reported local champions as crucial. The LMIC respondents cited the scarcity of implants and shaver blades as barriers to sustained success. The incorporation of these key ingredients in the establishment of new international collaborations will increase the chance of sustained success by better matching proposed interventions with host-identified needs. The improved success and sustainability of international arthroscopy partnerships will expand training and build capacity in arthroscopy in lower-resource settings. ■

NOTE: The authors acknowledge the participation of our respondents, without whose time and enthusiasm this project would not have been possible.

Ericka P. von Kaepler, BS<sup>1</sup>  
 Nathan Coss, BS<sup>1</sup>  
 Claire A. Donnelley, MD<sup>1</sup>  
 Dave M. Atkin, MD<sup>2</sup>  
 Marc Tompkins, MD<sup>3,4,5</sup>  
 Billy Haonga, MD<sup>6</sup>  
 Alberto M.V. Molano, MD<sup>7</sup>  
 Saam Morshed, MD, PhD, MPH<sup>1</sup>  
 David W. Shearer, MD, MPH<sup>1</sup>

<sup>1</sup>Institute for Global Orthopaedics and Traumatology, Department of Orthopaedic Surgery, University of California San Francisco School of Medicine, San Francisco, California

<sup>2</sup>California Pacific Medical Center, San Francisco, California

<sup>3</sup>Department of Orthopaedic Surgery, University of Minnesota, Minneapolis, Minnesota

<sup>4</sup>TRIA Orthopaedic Center, Minneapolis, Minnesota

<sup>5</sup>Gillette Children’s Specialty Healthcare, St. Paul, Minnesota

<sup>6</sup>Muhimbili Orthopaedic Institute, Dar es Salaam, Tanzania

<sup>7</sup>Department of Orthopaedics, University of Santo Tomas Hospital, Manila, Philippines

