

THE ORTHOPAEDIC FORUM

Transforming Global Orthopaedic Missions Through Adversity, Lessons Learned, and Sustainable Planning Using Quality Assurance Principles

The FAJR Methodology

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Global medical mission trips have become a prevalent practice for physicians seeking to provide orthopaedic surgical care to underserved populations around the world. This type of volunteer work has played an important role in providing both acute disaster response and long-term basic medical care for the affected populations¹. Over time, what was meant to be a temporary solution has resulted in international charitable organizations becoming permanent providers of medical and surgical care². The development of best practices surrounding international mission work has been advanced by medical associations and nonprofit organizations^{3,4}. Challenges in the global health setting include a lack of access to specialized orthopaedic expertise and facilities, a lack of access to high-quality implants, logistical challenges (e.g., medical record-keeping limitations), and safety issues due to war or natural disasters⁵⁻⁷. FAJR Scientific (“FAJR”), a nonprofit organization, has recently published findings from its first orthopaedic medical mission trip, during which it was faced with many of these challenges, which made it difficult to attain its mission goals⁸.

On its second mission trip, FAJR developed a systematic approach with use of the Six Sigma quality control principles to optimize future missions. By applying these principles, FAJR met

and surpassed its mission goals, including the completion of 153 complex lower-extremity orthopaedic cases in challenging conditions over a period of 5 days. The FAJR team was composed of 32 carefully selected medical professionals, including surgeons, residents, anesthesiologists, nurses, and physical therapists. Additionally, the FAJR team educated and trained over 43 orthopaedic residents, 55 operating and circulating room nurses, 34 anesthesiologists, 28 floor nurses, 12 physical therapists, and 90 researchers to manage and maintain a newly developed electronic medical record (EMR) that was created to meet the unique needs of the host country. Furthermore, FAJR provided education to orthopaedic attending physicians on adopting advanced surgical principles and implementing accepted guidelines for perioperative management. In this article, we introduce the “FAJR methodology” as a standardized method for performing high-quality global orthopaedic mission trips. This novel approach is based on quality assurance principles that provide a comprehensive and standardized approach to subspecialized orthopaedic surgical care in underserved settings.

Methodology

FAJR completed its first mission in the West Bank, Palestine, in January 2023; we performed 48 surgeries, including hip and

*A list of the FAJR Scientific Research Collaborative members is provided in a Note at the end of the article.

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knee arthroplasty, pediatric spine surgery, and sports reconstruction surgery, at 2 major academic centers (the Palestine Medical Complex in Ramallah and Rafidia Surgical Hospital in Nablus). As noted earlier, the team faced substantial challenges that hindered the goal of performing a larger number of essential surgeries⁸.

The subsequent mission protocol was based on a framework of lessons learned from the previous trip and quality assurance principles utilizing the Six Sigma quality improvement methodology⁶. This method represents a standardized set of 7 steps that are categorized into 3 phases (preoperative, intraoperative, and postoperative), which we modified to increase applicability to the surgical process. Table I further defines and details the steps taken by FAJR to meet each of the recommended measures.

There were several important planning elements performed that were not covered by the quality assurance principles described in Table I. The local and visiting teams met with the Gaza Palestine Ministry of Health and exchanged ideas about the methodology, which culminated in the development of 8 defined goals to encompass this protocol (Table II).

During the mission trip planning phase, FAJR provided education on the methodology of Define, Measure, Analyze, Improve, and Control (DMAIC), part of the Six Sigma approach, to address challenges that were encountered during the previous mission, identify their root causes, and subsequently implement solutions. The implementation of these DMAIC principles was also categorized into preoperative, intraoperative, and postoperative phases, and the outcomes form an important part of the key findings of this study.

Mission Trip Costs and Expenditures

All patients treated by the FAJR team were provided with free treatment. Expenses, including the cost of surgery and surgical implants, as well as inpatient services such as nursing and physical therapy, were provided free of charge. Patients were responsible for the cost of nominal tests at the time of follow-up visits, such as radiographic imaging. Mission trip costs, totaling nearly \$4 million U.S. dollars, were covered primarily by in-kind donations, including surgical implants, instrument sets, and medications. These costs were categorized by surgery type. The cost of equipment procured for foot and ankle surgeries was \$1.1 million, while the cost of equipment for knee surgeries (arthroplasty and sports medicine procedures) was \$1.6 million. The cost of installing 2 arthroscopy towers and upgrading 2 laparoscopy towers was \$300,000. Given the volume of surgery that was performed, a substantial amount of disposable equipment was required; the cost was \$600,000, including shipping. Postoperative braces, immobilization devices, and rehabilitation equipment were also procured for the mission trip at a cost of \$250,000, including shipping. The cost of the logistics of the mission trip, including airfare, lodging, transportation, and accommodation, was \$150,000. None of the FAJR team members or any of the local staff from the host country were compensated for their time and services, financially or otherwise.

