Safe Surgery 2020 Ethiopia

A Mixed-Methods Assessment of Safe Surgery 2020 in Amhara and Tigray, Ethiopia 2016-2018

APRIL 2019

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Table of Contents

Tables

Appendix

Introduction

Safe Surgery 2020 in Ethiopia

Safe Surgery 2020 is a multinational partnership of governments, implementers, and researchers that aims to build the surgical capacity of hospitals in low-resource settings to improve patient outcomes. Partners include *Dalberg*, a strategy advisory firm, *Jhpiego*, an international health NGO, *Harvard Medical School Program in Global Surgery and Social Change (PGSSC)*, a research institution, and *Assist International*, a humanitarian organization.

The primary strategic goal of SS2020 is to drive major improvements in the volume and quality of emergency and essential surgical procedures in primary health care facilities and district-level hospitals. To achieve this goal, SS2020 has four key objectives, which are accomplished through the leadership and networks of its implementing partners:

1. Advocate for increased prioritization of surgery at the national level, and support Ministries of Health to prioritize surgery in their national surgical planning process;
2. Develop and scale a leadership development program for surgical teams that improves their ability to communicate effectively, problem solve around resource constraints, and lead the way to transforming care at their hospitals;
3. Enable increased innovation in safe surgery and anesthesia through partnerships and direct programs in priority areas for our partner countries and hospitals;
4. Support the design and implementation of robust M&E systems that allow us to continuously monitor and improve our programs, build local and national capacity for collecting and reporting on surgical indicators, and avoid duplicative efforts.

In 2016, Safe Surgery 2020 launched its programs in Ethiopia by establishing partnerships with the FMOH – specifically with its innovative national surgical program, *Saving Lives Through Surgery (SaLTS)* – and other local and international partners.

Figure 1. SS2020 and SaLTS Partners and Stakeholders

Upon its 3rd year of implementation in Ethiopia, the SS2020 team conducted data collection and analyses using quantitative and qualitative methodologies to evaluate the overall progress and perception of impact of SS2020 in 10 intervention hospitals in Amhara and Tigray, Ethiopia. The primary objective of this report is to summarize these key mixed-methods results.

SS2020 Interventions

Since 2016, SS2020 has collaborated with SaLTS to implement a diverse package of interventions. A multi-pronged approach was used to improve overall surgical knowledge and skills, hospital infrastructure, and surgical data quality. The results summarized in this report evaluated a core suite of interventions that have the primary objective of creating long-term, sustainable impact on surgical quality in Ethiopia. The medium and long-term objectives of Safe Surgery 2020 are:

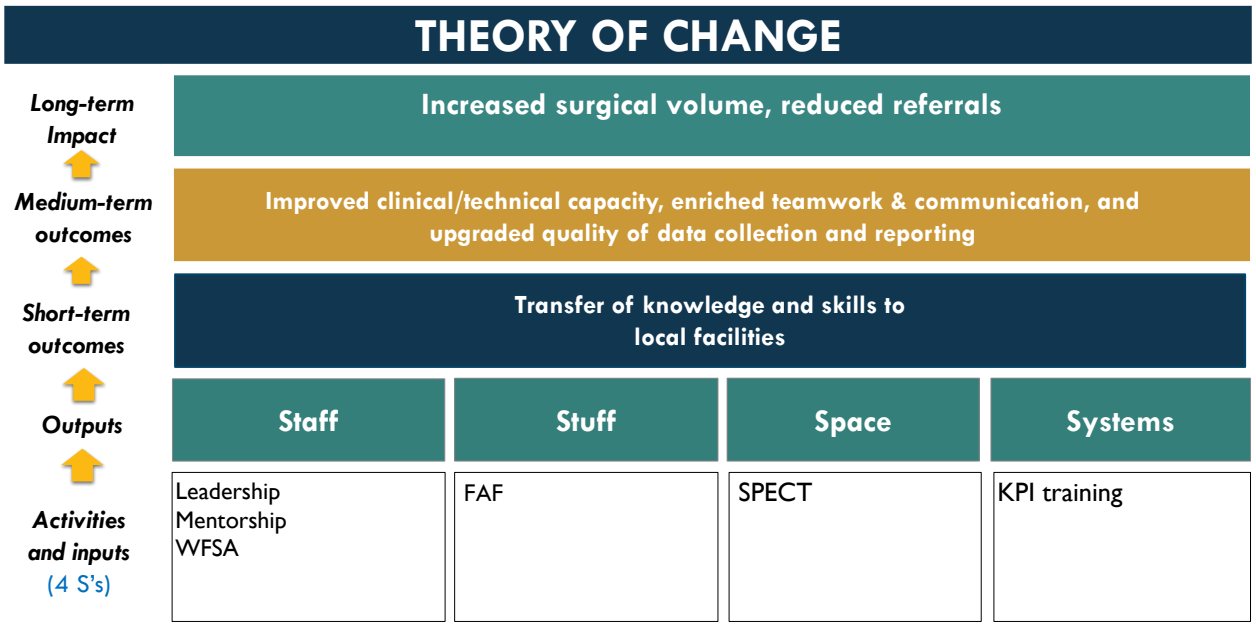

Figure 2. SS2020 Ethiopia Program Theory of Change

Most interventions were implemented in 10 facilities in the Tigray and Amhara regions of Ethiopia as a package aimed at improving access to and quality of surgical care. While some interventions have also been implemented separately in other regions, this report is limited to Amhara and Tigray and focus on 6 core interventions:

1. Leadership Training
2. Multidisciplinary Mentorship Model (MDM)
3. Sterile Processing Education (SPECT)
4. Anesthesia Training (WFSA)
5. Facility Accelerator Fund (FAF)
6. Key Performance Indicator (KPI) Data Intervention

Leadership Training & Multi-Disciplinary Mentorship Model (MDM)

Led by Jhpiego, the leadership and mentorship program focuses on equipping hospital leaders and surgical teams with the competencies and support needed to improve the performance of and the environment in which surgical care is conducted. Quality improvement projects within the hospitals were a primary focus, emphasizing improving the quality of clinical care, safety culture within the hospital, and increased agency that allows for better practice by building teamwork, communication, and leadership behaviors. The implementation of this program was twofold: (1) launching the program with a Leadership Training that brought key hospital staff, both surgical and non-surgical, together to sharpen the soft skills of communication, teamwork, and leadership, and (2) monthly on-site mentorship to continue the development of clinical and non-clinical skills.

At the national level, the mentorship model allowed for direct assistance to the FMOH and the SaLTS project team by providing opportunities to collaborate on policy formulation and the national surgical plan. SS2020 seconded a Technical Advisor to the SaLTS Team for 2 years to facilitate this collaboration. At the subnational level, multidisciplinary teams consisting of surgeons, obstetricians, anesthetists, and nurses conducted trainings and visits to hospitals to provide support for the MDM. Clinical mentorship training was provided to senior professionals who helped lead facility-based SaLTS committees to support progress towards improving surgical care. Mentorship visits were conducted by the multidisciplinary teams to provide onsite clinical skills training, consultations with patients, transferring of skills, cased-based discussions, and help mobilize resources for the hospital.