Email for corresponding author: david.shearer@ucsf.edu

## References

1. GBD 2017Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018 Nov 10; 392(10159):1789-858.
2. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, Abraham J, Adair T, Aggarwal R, Ahn SY, Alvarado M, Anderson HR, Anderson LM, Andrews KG, Atkinson C, Baddour LM, Barker-Collo S, Bartels DH, Bell ML, Benjamin EJ, Bennett D, Bhalla K, Bikbov B, Bin Abdulhak A, Birbeck G, Blyth F, Bolliger I, Boufous S, Bucello C, Burch M, Burney P, Carapetis J, Chen H, Chou D, Chugh SS, Coffeng LE, Colan SD, Colquhoun S, Colson KE, Condon J, Connor MD, Cooper LT, Corriere M, Cortinovis M, de Vaccaro KC, Couser W, Cowie BC, Criqui MH, Cross M, Dabhadkar KC, Dahodwala N, De Leo D, Degenhardt L, Delossantos A, Denenberg J, Des Jarlais DC, Dharmaratne SD, Dorsey ER, Driscoll T, Duber H, Ebel B, Erwin PJ, Espindola P, Ezzati M, Feigin V, Flaxman AD, Forouzanfar MH, Fowkes FG, Franklin R, Fransen M, Freeman MK, Gabriel SE, Gakidou E, Gaspari F, Gillum RF, Gonzalez-Medina D, Halasa YA, Haring D, Harrison JE, Havmoeller R, Hay RJ, Hoen B, Hotez PJ, Hoy D, Jacobsen KH, James SL, Jasrasaria R, Jayaraman S, Johns N, Karthikeyan G, Kassebaum N, Keren A, Khoo JP, Knowlton LM, Kobusingye O, Koranteng A, Krishnamurthi R, Lipnick M, Lipshultz SE, Ohno SL, Mabweijano J, MacIntyre MF, Mallinger L, March L, Marks GB, Marks R, Matsumori A, Matzopoulos R, Mayosi BM, McAnulty JH, McDermott MM, McGrath J, Mensah GA, Merriman TR, Michaud C, Miller M, Miller TR, Mock C, Moccumbi AO, Mokdad AA, Moran A, Mulholland K, Nair MN, Naldi L, Narayan KM, Nasseri K, Norman P, O'Donnell M, Omer SB, Ortblad K, Osborne R, Ozgediz D, Pahari B, Pandian JD, Rivero AP, Padilla RP, Perez-Ruiz F, Perico N, Phillips D, Pierce K, Pope CA 3rd, Porrini E, Pourmalek F, Raju M, Ranganathan D, Rehm JT, Rein DB, Remuzzi G, Rivara FP, Roberts T, De León FR, Rosenfeld LC, Rushton L, Sacco RL, Salomon JA, Sampson U, Sanman E, Schwebel DC, Segui-Gomez M, Shepard DS, Singh D, Singleton J, Sliwa K, Smith E, Steer A, Taylor JA, Thomas B, Tleyjeh IM, Towbin JA, Truelsen T, Undurraga EA, Venketasubramanian N, Vijayakumar L, Vos T, Wagner GR, Wang M, Wang W, Watt K, Weinstock MA, Weintraub R, Wilkinson JD, Woolf AD, Wulf S, Yeh PH, Yip P, Zabetian A, Zheng ZJ, Lopez AD, Murray CJ, Al-Mazroa MA, Memish ZA. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012 Dec 15;380(9859):2095-128.
3. Gosselin RA, Spiegel DA, Coughlin R, Zirkle LG. Injuries: the neglected burden in developing countries. *Bull World Health Organ*. 2009 Apr;87(4):246-246a.
4. Tibor LM, Hoenecke HR Jr. Introducing arthroscopy to a developing nation: when and how to make it sustainable. *J Bone Joint Surg Am*. 2012 Jan 18;94(2):e8.
5. Emami Meybodi MK, Ladani MJ, Emami Meybodi T, Rahimnia A, Dorostegan A, Abrisham J, Yarbeygi H. Concomitant ligamentous and meniscal knee injuries in femoral shaft fracture. *J Orthop Traumatol*. 2014 Mar;15(1):35-9.
6. Brouillette MA, Kaiser SP, Konadu P, Kumah-Ametepey RA, Aidoo AJ, Coughlin RC. Orthopedic surgery in the developing world: workforce and operative volumes in Ghana compared to those in the United States. *World J Surg*. 2014 Apr;38(4):849-57.
7. Arilla FV, Rothrauff BB, Guglielmino C, Murawski CD, Fu FH. Future in Arthroscopy and Sports Medicine. In: Volpi P, editor. *Arthroscopy and Sport Injuries: Applications in High-level Athletes*. Springer International Publishing; 2016. p 1-7.
8. Carr AJ, Price AJ, Glyn-Jones S, Rees JL. Advances in arthroscopy-indications and therapeutic applications. *Nat Rev Rheumatol*. 2015 Feb;11(2):77-85.
9. Butt U, Amisssah-Arthur M, Khattak F, Elsworth CF. What are we doing about septic arthritis? A survey of UK-based rheumatologists and orthopedic surgeons. *Clin Rheumatol*. 2011 May;30(5):707-10.
10. Street EJ, Jacobsen KH. Prevalence of Sports Injuries Among 13- to 15-Year-Old Students in 25 Low- and Middle-Income Countries. *J Community Health*. 2017 Apr; 42(2):295-302.
11. Bhashyam AR, Fils J, Lowell J, Meara JG, Dyer GSM. A novel approach for needs assessment to build global orthopedic surgical capacity in a low-income country. *J Surg Educ*. 2015 Jul-Aug;72(4):e2-8.
12. Bhashyam AR, Logan C, Roberts HJ, Qudsi RA, Fils J, Dyer GSM. A Randomized Controlled Pilot Study of Educational Techniques in Teaching Basic Arthroscopic Skills in a Low-income Country. *Arch Bone Jt Surg*. 2017 Mar;5(2):82-8.
13. von Kaeppeler E, Donnelley C, Roberts HJ, O'Hara NN, Won N, Shearer DW, Morshed S. Impact of North American Institutions on Orthopedic Research in Low- and Middle-Income Countries. *Orthop Clin North Am*. 2020 Apr;51(2):177-88.
14. Thomas J, Harden A. Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Med Res Methodol*. 2008 Jul 10;8:45.
15. Pean CA, Premkumar A, Pean MA, Ihejirika-Lomedico R, Woolley PM, McLaurin T, Israelski R, Schwarzkopf R, Caplan A, Egol K. Global Orthopaedic Surgery: An Ethical Framework to Prioritize Surgical Capacity Building in Low and Middle-Income Countries. *J Bone Joint Surg Am*. 2019 Jul 3;101(13):e64.
16. Patel PB, Hoyler M, Maine R, Hughes CD, Hagander L, Meara JG. An opportunity for diagonal development in global surgery: cleft lip and palate care in resource-limited settings. *Plast Surg Int*. 2012;2012:892437.
17. Sue GR, Covington WC, Chang J. The ReSurge Global Training Program: A Model for Surgical Training and Capacity Building in Global Reconstructive Surgery. *Ann Plast Surg*. 2018 Sep;81(3):250-6.
18. Shapiro LM, Park MO, Mariano DJ, Kamal RN. Development of a Needs Assessment Tool to Promote Capacity Building in Hand Surgery Outreach Trips: A Methodological Triangulation Approach. *J Hand Surg Am*. 2020 Aug;45(8):729-737.e1.
19. Grant CL, Robinson T, Al Hinai A, Mack C, Guilfoyle R, Saleh A. Ethical considerations in global surgery: a scoping review. *BMJ Glob Health*. 2020 Apr 21;5(4): e002319.
20. Bärnighausen T, Bloom DE, Humair S. Going horizontal—shifts in funding of global health interventions. *N Engl J Med*. 2011 Jun 9;364(23):2181-3.
21. Lough BJ, Tiessen R, Lasker JN. Effective practices of international volunteering for health: perspectives from partner organizations. *Global Health*. 2018 Jan 24;14(1):11.
22. Thomas J, Harden A, Oakley A, Oliver S, Sutcliffe K, Rees R, Brunton G, Kavanagh J. Integrating qualitative research with trials in systematic reviews. *BMJ*. 2004 Apr 24;328(7446):1010-2.