Data Acquisition and Postoperative Outcome Measurement

In close collaboration with the orthopaedic department chiefs at each university, research groups were created by assigning FAJR research and quality parameter mentors, who were responsible for topic curation and survey selection. All data collection efforts were approved by the ethics committee of the hospitals and local universities, and informed consent was obtained from each of the participating patients. The evaluation of patient records took place during the pre-mission site visit; no reliable electronic medical recording was demonstrated. For this reason, a new secure EMR (called “Maryam”) was specifically created for the mission trip; it was stored locally and maintained under the ownership of the hosting hospitals. These data were used as a supplement to the inpatient health record. Preoperatively, they were used to optimize patient modifiable risk factors such as smoking habits and metabolic syndrome, as well as to obtain and store all imaging. Postoperatively, the new EMR was used to track patient pain, function, and the incidence of complications.

Team Safety

The safety and security of all of the visiting team members were of utmost importance throughout the planning and execution of the mission trip. All team members were grouped in pairs for safety during the mission trip, and each person had a designated local contact for emergencies. All travel plans and arrangements, which were made through direct communication with local authorities and government officials, included an emergency exit strategy.

Results

An overview and visual timeline of the mission trip, from pre-trip planning stages through the completion of the mission, are provided in Figure 1.

Although 270 patients were originally selected for operative consideration, 153 patients were ultimately selected for inclusion during the mission. Table III provides a demographic overview of the patients who underwent surgical intervention. Importantly, there were no patient cancellations, no surgical complications, and no safety incidents during the mission.

Orthopaedic surgeons from multiple subspecialties were specifically recruited to perform lower-extremity surgery, which is detailed in Table IV. As for specific site selection, 3 key academic hospitals that had the necessary orthopaedic facilities to support a mission of this caliber were identified and selected.

More than 90 local medical students, 30 resident physicians, and 40 support medical personnel participated in the data collection regarding all of the surgical patients. In addition to recording the typical inpatient data (e.g., vital signs and blood tests), the newly developed patient EMR was created to collect relevant orthopaedic metrics, including sociodemographic, socioeconomic, medical, and surgical history, preoperative pain and functional scores, and postoperative complications. More information about the data metrics is provided in Table V.

TABLE I Quality Assurance Measures Utilized for Mission Trip Planning (Preoperative, Intraoperative and Postoperative Phases)⁶

Quality Assurance Measure and Definition	Actions Performed to Ensure Compliance
1: Site selection Develop a rigorous protocol to be used in the selection and evaluation of potential mission sites.	Among the first topics of discussion was deciding where to set up geographically in order to maximize patient access. Factors contributing to a final decision included population density and orthopaedic demand, institutional capacity limitations and operative efficiency, and organizational logistics built around the type of surgery performed. Three hospitals were selected from which to provide care during the mission trip. One care subspecialty was designated per hospital (arthroscopy and sports medicine was performed at Shifa Hospital in Gaza City, foot and ankle surgery was performed at European Hospital in Khan Yunis, and total knee arthroplasty was performed at Nasser Hospital in Khan Yunis). One of the reasons behind the decision to operate out of 3 distinct hospitals was to provide a full and dedicated surgical staff for each orthopaedic subspecialty (joints, foot and ankle, sports medicine/arthroscopy). This allowed for specialized surgical care teams, training sessions, and approaches based on types of surgeries performed. For example, physical therapists at 1 hospital were able to commit to learning a specific set of physical therapy modalities, reducing the potential room for error. Another reason why we decided to split up by surgery type was to keep specific instrument sets in 1 place, with the goal of improving operative turnover efficiency.
2: Site visit Use a standardized form to assess and document available facilities and equipment. Network with the local medical community; identify a local coordinator.	FAJR's Chief Executive Officer traveled to Gaza 3 months prior to the scheduled mission to meet with key stakeholders from the Ministry of Health, perform an in-person assessment of health facilities, and better understand the scope of challenges ahead of our mission. An itemized report of both capital and disposable infrastructure was produced, and photo documentation of the host facilities was obtained. Local leaders for each hospital were appointed to maximize communication and logistical efficiency.
3: Trip preparation Develop and implement a comprehensive staffing algorithm. Appoint a team leader to review the site survey and determine the necessary resources to be acquired and shipped prior to the mission.	Recruitment of a broadly talented group of professionals took place after the site visit and as necessitated by local staff shortages. A group consisting of 2 attending sports medicine surgeons, 4 attending hip and knee arthroplasty surgeons, 3 attending podiatric surgeons, 3 attending anesthesiologists, 3 physical therapists, and 2 operating room nurses was assembled. A team leader was made responsible for obtaining and shipping both capital and disposable equipment that was necessary for the trip.
4: Patient screening Institute a rigorous screening process with evidence-based inclusion criteria.	A 2-step patient selection and optimization process was adopted by first conducting a chart review of patients who had initially been identified by local orthopaedic surgeons. This list included hundreds of patients requiring surgical intervention; they were assessed during an initial chart review, noting medical and surgical histories, as well as laboratory studies. After the initial chart review process, a second preoperative patient evaluation was performed, this time in-person and within 3 days of a given patient's scheduled surgery. This was done via the holding of a formal clinic day on the first working day of the mission. This ensured that the patient would undergo a physical examination and assessment for acute changes that would otherwise exclude a patient from surgery.
5: Case selection Develop an operative schedule based on capacity, level of deformity, and urgency of care.	The team shared a strong commitment to maximizing time while in Gaza, and an ambitious goal of 150 procedures (50 procedures per subspecialty) was set. Local stakeholders recommended focusing on lower-extremity procedures, citing the disease burden of degenerative arthritis on the aging population, in addition to a high incidence of traumatic disability in the younger population. Three hospitals were selected; each hospital was to provide 1 subspecialty care type: Shifa Hospital in Gaza City (sports medicine/arthroscopy), European Hospital in Khan Yunis (foot and ankle surgery), and Nasser Hospital in Khan Yunis (total knee arthroplasty). This resulted in a full and dedicated surgical staff for each orthopaedic subspecialty. It also allowed for standardized surgical care teams, training, and postoperative rehabilitation, as well as instrument centralization.