Sterile Processing Education

Sterile Processing Education Charitable Trust (SPECT) led sterile processing education, training, and mentorship in SS2020 intervention facilities in Ethiopia. The objective of this program was to reduce the risk of infection related to sterile processing techniques and teach critical knowledge and practices of sterile processing to surgical teams. Staff were educated on theoretical knowledge and trained to master tangible skills for sterile processing. Staff trainees from SS2020 intervention facilities also received mentorship from the SPECT team during follow-up, on-site visits in which they work to integrate sterile processing practices in their own facilities. Following the initial training on fundamentals, clinicians who excelled are invited to attend a training of trainers (TOT) workshop to cover sterile processing topics in more detail. This enables these clinicians to train other staff at their facilities and in their regions.

WFSA Training Program

WFSA training programs work to sustainably increase the capacity of all levels of anesthesia providers, allowing for the delivery of safe anesthesia care. The SAFE Obstetric course taught in Ethiopia has a specific focus on improving anesthesia care for patients experiencing life-threatening obstetric conditions.

This course teaches fundamentals of the role of the anesthetist in managing obstetric emergencies. An anesthesia fellow trained by the WFSA team follows up with trainees in each SS2020 intervention facility to provide additional mentorship and training, and to evaluate progress.

Facility Accelerator Fund (FAF)

FAF supports health facilities by addressing gaps in surgical capacity by providing the means for hospitals to procure equipment and improve infrastructure for surgery. Small grants are provided to allow clinical teams to address what they believe are the main barriers to providing safe surgical services to their patients. The teams are asked to identify and prioritize gaps before submitting proposals to the FAF program requesting support for interventions that aim to improve the surgical outcomes at their facilities.

KPI Data Intervention

High-quality surgical data is needed across the globe. In Ethiopia, the objective of the KPI Data Intervention is implementation of a system of surgical registries to aid in the collection of high-quality surgical data. Designed to collect surgical data at a hospital level, including national SaLTS Key Performance Indicators, this intervention yields ongoing collection and reporting from hospitals to the regional and national levels on a monthly basis.

A comprehensive registry system provides a basis for hospital-level collection of all data elements needed to calculate 11 of the 15 SaLTs KPIs, with the remainder requiring patient surveys and human resource records. The following KPIs can be collected via registers implemented in this intervention:

- Surgical Volume
- Peri-Operative Mortality Rate (POMR)
- Rate of Safe Surgery Checklist Utilization
- Surgical Site Infection (SSI) Rate
- Anesthetic Adverse Outcome Rate
- Delay for Elective Surgical Admission
- Mean Duration of In-Hospital Pre-Elective Operative Stay
- Blood Unavailability Ratio for Surgical Patients
- Surgical Bed Occupancy Rate
- Rate of First Elective Case On-Time Theater Performance
- Rate of Cancellation of Elective Surgery

Evaluation Overview

Mixed-Methods Assessment of SS2020

Over the duration of SS2020 implementation in Ethiopia, a number of key outputs and outcomes were tracked. Some of the achievements from the partnership between SS2020 and SaLTS include:

- Contributed to the development and implementation of SaLTS strategic plan;
- Built the capacity of 150 surgical leaders and 24 clinical mentors;
- Enhanced leadership capacity of FMOH, RHBs and Hospitals and catalysed national scale-up of a Jhpiego-led leadership program to impact on at least 1,000 more leaders;
- Developed a public-private partnership for two medical oxygen plants that will serve the Amhara region, coordinated by Assist International;
- Conducted rigorous assessment of our programs to understand what works – and what doesn't;
- Trained 377 hospital staff on sterilization and surgical infection prevention;
- Trained approximately 200 hospital staff on anesthesia best practices;
- Supported SaLTS team to develop a monitoring and evaluation plan for the SaLTS strategic plan, including 15 Key Performance Indicators (KPIs) to measure the capacity and quality of surgical care in hospitals in Ethiopia;
- Implemented a surgical data quality improvement intervention in all intervention hospitals; and
- Donated supplies to several hospitals to improve hospital infrastructure

To further explore the achievements of SS2020 Ethiopia, a mixed-methods evaluation of the program was conducted in late 2018. This report summarizes the results of three key components of this evaluation framework:

1) Situational Analysis Tool (SAT)

Background

The World Health Organization Tool for Situational Analysis (WHO SAT) is a surgical assessment tool designed by the WHO Global Initiative for Emergency and Essential Surgical Care (EESC) research group in 2007. The WHO SAT is a facility-based assessment with 108 quantitative questions across four domains: (1) Infrastructure, (2) Human Resources, (3) Interventions, and (4) Emergency & Essential Surgical Care Equipment and Supplies.[1]

During 2016-2017, the WHO SAT was updated through a collaborative effort with PGSSC. The new WHO-PGSSC Tool was derived from a systematic review of surgical assessment tools and received two

[1] World Health Organization Integrated Management for Emergency & Essential Surgical Care (IMEESC) toolkit. Tool for Situational Analysis to Assess Emergency and Essential Surgical Care. [Internet]. Geneva: World Health Organization; 2018 [cited 2018 February 25]. Available from: www.who.int/surgery/publications/s15986e.pdf.

rounds of Delphi validation.[2,3] The 169-item instrument aligns with the Lancet Commission on Global Surgery's national surgical planning framework and intended to be adapted to individual country needs as part of the NSOAP process.[4,5]

The updated WHO-PGSSC Tool was administered at baseline and endline to evaluate the long-term quantitative impact of Safe Surgery 2020 activities in Tigray and Amhara. Data collected with this tool is presented in the analysis section of this report within the following domains: 1) Basic infrastructure, 2) Laboratory and imaging diagnostic services, 3) Surgical procedures, and 4) Surgical equipment and supplies.

WHO-PGSSC Tool adaptation

During the baseline data collection process, the SaLTS team noted that the WHO-PGSSC Tool could be better aligned to the Ethiopian health system and national surgical policy. In November 2016, the Ethiopian FMOH began to work with the PGSSC to adapt the Tool to the local context. Completed in spring 2017, the adapted Ethiopia SaLTS tool aims to evaluate the impact of SaLTS implementation and reflect FMOH needs. Extensive input was provided by key stakeholders including the Surgical Society of Ethiopia and the Ethiopian Society of Anesthesiologists.

The modified Ethiopian SaLTS Tool was administered at midline and endline to support SaLTS M&E activities and evaluate the long-term quantitative impact of SS2020 programs [5]. While the majority of data in this report considers change between baseline and endline evaluation using the WHO-PGSSC Tool, data quality was higher in the Ethiopian SaLTS Tool for the reported availability of surgical, obstetric, and anesthesia providers. Therefore, the human resources domain includes midline and endline data collected with the Ethiopian SaLTS Tool.

Subjects and data collection

Quantitative data was collected at baseline, midline, and endline in ten SS2020 intervention hospitals in Tigray and Amhara (8 primary, 2 general). Assessment consisted of semi-structured interviews using the WHO-PGSSC Tool and the Ethiopian SaLTS Tool. Four providers were typically interviewed per facility. Participants included hospital leadership (CEOs, medical directors, and matrons), surgeons, IESOs, OB/GYNs, mid-level anesthesia providers, and OR nurses. Interviews were conducted in Amharic or English depending on interviewee preference and lasted between 30 minutes and one hour. If a provider was unavailable or clarification was needed, data collectors followed-up via e-mail and/or telephone. Responses were recorded on paper in English and transferred to Excel.