continued

TABLE I (continued)

Quality Assurance Measure and Definition	Actions Performed to Ensure Compliance
6: Operative care Verify the functionality of all equipment and facilities prior to the first case. Incorporate local physicians and surgeons into the operative and teaching process, with graduated involvement throughout the week. 7: Screening/follow-up Provide clear discharge instructions, verbal and written, to patients and their families in their native language. Screen all operative patients on the penultimate day of the mission to evaluate for potential complications and plan for future procedures	Surgical teams spent the first day of the mission trip sorting through and organizing medical supplies for the operating rooms. All equipment was tested to ensure proper functionality ahead of the first surgical case. Local attending orthopaedic surgeons and residents were incorporated into every surgical case, becoming involved months ahead of the mission trip as part of the preoperative planning, and assuming care postoperatively for all surgical patients. Postoperative rehabilitation and patient education materials distributed upon discharge were specific to each subspecialty care team (e.g., patients who underwent total knee arthroplasty were expected to be safely discharged using a standardized 24-hour total knee arthroplasty discharge protocol). All patients underwent a postoperative physical examination, including a wound check prior to discharge. Vitals and laboratory measures were reviewed and stored in the electronic medical record. Patients were given discharge instructions; signs of potential complications were provided in the patient's native language. Patients were scheduled for their first follow-up appointment prior to discharge.

Aside from patient care, a substantial effort was dedicated to identifying process problems and working to resolve them. This was performed using the Six Sigma methodology of DMAIC. Tables VI, VII, and VIII detail the DMAIC approach and outcomes for the preoperative, intraoperative, and postoperative phases, respectively.

Discussion

When evaluating the effectiveness and impact of a surgical mission, it is crucial to assess the extent to which each of the

mission goals was achieved. These goals not only guided the approach but also formed the basis for many of the solutions that were implemented during the mission. The valuable insights that were gained from the mission goals and the critical assessment analysis were instrumental in shaping the core of the FAJR methodology, which was built around 7 key considerations. After integrating these lessons into our logistical approach, the team was better equipped to plan, execute, and evaluate the goals and outcomes of future mission trips (Fig. 2).

TABLE II FAJR's 2023 Mission Goals in Gaza

Goals
1. Alleviate the undue burden of orthopaedic disease on the patient population living in Gaza by way of high-volume surgical intervention. 2. Train/educate orthopaedic surgeons and residents in subspecialties that previously have been unavailable in Gaza, while providing advanced training/education in existing subspecialties. 3. "Do No Harm": Apply rigorous clinical and functional outcomes quality data collection to evaluate the impact of our interventions, education, and training. 4. Establish accepted orthopaedic guidelines and health policies to standardize preoperative, intraoperative, and postoperative approaches to orthopaedic care in Gaza. 5. Secure necessary infrastructure to carry out complex orthopaedic cases such as advanced imaging capabilities, spacious operating rooms to accommodate the necessary equipment (e.g., fluoroscope and arthroscopic towers), and personnel who can operate these systems. Operating rooms should have reliable and efficient anesthesia systems, adequate lighting, and a sterile environment to minimize the risk of infection. 6. Develop an a priori memorandum of understanding (MoU) with the Federal Medical Organization, which can serve as a guide, akin to a cookbook, outlining the management and leadership responsibilities of the mission from both sides. The MoU outlined critical aspects such as management of the patients postoperatively while delineating roles and responsibilities. 7. Develop an orthopaedic electronic medical record (EMR) de novo named "Maryam" to optimize data integrity and continuity. Patient selection was primarily based on case complexity and/or "wait times, with relevant data populated in the EMR. This information, along with medical imaging and laboratory testing, was made available for the FAJR team to assess and evaluate the surgical candidacy of the patients. 8. Adhere to legal and professional requirements when planning a medical mission, including securing support for travel documents for entry and exit from the host country. This process entails not only obtaining the necessary visas and permits, but also ensuring that all team members meet the host country's medical credentialing and licensing requirements.

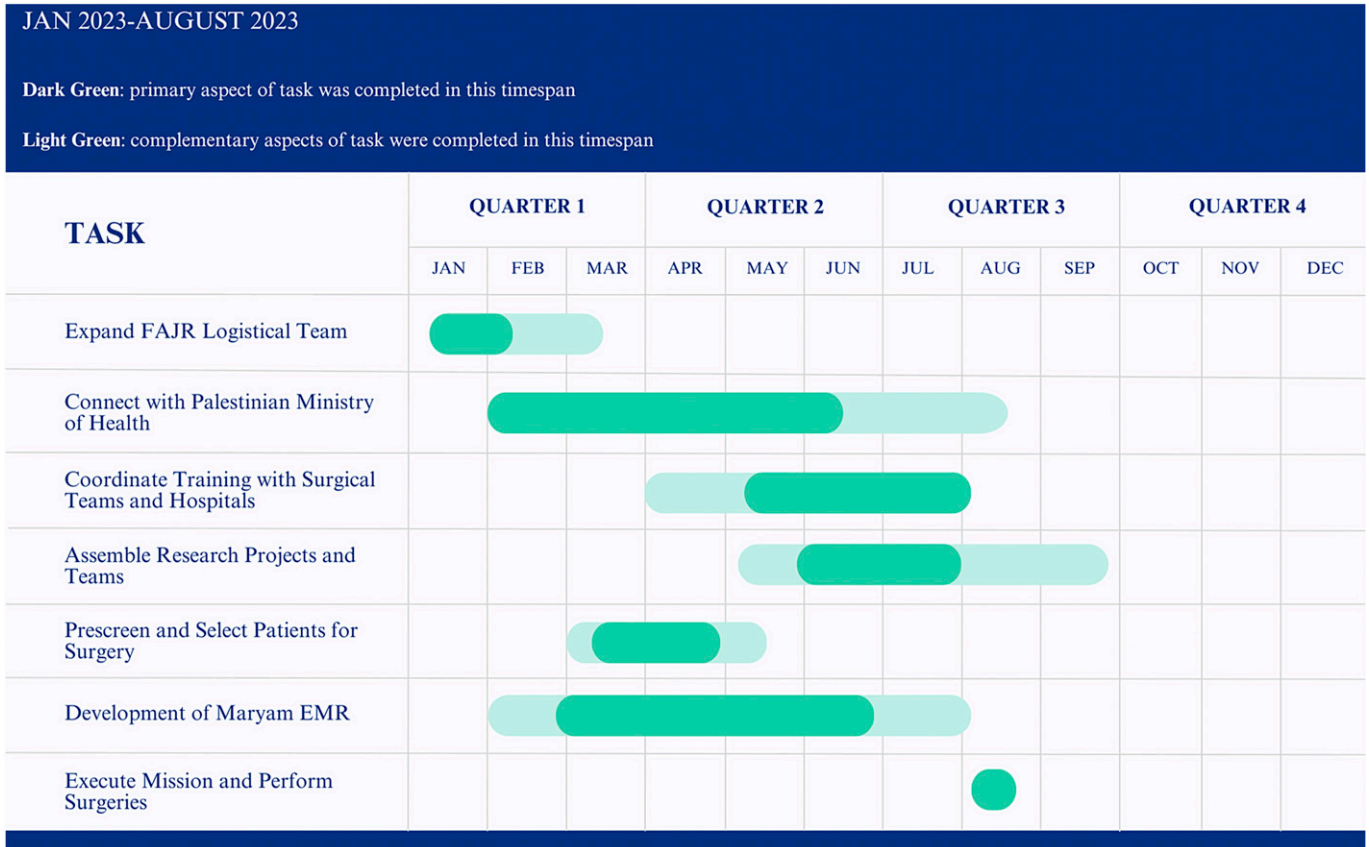


Fig. 1

Logistics and solution integration timeline for the second FAJR mission trip (January to August 2023), split into 4 quarters. The green horizontal bars represent the time that was spent on each task, with dark green representing most of the task completion and light green representing partial task completion.