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[2] Program in Global Surgery and Social Change [Internet]. Boston: Harvard Program in Global Surgery and Social Change; c2017 [cited 2018 January 7]. WHO-PGSSC Surgical Assessment Tool. Available from: http://media.wix.com/ugd/346076_b9d8e8796eb945fe9bac7e7e35c512b1.pdf.

[3] Lin Y, Raykar NP, Saluja S, Mukhopadhyay S, Sharma S, Frett B, Enumah S, Iverson KR, Johnson W, Meara JG, Shrime MG. Identifying essential components of surgical care delivery: an updated Surgical Assessment Tool. Under review at World Journal of Surgery.

[4] Meara JG, Greenberg SL. The Lancet Commission on Global Surgery Global surgery 2030: evidence and solutions for achieving health, welfare and economic development. Surgery. 2015 May 1;157(5):834-5.

[5] Program in Global Surgery and Social Change [Internet]. Boston: Harvard Program in Global Surgery and Social Change; c2017 [cited 2018 7 January]. Tool for Situational Analysis to Assess Emergency and Essential Surgical Care in Ethiopia. Available from: https://docs.wixstatic.com/ugd/d9a674_e9481999bec443b5a291199ff33890a4.pdf.

Data analysis

Data collected at baseline, midline, and endline are analyzed and presented in *Section D* of this report and span the following domains:

1) *Basic infrastructure*
2) *Laboratory and imaging diagnostic services*
3) *Surgical procedures*
4) *Surgical equipment and supplies*
5) *Human resources*

2) Key Performance Indicators: Surgical Volume & Referrals Out

Background

The collection of surgical data in SS2020 intervention facilities in Ethiopia has been largely inconsistent. In data quality assessments conducted in late 2017 in all 10 facilities in Amhara and Ethiopia, it was discovered that data recorded in clinical registration books were of poor quality and did not always accurately capture surgical data. These registries were used as the primary data source for hospitals to aggregate and report newly established surgical Key Performance Indicators (KPIs) to Regional Health Bureaus and the Federal Ministry of Health. Recognizing the need for data quality improvement, PGSSC implemented a robust months-long *KPI Data Intervention* in both Amhara and Tigray. During this intervention, which trained surgical teams on accurate data capture of 15 different KPIs, emphasis was placed on 2 indicators: *Surgical Volum*e and *Surgical Referrals Out*.

Subjects and data collection

During the data intervention, key hospital staff were trained on how to correctly collect, aggregate, and report several KPIs. After the intervention, surgical team members were responsible for prospectively collecting KPI data elements every month and reporting them to SS2020 and the Regional Health Bureau. After the intervention, PGSSC collaborated with newly trained hospital staff to retrospectively collect data for all 10 facilities for *Surgical Volum*e and *Surgical Referrals Out.*

Surgical Volume is a Lancet Commission on Global Surgery (LCoGS) indicator that captures met need for surgical and anesthesia care. The LCoGS established a target surgical volume of 5,000 procedures per 100,000 population in every country by 2030. The number of surgical procedures done per year is an indicator of met need for surgical and anesthesia care. With the high surgical need of the population, this indicator shows progress toward meeting this need across time. For SS2020 Ethiopia purposes, volume is defined as: Total number of major surgical procedures performed in the operating theater per month. A major surgical procedure is any procedure conducted in an Operating Room under general, spinal or major regional anesthesia. This data was derived from the Operating Room Registry.

Surgical Referrals Out at a facility level are indicative of the capability to provide surgical services. The data collected regarding referrals allows hospitals to track number of referrals out and better recognize areas for improvement that may be contributing to these referrals. For SS2020 Ethiopia purposes, referrals out is defined as: Total number of patients referred out of the hospital for surgical services after an on-site assessment by a medical professional per month. This data was derived from the Referral Registry.

Data Analysis

This report summarizes the surgical volume and referrals out data collected retrospectively and prospectively since 2016 in Amhara and 2017 in Tigray. A scatterplot with trendlines over time were created for each indicator to highlight existing patterns in the longitudinal data. The graphs are found in *Section E*.

3) Surgical Team Focus Groups: A Qualitative Assessment

Background

The quantitative monitoring and evaluation data included in this report, while valuable, do not comprehensively capture the primary outputs and outcomes of SS2020 in Ethiopia. Because of these limitations, a qualitative assessment, in the form of several targeted focus groups, was conducted in late 2018 to provide a more substantive evaluation of the success of SS2020 activities in intervention hospitals.

Subjects and data collection

Focus group participants were members of the intervention hospitals' surgical teams that were directly involved in the implementation of the suite of SS2020 interventions. The inclusion criteria for subjects was (1) participation in at least one SS2020 program and (2) employment in current position for at least 1 year. The goal of these discussions was to gauge the surgical teams' understanding of SS2020 and its perceived impact on their hospital.

Conducted between 1 to 2 hours, the focus groups asked specific questions about each of the SS2020 interventions, probing participants to share their opinions on the program and provide feedback. The surgical teams were encouraged to share as much or as little as they liked and were guided through the discussion by an Amharic-speaking moderator well versed in the suite of interventions.

Data analysis

Focus group discussions were recorded, transcribed, and translated into English for qualitative thematic analysis by the PGSSC, the results of which are summarized in this report in *Section F*. The focus group participants discussed SS2020 as a whole while also addressing 6 specific programs: i. *Leadership Training, ii. Mentorship Program, iii. Sterile Processing Education (SPECT), iv. Anesthesia Training (WFSA), v. Facility Accelerator Fund (FAF), and vi. Key Performance Indicator (KPI) Intervention*. Analysis of the focus groups consisted of multiple steps that follow standard qualitative analysis methodologies.[6,7] First, five of the authors coded each transcript independently to generate preliminary thematic codes and identify representative quotes. After a series of discussions, the team consolidated and summarized emerging themes when consensus and saturation was reached. Themes for each program are primarily grouped into the following categories: *Perceived Impact, Barriers to Implementation,* and *Areas of Improvement*.

[6] Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research.*
[7] Miles M, Huberman A. Qualitative data analysis: an expanded sourcebook. 2. Thousand Oaks, CA: Sage Publications; 1994.

Situational Analysis Tool (SAT) Results

Quantitative Assessment of SS2020

The Situation Analysis Tool (SAT) was administered in Amhara and Tigray intervention hospitals collected at baseline (January 2016), midline (May-June 2017), and endline (November 2018). These data were analyzed and summarized into 5 core sub-categories. The methodology and results are as follows:

1) ***Basic infrastructure:*** Change in the reported availability of water, electricity, a generator, and internet was estimated between baseline and endline. Change was categorized into three levels across each infrastructure item: 1) improved availability or maintenance of 100% availability, 2) no change, or 3) reduced change.