Surgical Mission Goals

From a surgical volume standpoint, FAJR completed the highest recorded volume of surgeries during a mission trip to Gaza. This

accomplishment is a testament to the meticulous planning and thoughtful execution by the entire organizing team. However, there are thousands of patients in Gaza who remain on a surgical

TABLE III Surgical Patient Demographics

	Total Knee Arthroplasty (N = 42)	Foot/Ankle Surgery (N = 48)	Arthroscopy/Sports Medicine Surgery (N = 63)
Average age (yr)	65	31	32
Gender			
Male	29% (n = 12)	63% (n = 30)	87% (n = 55)
Female	71% (n = 30)	37.5% (n = 18)	13% (n = 8)
Employment			
Employed	12% (n = 5)	21% (n = 10)	59% (n = 37)
Unemployed	71% (n = 30)	37.5% (n = 18)	32% (n = 20)
Student	0% (n = 0)	25% (n = 12)	8% (n = 5)
Retired	17% (n = 7)	17% (n = 8)	2% (n = 1)
Surgery subtype performed	Total knee replacement, cruciate-retaining (n = 42)	Open reduction and internal fixation (n = 12) Osteotomy (n = 8) Tenotomy (n = 15) Other (n = 13)	ACL reconstruction (n = 23) Meniscal repair/meniscectomy (n = 34) Other (n = 6)

TABLE IV FAJR Team Composition Divided by Host Hospital

Team and Facility	Team Demographics
Joint replacement/arthroplasty 4 operating rooms Nasser Hospital Khan Yunis, Gaza	Visiting FAJR team • 4 attending hip and knee surgeons • 1 attending anesthesiologist • 1 operating room nurse • 1 Stryker technician • 1 physical therapist Gaza team • 4 attending hip and knee surgeons • 8 resident orthopaedic surgeons • 4 attending anesthesiologists • 8 operating room nurses • 2 physical therapists
Sports medicine/arthroscopy 3 operating rooms Shifa Hospital Gaza City, Gaza	Visiting FAJR team • 2 attending sports medicine surgeons • 1 attending anesthesiologist • 2 operating room nurses • 1 physical therapist Gaza team • 2 attending sports medicine surgeons • 12 resident orthopaedic surgeons • 4 attending anesthesiologists • 8 operating room nurses • 2 physical therapists
Foot and ankle surgery European Hospital 3 operating rooms Khan Yunis, Gaza	Visiting FAJR team • 3 attending foot and ankle surgeons • 1 resident foot and ankle surgeon • 1 attending anesthesiologist • 1 operating room nurse • 1 physical therapist Gaza team • 3 attending foot and ankle surgeons • 6 resident orthopaedic surgeons • 3 attending anesthesiologists • 6 operating room nurses • 2 physical therapists

waitlist, either unable to afford their treatment or unable to access the necessary care. From this standpoint, there remains much work to be done.

Training and Education

More than 100 host-nation medical personnel, including surgeons, anesthesiologists, resident physicians, physical therapists, nurses, and infection control specialists, were provided with education and training during the surgical mission. Surgical training took place in a ratio of 1:1 or 2:1 between visiting attending surgeons and local attending surgeons. Daily didactic lectures were prioritized for both the local and visiting surgical teams. Based on feedback, the approach of graduated involvement was overwhelmingly successful, and by the end of the mission, all of the attending orthopaedic surgeons felt more comfortable using the new orthopaedic equipment and surgical approaches that had been utilized during this process. On the next mission, surgeon education and confidence measures will be collected, both pre- and post-mission, to assess the change in each surgeon's education and comfort level.

During the second mission trip, and in collaboration with the Wayne State University Department of Orthopaedic Surgery, the FAJR leadership was able to provide 41.00 AMA PRA (American Medical Association Physician's Recognition Award) Category I credits via continuing medical education (CME) for the host and visiting medical teams. We found that the visiting medical team had a high level of interest in receiving CME course credits: nearly all members (14 of 15) claimed some form of CME credit by the end of the mission. Feedback from the team indicated that the CME course encouraged FAJR surgeons to improve their operating room efficiency, sterility while operating, and quality of communication with both patients and team members.

Functional Outcome Quality Data Collection

FAJR established a large-scale research initiative by incorporating local medical students and residents in the data collection involving quality variables under the support and guidance of FAJR research mentors. Thirteen dedicated research projects were formed before the mission trip. The research team collected data at preset points, with patient retention of >90% at the time of the 1-month follow-up. This model of mentorship will carry over into future mission trips to sustain long-term relationships with host-team members.

Health Policy and Orthopaedic Centers of Excellence

FAJR founded 3 centers of excellence to elevate the quality of care that was provided during the mission: a Center of Arthroplasty at Nasser Hospital, a Center of Sports Surgery at Shifa Hospital, and a Center of Foot and Ankle Surgery at European Hospital. The unique combination of subspecialized care and staff at a dedicated hospital was intended to elevate the standards of orthopaedic care in Gaza. Furthermore, a systematic review of charitable platforms in global surgery demonstrated that specialized surgical centers provided more effective and cost-effective care when compared with the data from short-term surgical mission trips⁹.

One Arthroscope for 2 Million People

FAJR gave special consideration to procuring capital versus disposable equipment. Attaining and providing capital equipment,

TABLE V Types of Data Collected by Surgery Type*

All Surgeries	Sports/Arthroscopy	Joint	Foot/Ankle
Sociodemographic	KOOS	KOOS	HADS
Medical, surgical histories	HADS	BBS	BBS
SF-12	BSFC-s	BSFC-s	
WHOQOL-BREF			

*KOOS = Knee injury and Osteoarthritis Outcome Score; HADS = Hospital Anxiety and Depression Scale; BBS = Berg Balance Scale; SF-12 = Short Form-12; BSFC-s = Burden Scale for Family Caregivers, Short; and WHOQOL-BREF = World Health Organization Quality of Life Scale, Brief Form.

TABLE VI DMAIC Process for the Preoperative Phase*

Define	Measure	Analyze	Improve	Control
Team integration and early preparation	Successful engagement with the host nation's medical team and MoH leaders necessitated meticulous planning and regular communication.	Completed during the primary mission trip in January.	Facilitation of monthly education seminars, early needs assessments, and informative workshops. Dissemination of mission expectations and benchmarks (e.g., 24-hour total knee arthroplasty discharge protocol).	Conclusion of the mission, marked by harmonized team dynamics and adherence to "zero-incident" commitment.
EMR keeping	Medical record-keeping was found to be underprioritized and outdated, which contributed to difficulty with patient selection and optimization. Large gaps in data documentation among patient charts were common, and methods of documentation (digital vs. paper) differed among facilities.	Completed during the primary mission trip in January. Continued during pre-site visits by various FAJR team members.	In collaboration with the MoH, FAJR helped identify key stakeholders within the hospital's information technology department to build out a supplemental patient database ("Maryam") within the protected hospital electronic medical record. FAJR's CEO worked directly with the information technology department to outline specific metrics needed to evaluate patients safely and comprehensively in a perioperative setting. An in-person meeting with all perioperative nursing staff, members of the MoH, and FAJR's CEO in attendance took place to review our plan of action and emphasize the importance of comprehensive data collection.	Heightened efficiency in patient screening process while maintaining stringent privacy protocols and developing an advanced EMR.
Patient selection and optimization	Patient selection in the preoperative setting was not occurring in a comprehensive manner under the current system of local orthopaedic care.	Completed during pre-site visits by various FAJR team members.	The FAJR team adopted a 2-step patient selection and optimization method by first conducting a chart review of patients identified initially by local orthopaedic surgeons, with the focus of performing a thorough patient history and physical examination, as well as any pertinent laboratory studies required prior to consideration for surgery. After this initial chart review process, a second preoperative patient evaluation was performed, this time in-person and within 3 days of the patient's scheduled surgery through our formal clinic day to allow the team to meet the patients, perform necessary evaluations, and assess for acute changes that would otherwise exclude them from surgery.	There were 153 completed surgeries and adherence to "zero-incident" commitment.
Cultural sensitivity training	Strategic emphasis on fostering cultural humility and sensitivity, a pivotal aspect in establishing a collaborative and trustful environment with the host nation.	Completed during pre-site visits by various FAJR team members.	Rigorous interteam dialogues that included local Palestinians facilitated nuanced cultural, religious, and political understanding. Media recognition elevated FAJR's profile.	Elevated trust and collaboration with the host nation, epitomized by supportive local reception and international recognition.

continued

TABLE VI (continued)

Define	Measure	Analyze	Improve	Control
Stakeholder management and partnership	Primary challenges lay in securing essential surgical supplies (e.g., disposables, implants, power tools, and instrument sets). Notably, Gaza only had 1 functional arthroscope for a population of 2 million. Only 1 functional power-tool set was identified in the host hospitals.	Completed during pre-site visits by various FAJR team members.	Strategic alignment with Project C.U.R.E., a distinguished nonprofit, engendered tailored “C.U.R.E. Kits,” reinforcing the surgical supply cache. A total of 31 custom “C.U.R.E. Kits” furnished comprehensive orthopaedic resources.	Ensured an ample inventory of critical surgical supplies, bolstering mission capabilities and allowing an increased number of surgeries.
Implant estimation for cost optimization	Limited data regarding patients and surgeries led to the estimation of required implants that were based on minimizing costs, since any excess of implants cannot be returned or exchanged in Gaza.	Completed during the primary mission trip in January. Continued during pre-site visits by various FAJR team members.	There were 47 implants procured for 43 surgeries based on the extensive experience of the Medical Lead and CEO, emphasizing optimization and efficiency.	Cost optimization and surgical efficiency to maximize the volume of surgeries performed.
Sterilization equipment and turnaround time	Outdated sterilization equipment coupled with extended turnaround times were observed, affecting postoperative patient mobility and safety. Notably, there were no standardized sterilization protocols, contributing to delays in surgical schedules.	Completed during the primary mission trip in January. Continued during pre-site visits by various FAJR team members.	FAJR surgeons educated local medical staff on sterilization techniques and modern practices through CME-endorsed education seminars. This approach aimed to ensure adequate time for sterilization, facilitating smoother surgical scheduling. Furthermore, the FAJR team advocated for investments by the MoH in modern sterilization equipment, aiming to enhance both safety and efficiency. All necessary disposable materials, including surgical drapes, were shipped ahead of time. Two seasoned operating room nurses, each with >20 years of experience, joined from the Detroit Veterans Affairs Medical Center to help identify gaps in operating room sterility and correct them during our mission.	Improved sterilization efficiency and patient safety were realized through the adoption of proactive patient screening and the introduction of modern sterilization equipment. Zero postoperative infections were recorded.
*MoH = Ministry of Health, EMR = electronic medical record, CEO = chief executive officer, and CME = continuing medical education.				