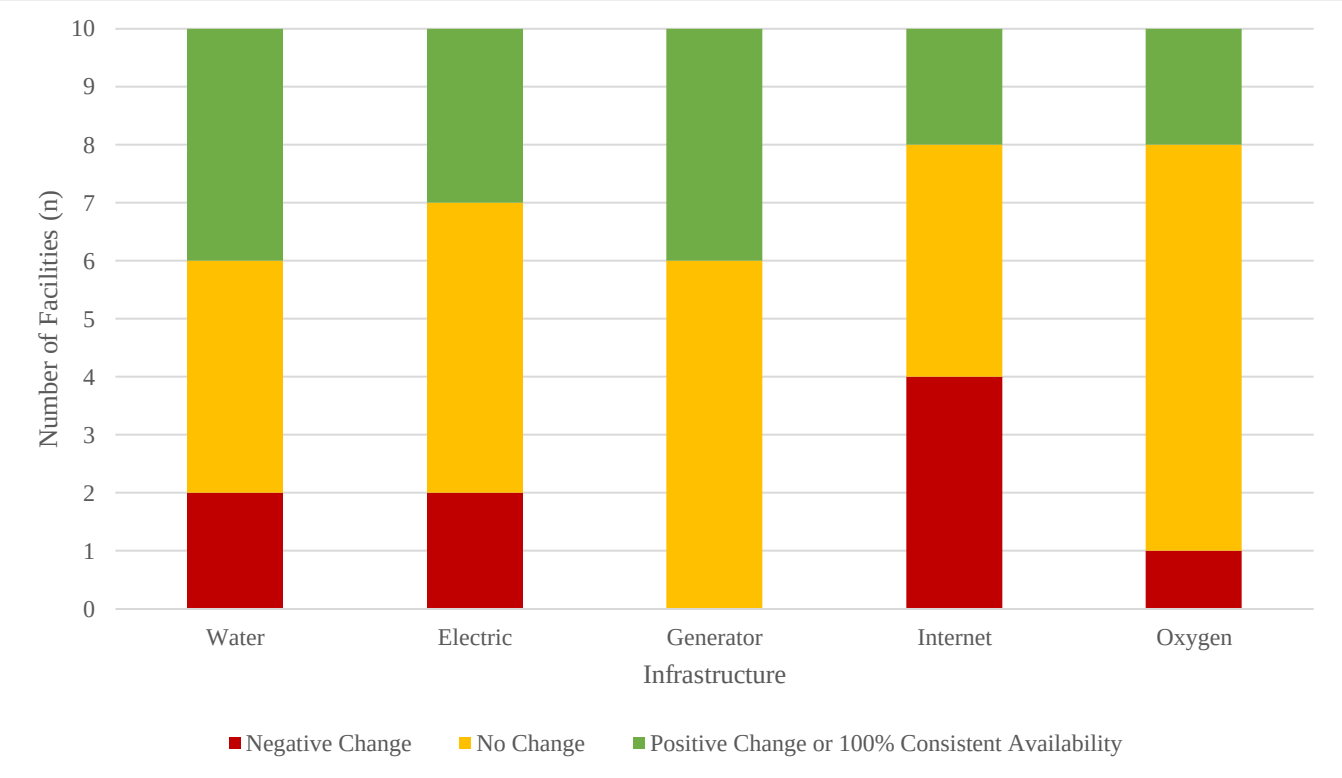

Figure 3. Change in Reported Infrastructure Availability

As seen in Figure 3, the change in the availability of infrastructure was estimated among all facilities surveyed including 2 general hospitals and 8 primary hospitals. Change was categorized as 1) improved change or maintenance of 100% availability, 2) no change, or 3) reduced availability.

2) ***Laboratory and imaging diagnostic services:*** Change in the reported availability of laboratory (blood bank, CBC, chemistry panel, coagulation studies, and infectious panel) and imaging (24-hour radiology, x-ray, ultrasound) diagnostic services was estimated between baseline and endline. Change was categorized into the same levels reported for basic infrastructure.

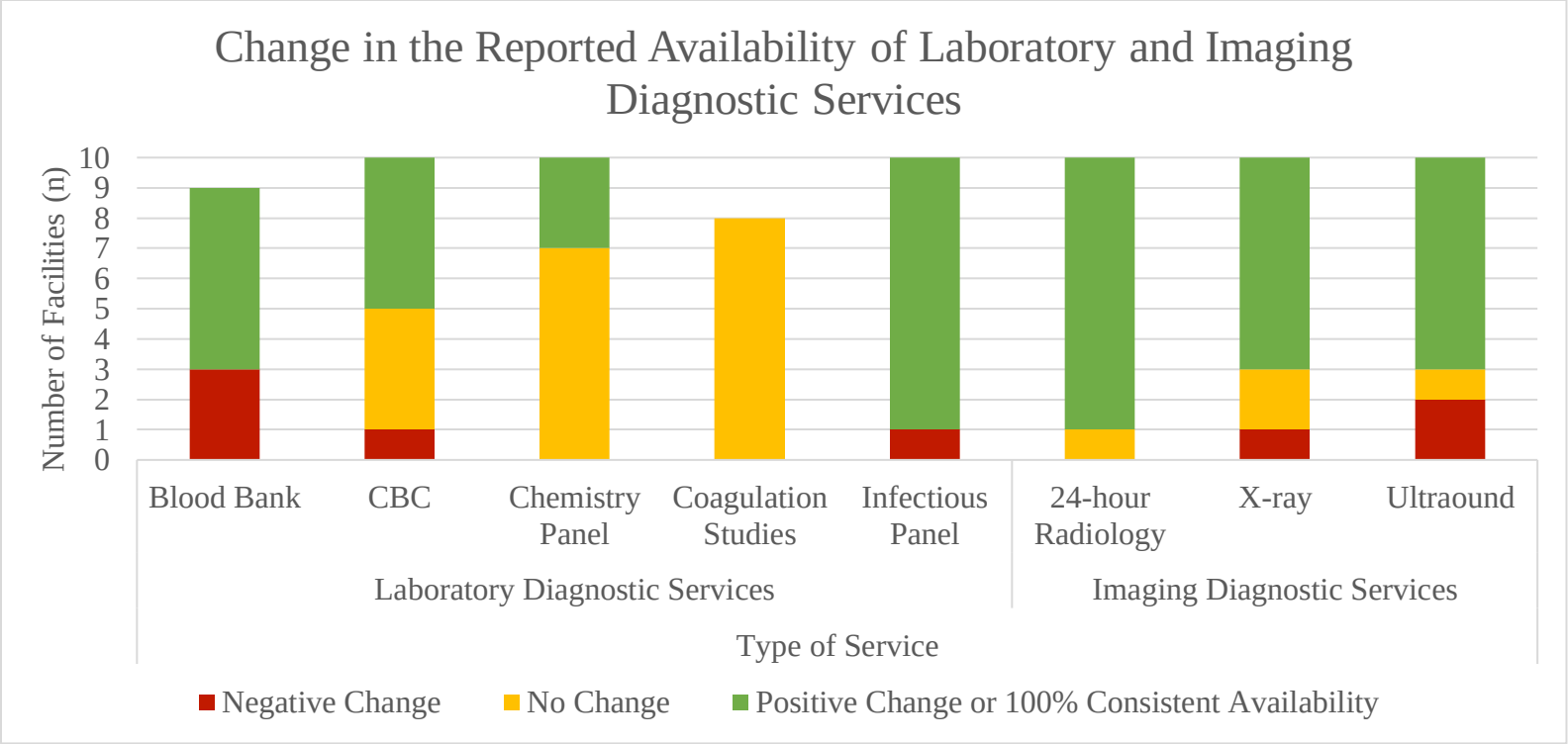

Figure 4. Change in the reported availability of laboratory and imaging diagnostic services.