defined as tools that are not regularly replaced, was prioritized given the host nation's lack of a substantial baseline infrastructure. FAJR also procured disposable equipment, normally replaced with every surgery, which composed a substantial portion of the shipping costs. We found that donating capital surgical equipment was one of the most impactful aspects of the mission trip. For example, FAJR introduced Gazan surgeons to some of their first orthopaedic arthroscopic equipment. Prior to our arrival, there was only 1 functional arthroscope serving 2 million people in Gaza. By the end of the mission

trip, and in congruence with the effectiveness of the FAJR surgical training program, the sports medicine team from Shifa Hospital had completed their first independent anterior cruciate ligament (ACL) reconstruction using methods taught by Dr. Hussein Elkousy, Director of Sports Medicine at FAJR Scientific.

Maryam: Gaza's New EMR

Challenges surrounding data collection and consistency have been encountered and well documented during previous

TABLE VII DMAIC Process for the Intraoperative Phase

Define	Measure	Analyze	Improve	Control
Lack of orthopaedic supplies and infrastructure	A lack of essential orthopaedic supplies and infrastructure was observed across all 3 hospitals, including limited power tools and arthroscopic towers.	Identified during the pre-site visits as well as during the mission trip in August.	Two functional arthroscopes were provided to Shifa Hospital. Two instrument sets and a Stryker System 7 power tool were supplied to both the European Hospital and Shifa Hospital.	Application of lessons learned by the host nation, with a noteworthy achievement being Shifa Hospital's successful completion of their first anterior cruciate ligament reconstruction. In total, >\$4 million worth of surgical resources were allocated, substantially enhancing the surgical capabilities of the 3 major hospitals in Gaza.
Uncertainty in implant distribution	While implants were estimated to follow a normal distribution, they actually followed a bimodal distribution, with specific implants being depleted faster than usual.	Identified during the mission trip in August while conducting surgeries.	FAJR's team actively communicated with regional providers to acquire implants (size 7 and size 2/3).	Ensured an adequate inventory of implants, allowing an increased number of surgeries.
Mismanagement of radiographic services	Radiographic imaging exhibited inefficiencies and lacked standardization protocols. Image views were frequently mislabeled, raising the risk of erroneous surgical site identification.	Identified during the pre-site visits as well as during the mission trip in August.	The FAJR team advocated for the implementation of standardized protocols within radiology departments, specifically addressing labeling accuracy and procedure uniformity. Training initiatives were recommended for radiographic technicians to enhance their proficiency and attentiveness.	A reduction in the risk of surgical misidentification was achieved thanks to the adoption of standardized protocols and enhanced accuracy in radiographic services.
Staff safety and nourishment	Staff experienced dehydration and undernourishment during surgeries and surgery preparation due to high temperatures, extended durations, and limited access to food.	Identified during the pre-site visits as well as during the mission trip supply preparation in August.	Small, energy-rich snacks and electrolyte-infused hydration were provided to staff members to mitigate the effects of heat and prolonged surgical procedures.	There were no issues or complications experienced by any volunteers because of dehydration or safety.

mission work¹⁰. In March 2023, FAJR coordinated efforts with the Gaza Ministry of Health to overcome this challenge by designing and implementing an EMR named "Maryam." The creation of Maryam took substantial effort in close coordination with the Ministry of Health and the information technologists at the hospitals. Most of this preparation took place during the pre-trip site visit. Some challenges with the implementation of Maryam included the transfer of information from the existing system; insufficient or missing data (e.g., height or body mass index), which limited surgeon evaluations; and difficulty navigating the EMR due to language barriers.

Mission Trip Challenges and Criticisms

Not all elements of the mission trip went smoothly. Surgical planning proved challenging as many surgical procedures (e.g., total joint arthroplasty) required different sizes of each implant for each surgery. Although implants had been purchased assuming a Gaussian distribution of sizes, the actual size distribution of our patient population proved to be bimodal. This resulted in the utilization of only a few sizes, and other sizes were not used. Fortunately, FAJR was able to provide the necessary implant for each surgery, and despite this issue, no surgeries were canceled due to