The change in the availability of laboratory and imaging diagnostic services was estimated among all facilities surveyed (2 general, 8 primary). Change was also categorized as described for Figure 3 (above). In laboratory services, 6 facilities reported improved change in the availability of a blood bank, 5 in CBC services, 3 in the availability of a chemistry panel, and 9 in the availability of an infectious panel. In imaging services, 9 facilities reported improved change in the availability of 24-hour radiology, and 7 facilities in the availability of an x-ray machine and ultrasound. Blood bank data was unavailable from one facility and coagulation studies data was unavailable from two facilities.

3) ***Surgical procedures:*** Change in the percentage of facilities that reported offering primary surgical services as defined in the SaLTS plan is presented for each surgical service.[8] A mean availability of primary surgical procedures was calculated for each facility at baseline and endline and subsequently averaged across the ten facilities. The SaLTS Primary Surgery scores reflects change in the mean availability of the primary surgical services between baseline and endline. To determine statistical significance of the change in *n* of each procedure, *McNemar's Test* was conducted. To assess change in SaLTS Primary Surgery Scores, a *Paired Samples T-te*st was conducted. Differences with a p-value < .05 are noted below as statistically significant.

Table 1. Change in the percentage of facilities that reported offering primary surgical services.

	Baseline (%) (N = 10)	Endline (%) (N = 10)	**Change (%) (N = 10)**
SaLTS Primary Surgical Services (calculated among all facilities)			
Obstetrics, gynecology, family planning			
Cesarean birth	78	100	22
Vacuum extraction/forceps delivery	100	100	0
Ectopic pregnancy	70	90	20
Manual vacuum aspiration and dilation and curettage	70	100	30
Tubal ligation	90	90	0
Vasectomy	33	60	27
Inspection with acetic acid, cryotherapy for cervical lesions	75	30	-45
General surgery			
Repair of perforations	22	90	68*
Appendectomy	78	90	12
Bowel obstruction	89	90	1
Hernia, including incarceration	67	60	-7
Hydrocelectomy	89	90	1
Relief of urinary obstruction	67	100	33
Injury			
Resuscitation with advanced life support measures	78	80	2
Tube thoracostomy	33	80	47
Trauma laparotomy	67	70	3
Fracture reduction	70	60	-10
Irrigation and debridement of open fractures	67	80	13
Placement of external fixator; use of traction	22	0	-22
Escharotomy/fasciotomy	44	50	6
Trauma-related amputations	67	50	-17
Skin grafting	33	10	-23
Non-trauma orthopedic			
Drainage of septic arthritis	44	60	16
SaLTS Primary Surgery	**66**	**71**	**5**

**p < .05, McNemar's Test*

The change in the availability of SaLTS primary surgical services was estimated among all facilities and defined as the mean change in the percentage of primary surgical services being offered. Facilities reported offering an average of 66% of inquired SaLTS primary surgical services at baseline and 71%

[8] Federal Ministry of Health of Ethiopia. National Five Years Safe Surgery Strategic Plan 2016-2020. 2016 [cited 2018 January 7]. Available from: https://docs.wixstatic.com/ugd/d9a674_229834ef81bd47ee9cd72f94be1739fe.pdf.

at endline, estimating a 5% increase in the average availability of SaLTS primary surgical services. Non-responses were analyzed as missing data. Analysis of general services were excluded from this report as data for <5 procedures was collected at only one hospital. An increase in total availability across all hospitals was reported for 15 out of 23 procedures. Availability of only one procedure – *Repair of Perforations* – had a statistically significant increase (*p = .034*) between baseline and endline. The change in SaLTS Primary Surgery score was not statistically significant.

4) ***Surgical equipment and supplies:*** Change in the percentage of facilities that reported consistent availability of surgical equipment and supplies is presented. A mean availability of equipment and supplies was calculated for each facility at baseline and endline and averaged across all the ten facilities. This value is represented by the Readiness score. To determine statistical significance of the change in *n* of each procedure, *McNemar's Test* was conducted. To assess change in Readiness Scores, a *Paired Samples T-tes*t was conducted. Differences with a p-value < .05 are noted below as statistically significant.

Table 2. Change in the percentage of facilities with Operating Theater/Room equipment and supplies and the readiness score (mean % of items).

	Baseline (%) (N = 10)	Endline (%) (N = 10)	**Change (%) (N = 10)**
Operating Theater/Room Equipment			
Anesthesia machine	90	100	10
Ventilator	60	50	-10
Oxygen concentrator	60	100	40*
Blood pressure equipment	90	100	10
Adult oropharyngeal airway	90	100	10
Pediatric oropharyngeal airway	90	60	-30
Tracheal tube	60	90	20
Laryngoscope	90	100	10
Facemask bag valve	89	100	11
Bougies	20	30	10
Pulse oximeter	90	100	10
Stethoscope	90	100	10
Suction apparatus	90	100	10
Thermometer	70	80	10
Light source	40	90	50*
Nasogastric tubes	80	100	20
Chest tube	30	40	10
Electrocautery	30	50	20
Sterilizer	70	90	20
Forceps	60	100	40*
IV pressure bag	20	70	50*
Operating Theater/Room Supplies			
Syringes	89	100	11
Scalpel	100	100	0
Sterile gloves	100	100	0
Urinary catheters	78	100	22

Drapes	89	100	11
Tourniquet	44	50	6
Face masks	88	100	13
Gowns	90	90	0
Disinfectant hand wash	100	90	-10
Sterilizing skin prep	90	100	10
Eye protection	100	80	-20
Sharps disposal	100	100	0
Apron	90	100	10
Readiness score	**76**	**87**	**11**

**p < .05, McNemar's Test*

Change in readiness for surgical services was assessed based on the presence of Operating Theater/Room equipment and supplies inquired about in the SAT. The readiness score is defined as the mean availability ('always available') of OR equipment and supplies. Items were analyzed as 'always' available if providers reported them being 'always' available on the 3-part scale or '76-100%' available on 4-part percentage scale. Change in the readiness score was estimated among all hospitals. Hospitals reported an average availability of 76% of inquired equipment and supplies at baseline and 87% at endline, estimating an 11% increase in the average availability of OR items. Non-responses were analyzed as missing data. An increase in total availability across all hospitals was reported for 26 out of 34 supply categories. Availability of four supplies – *Oxygen Concentrator* (*p=.046), Light Source (p=.025), Forceps* (*p=.046),* and *IV Bag* (*p=.025)* – had statistically significant increases between baseline and endline. The change in readiness score was not statistically significant.

5) ***Human resources:*** Change in the number of surgical, obstetric, and anesthesia providers between midline and endline is presented. The change in the number of ancillary staff for surgery between midline and endline is also presented. To determine statistical significance of the change in *n* of each provider category, *Wilcoxon Signed Rank Test* was conducted. Differences with a p-value < .05 are noted below as statistically significant.

Table 3. Change in the reported availability of surgical and obstetric providers.

	Provider (n)				
	General Surgeons	IESOs	Other Surgeons	OBGYNs	Midwives
Midline	4	23	4	1	97
Endline	3	26	0	3	138
Change (n)	-1	3	-4	2	41*

**p < .05, Wilcoxon Signed Rank Test*

Change in the availability of surgical and obstetric providers was aggregated from all 10 facilities surveyed (2 general, 8 primary). Change is defined as the difference in the number of reported providers between midline and endline assessments. Facilities reported an addition of 3 IESOs, 2 OBGYNs, and 41 midwives, and a loss of 1 general surgeon and 4 surgeon subspecialists. A total increase of 40 surgical and obstetric providers across all hospitals was reported. Only one provider category – *Midwives* – had a statistically significant increase (*p = .031*).

Table 4. Change in the reported availability of anesthesia providers.

	Provider (n)				
	Anesthesiologists	Full-time BSc. Anesthetists	Part-time BSc. Anesthetists	MS Anesthetists	Level 5 Nurse Anesthetists
Midline	0	10	0	0	7
Endline	0	13	1	0	0
Change (n)	0	3	1	0	-7*

**p < .05, Wilcoxon Signed Rank Test*

Change in the availability of anesthesia providers was also aggregated from all 10 facilities. Change was defined as the difference in the number of reported anesthesia providers between midline and endline assessments. The facilities reported a total addition of 3 full-time BSc. anesthetists and 1 part-time BSc. anesthetists. No anesthesiologists (physician anesthesia providers) were reported. A total decrease of 3 anesthesia providers across all hospitals was reported. One provider category – *Level 5 Nurse Anesthetists* – had a statistically significant decrease ($p = .008$).

Table 5. *Change in the reported availability of ancillary staff.*

	Staff (n)					
	Radiologists	Pathologists	Biomedical Technicians	X-ray Technicians	OR Nurses	Pharmacists
Midline	0	0	5	22	23	81
Endline	1	0	14	22	45	103
Change (n)	1	0	9*	0	22*	22

**p < .05, Wilcoxon Signed Rank Test*

Change in the availability of ancillary staff was aggregated from all 10 facilities. Change was defined as the difference in the number of reported staff members between midline and endline assessments. The facilities reported a total addition of 1 radiologist, 9 BMETs, 22 OR nurses, and 22 pharmacists. A total increase of 54 ancillary staff across all hospitals was reported. Particularly, the number of *Biomedical Technicians* and *OR nurses* had a statistically significant increase ($p = .027$ and $p = .026$, respectively).

Additional data from the Situational Analysis Tool can be found in the Appendix Tables A1 – A7.

Key Performance Indicators:
Surgical Volume & Referrals Analysis

Quantitative Assessment of SS2020

During the Key Performance Indicator (KPI) intervention in early 2018, hospital staff were trained on the use of new clinical registries that adequately captured data on newly established surgical indicators. Subsequent to the intervention, hospitals prospectively collected, aggregated, and reported monthly data to PGSSC and SS2020. Surgical Volume and Referrals Out were reported prospectively every month from March 2018 to December 2018 in Amhara, and May 2018 to December 2018 in Tigray. Using data from older clinical registries, the PGSSC team also collected data retrospectively for all 10 hospitals. In Amhara, monthly data for these 2 KPIs were collected retrospectively for January 2017 to February 2018. In Tigray, the KPIs were collected retrospectively for January 2016 to April 2018. The data for both regions and both KPIs are shown below.

1) Surgical Volume

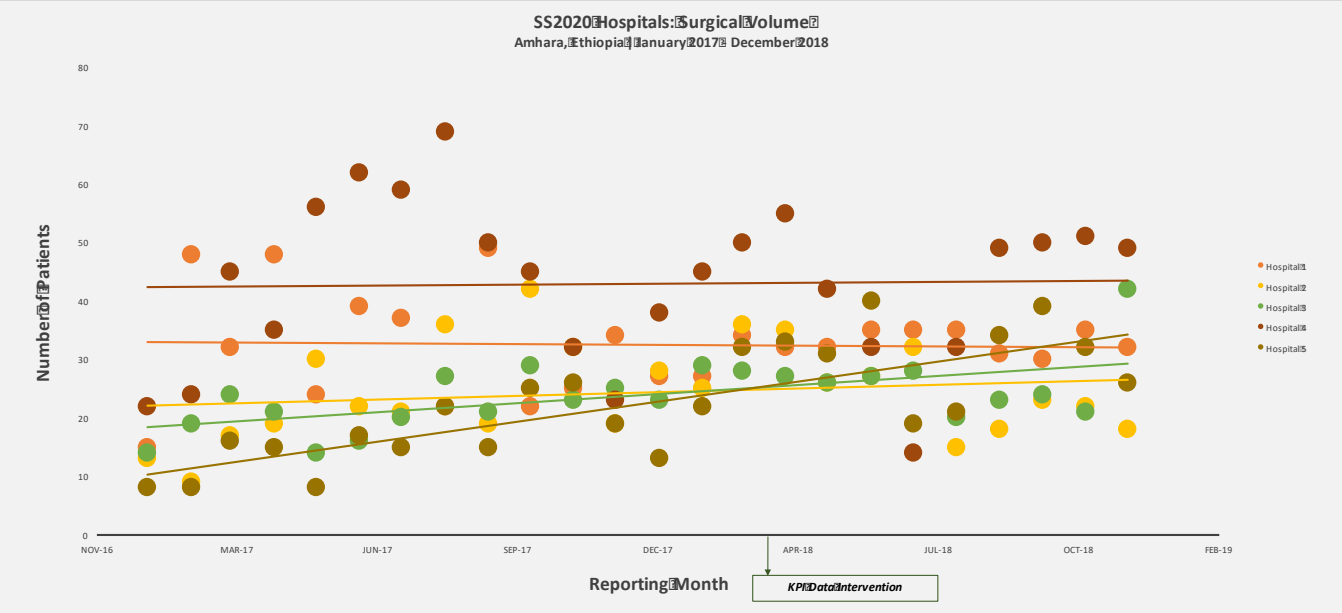

Figure 5. Surgical Volume in Amhara, Jan 2017 – Feb 2018, collected retrospectively; March 2018 – Dec 2018, collected prospectively.

Figure 5 above provides a scatter plot of the monthly data for surgical volume in the 5 SS2020 interventions hospitals in Amhara. Trendlines are also incorporated to show patterns over time. Three of five hospitals show a noticeable positive trend, where surgical volume has increased. The average monthly surgical volume in 2017 was 27.4 surgeries; in 2018, it was 31.[9]

[9] Average surgical volume calculated using monthly surgical volume for available cases only.