TABLE VIII DMAIC Process for the Postoperative Phase

Define	Measure	Analyze	Improve	Control
No standardized postoperative patient pathway	Postoperative care was observed to be outdated and suboptimal. Patients faced challenges with ambulation and weight-bearing status due to inadequate protocols. Fall risks were not adequately addressed. Indwelling Foley catheters were commonly utilized for extended periods, exposing patients to potential infection risks.	Identified during the mission trip in August through communication with patients who had undergone surgery.	The FAJR surgeons introduced updated postoperative protocols, focusing on patient mobility and safety. This included revised ambulation procedures and a reduction in the use of indwelling Foley catheters. Falls risks were systematically assessed and mitigated by the education of local support staff.	Substantial improvements in postoperative care were achieved. Patients experienced enhanced mobility, reduced infection risks, and improved overall safety. The implementation of updated protocols marked a substantial advancement in patient recovery, with no documented falls, complications, or infections.
Follow-up care and appointments	Patients often faced challenges in accessing follow-up care and appointments with the medical team of the host nation, posing a potential barrier to optimal postoperative recovery and monitoring.	Identified during the mission trip in August through communication with patients who had received surgery.	FAJR worked closely with the medical team of the host nation to ensure timely and accessible follow-up care for patients. This included coordinating appointments and providing comprehensive home-care plans. Furthermore, FAJR trained medical students in the host nation to conduct and maintain a database containing surgical outcome information, including complications and infections.	Improved access to follow-up care and appointments facilitated optimal postoperative recovery for patients. Timely monitoring and support contributed to enhanced overall outcomes and patient satisfaction.
A memorandum of understanding (MoU) with the Ministry of Health (MoH)	Administrative cost disputes and unclear patient follow-up guidelines.	Identified during the mission trip in August through communication with patients who had received surgery.	Establishment of a comprehensive MoU with the MoH, delineating expectations and mutually agreed-upon administrative costs.	Positive patient follow-up experiences and comprehensive care delivery, bolstered by clear expectations outlined in the MoU.

implant stock issues. Nonetheless, when planning for the next mission trip, assessing implant sizes using advanced imaging will be necessary to maximize efficiency and optimize implant inventory.

One common criticism of surgical mission trips is that financial resources used on transportation and lodging for the visiting team would be more effectively spent if they were sent directly to the host country^{10,11}. However, 1 study has shown that short-term orthopaedic missions have been found to be very cost-effective when comparing the cost of surgery to the number of quality-adjusted life years that are gained¹². Other common criticisms of surgical mission work are the inability to build sustainable care programs during short visits and the difficulty with following patients to monitor and treat any postoperative complications that may arise¹. These concerns are inevitable when a mission trip is done in isolation without proper planning and follow-up. FAJR has worked to ameliorate this concern by forming long-term relationships with host partners and monitoring for postoperative complications during patient follow-up visits, as established in the memorandum of understanding.

Previous Orthopaedic Mission Work

Many important lessons have been shared from previous global joint arthroplasty missions, including the importance of optimal sterile conditions in operating rooms, the difficulties that many host hospitals face in trying to meet sterility standards, and the importance of having a familiar and accustomed team in the operating room^{13,14}. However, both of these studies represent stand-alone missions with smaller visiting teams that were unable to report on comprehensive preoperative and postoperative care. Other studies that have been performed on an institutional level (e.g., those formally sponsored by a university, hospital, or professional association) have typically been broadly focused or focused only on trauma^{15,16}. Very few, if any, institutional programs that are aimed at providing subspecialized orthopaedic care, such as total joint arthroplasty, exist. This implies that subspecialized global orthopaedic surgical care has yet to be performed regularly on a large-scale institutional level.

Conclusions

The FAJR methodology is a novel approach to applying institutional-level infrastructure to subspecialized global orthopaedic care, which allows for transformational care delivery. This



Fig. 2

Seven key considerations for the successful planning and execution of orthopaedic surgical mission trips using the FAJR methodology. Each column represents a take-home point.

occurs through a comprehensive approach, specifically as it pertains to preoperative, intraoperative, and postoperative care. This multifaceted approach, in combination with the key considerations that are outlined in Figure 2, forms the FAJR methodology. This methodology is specifically recommended for use in planning, executing, and sustaining global orthopaedic sub-specialized mission trips. Executing our mission trip proved to be a monumental task; it included close coordination with the host country's Ministry of Health, hospitals, and adjacent universities; the creation of a new EMR; and the mobilization of hundreds of medical providers and volunteers. However, it is important to note that although this mission was performed on a large scale (32 team members performed 153 surgeries over a period of 5 days), the principles of planning and executing the mission remain the same for global orthopaedic mission trips of any size. All of the key considerations (Fig. 2) can be applied to any mission, regardless of team size, budget, or host country.

Although there are orthopaedic organizations that perform global surgical care in the field of trauma, FAJR is pioneering and successfully implementing scientific strategies to optimize mission work in reconstructive orthopaedic surgery, making it one of the first organizations to do so. The first FAJR mission was successful in that it provided a blueprint on how to perform the second, our most recent, mission trip. The need for increased global surgical intervention has been well-documented, and providing global orthopaedic surgical care remains an acutely and broadly impactful act of philanthropy

for surgeons. Through the development of the newly created FAJR methodology, FAJR Scientific is dedicated to answering the call for high-volume specialized surgical care in underserved global settings and doing so in a manner that is ethical, equitable, and sustainable. ■

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