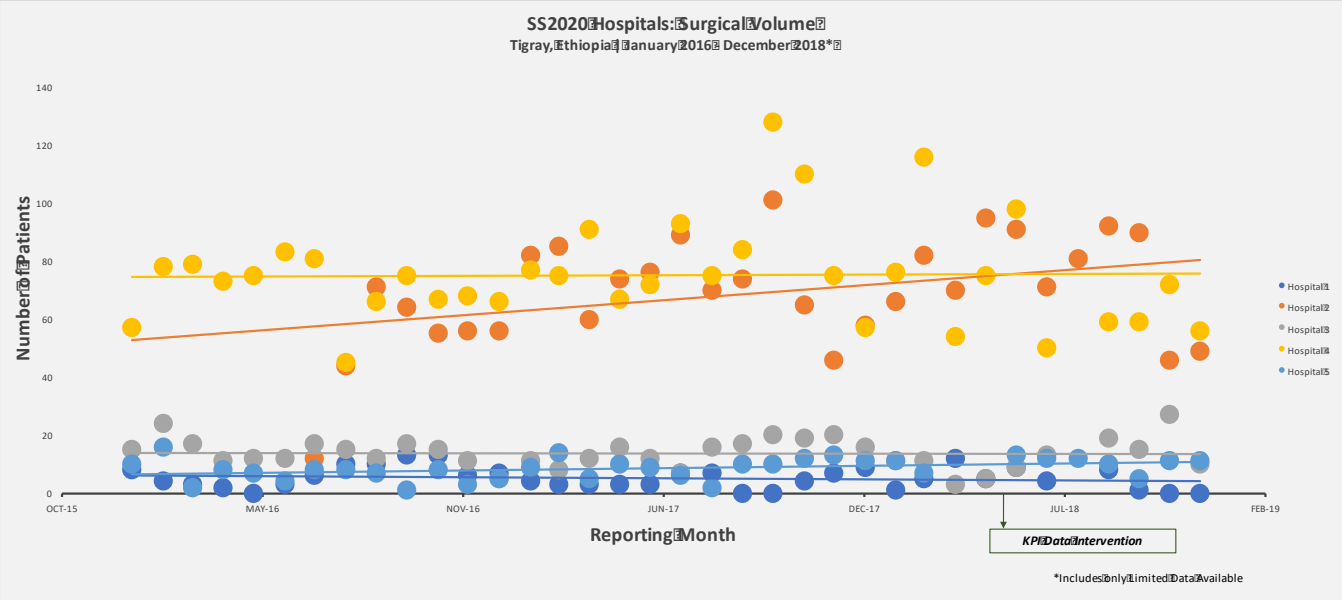

Figure 6. Surgical Volume in Tigray, Jan 2016 – Apr 2018, collected retrospectively; May 2018 – Dec 2018, collected prospectively.

Figure 6 above provides a scatter plot of the monthly data for surgical volume in the 5 SS2020 interventions hospitals in Tigray. Trendlines are also incorporated to show patterns over time. Only one of five hospitals show a noticeable positive trend, where surgical volume has increased. The average monthly surgical volume in 2016 was 29.8 surgeries; in 2017, it was 36.8 and in 2018, it was 34.5.[10]

2) Surgical Referrals Out

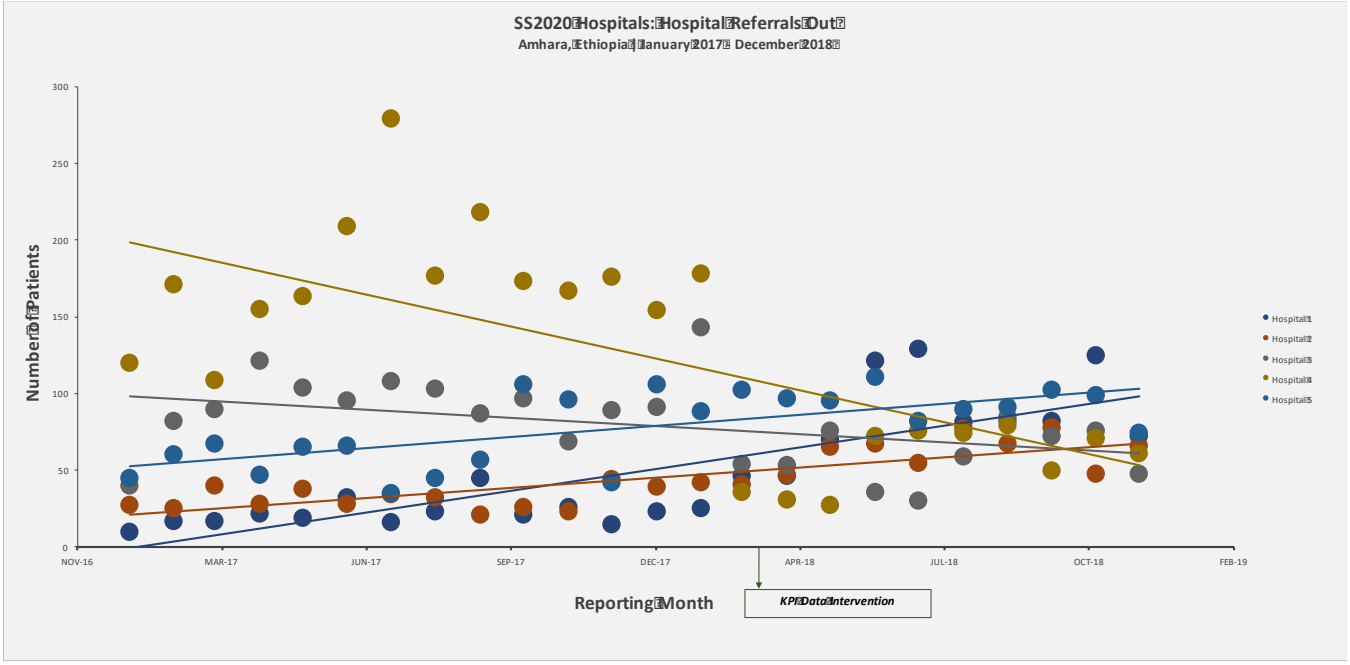

Figure 7. Surgical Referrals Out in Amhara, Jan 2017 – Feb 2018, collected retrospectively; March 2018 – Dec 2018, collected prospectively

[10] Average surgical volume calculated using monthly surgical volume for available cases only.

Figure 7 above provides a scatter plot of the monthly data for surgical referrals out in the 5 SS2020 interventions hospitals in Amhara. Trendlines are also incorporated to show patterns over time. Three of five hospitals show a noticeable positive trend, where referrals have increased, while the other 2 hospitals show a negative trend where referrals have decreased. The average monthly surgical referrals out in 2017 was 76 patients; in 2018, it was 74.4.[11] Only 1 hospital in Amhara (Hospital 3) reported both a decrease in the number of surgical referrals out and an increase in surgical volume.

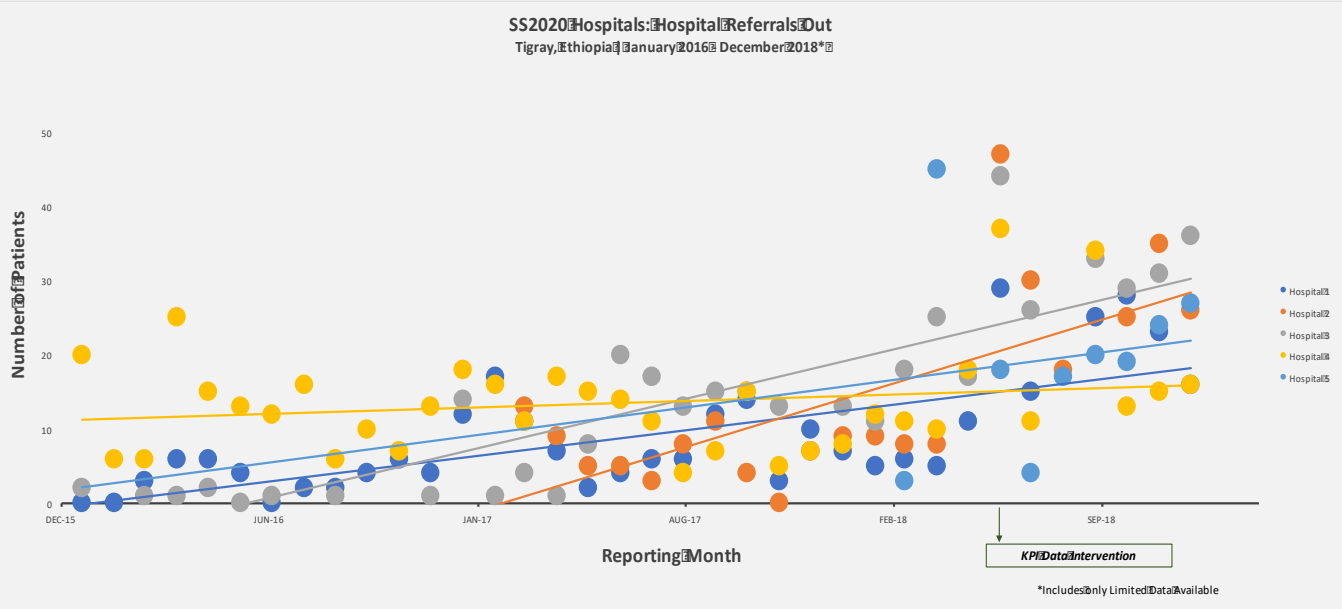

Figure 8. Surgical Referrals Out in Tigray, Jan 2016 – Apr 2018, collected retrospectively; May 2018 – Dec 2018, collected prospectively

Figure 8 above provides a scatter plot of the monthly data for surgical referrals out in the 5 SS2020 interventions hospitals in Tigray. Trendlines are also incorporated to show patterns over time. All five hospitals show a noticeable positive trend, where referrals have increased. The average monthly surgical referrals out in in 2016 was 5.5 patients, in 2017 it was 9.4, and in 2018, it was 19.8.[12] No hospitals in Tigray reported both a decrease in the number of surgical referrals out and an increase in surgical volume.

The overwhelming positive trend in the number of surgical referrals out made was likely due to the improved data capture post-KPI data intervention in 2018. Data collected retrospectively for referrals out were often incomplete in older registries and were thus not adequately captured in real-time. Corresponding tables for figures 5 – 8 capture monthly data points and are found in the Appendix Tables A8 – A12.

[11] Average surgical referrals out calculated using monthly referral counts for available cases only.
[12] Average surgical referrals out calculated using monthly referral counts for available cases only.

Surgical Team Focus Group Analysis

Qualitative Assessment of SS2020

This section details the key themes that emerged from the qualitative focus groups conducted in Amhara and Tigray. A total of 75 participants were included across all 10 SS2020 intervention hospitals. The results are summarized as follows: (a) General Understanding of SS2020; (b) Program-Specific Themes; and (c) Overall Perception of SS2020 Impact. The 6 specific programs discussed are: i. *Leadership Training, ii. Mentorship Program, iii. Sterile Processing Education (SPECT), iv. Anesthesia Training (WFSA), v. Facility Accelerator Fund (FAF), and vi. Key Performance Indicator (KPI) Intervention*. Themes for each program are primarily grouped into the following categories: *Perceived Impact, Barriers to Implementation,* and *Areas of Improvement*.

1) General understanding of SS2020

Understanding of the SS2020 program was fairly uniform across all participants. Each hospital provided testimonials to support that they understood the focus of SS2020 to build the capacity for safe surgery in their respective hospital. This sentiment is exhibited well by a hospital administrator from one hospital, who stated "Safe Surgery 2020 is an international project that targets in accessing basic surgical care until 2020. It gives high value for surgery especially at lower level. It is one of the effective initiatives aimed at increasing and the quantity and improving the quality of surgery". Overall, understanding was focused on the aims of SS2020, the implementation of a suite of interventions to improve surgical care, and the empowerment of surgical teams to be the best they could be.

Core components of the SS2020 suite of interventions are to increase the surgical capacity of a hospital by enhancing communication and teamwork within the surgical team, provide support through infrastructure and process improvements for the surgical department and team, and increase access to surgery and surgical outcomes within the hospital. These themes were also echoed by individuals during the qualitative analysis of their understanding of SS2020. The outcomes in the hospital were evident to the surgical teams and administrators. The following exemplifies the perceived impact of SS2020 as a whole as it pertains to their understanding of what the program aimed to accomplish:

"Since [SS2020's] commencement in our hospital, many successes have been achieved; increasing surgical volume, decreasing surgical site infection rate, and minimizing complications related to anesthesia are among others." – CEO, Amhara, Hospital 1

2) Program-Specific Themes

a) Leadership Program

Perceived Impact

1. SaLTS committee establishment

> *"The leadership program helped us in establishing a multidisciplinary SaLTs committee. We learned to look at our working procedures through the eyes of SaLTs committee. This committee schedules for meetings in every month; together they discuss on strengths and problems encountered and try to find strategies in taking interventions for the identified problems."*—CEO, Amhara, Hospital 1

> *"Bringing attitude change of the administrative staffs is one of the strengths of this program. Surgery, which was left for few technical staffs of the operation room, gets the attention of all the staff members including the administrative staffs. Currently, administrative staffs (example, finance, CEO) are part of the safe surgery committee, which is the strongest and most exemplary type of committee in the hospital."*—CEO, Tigray, Hospital 3

One of the primary outcomes of the leadership training was the establishment of a multidisciplinary SaLTS Committee within each SS2020 facility. The committee typically included surgical, obstetric, and anesthesia providers, OR nurses, data quality and liaison officers, laboratory personnel, and maintenance staff. The SaLTS Committee organized all members involved in safe surgical practices into a unified team to address facility-specific issues.

2. Improved team spirit and collaboration

> *"The program helps each team member not only in increasing attentiveness and in awareness of one's practices but also others' practices. Therefore, it helps the team members and other staffs to think and work collectively as an organization."*—Vice CEO, Tigray, Hospital 4

The leadership training reportedly enhanced communication and relationships among surgical team members. Providers believed that the leadership training increased the surgical team's adherence to the WHO Surgical Safety Checklist, which may have evolved in part from improved teamwork and collaboration.

3. Empowerment of surgical team members

"Before the training, many people including me were thinking that leadership was necessary only for management bodies of the hospital, particularly for CEO and medical director. After the training, however, our attitude is changed and we realized that everybody is a leader for his/her unit."—IESO, Amhara, Hospital 3

Despite limited resources, providers reported that the leadership training empowered them to address problems specific to their facility. Behaviors changes were not only observed in the organizational culture, but also in clinical decision-making and the provision of surgical care.

4. **Increased accountability and commitment among leadership and surgical team members**

"The project brings sense of ownership and communal responsibility within the organization. Before training, any problem or shortage of OR supplies were pushed to the higher administrative staff of the hospital, mainly to the CEO and medical director. Following the training, however all surgical team members become part of solution. Conversely, I also become sensitive in responding to questions coming from the team, which I was reluctant before."—CEO, Tigray, Hospital 5

The leadership training instilled accountability among hospital leadership and surgical team members. Not only was higher management more involved in improving surgical practices, but each surgical team member assumed a greater responsibility in the OR and a renewed motivation to practicing safe surgical care.

5. **Mobilization of resources**

"Following the training, the surgical committee was established. Re-arranging the A1:AS129 of the operation theatre the most interesting outcome due to this committee. The operation theatre was substandard having only three classes. The surgical committee along with the management committee of the hospital critically evaluated the theatre and upgraded the number of classes from three to ten, by restructuring the existing room. Accordingly, rest room, dressing room, nurses' office, minor operation room, recovery room that were missed in the original plan were added. For example, minor operation before re-structuring was done in the corridor."—IESO, Tigray, Hospital 3

Identification of surgical system issues and creative solutions with existing resources frequently evolved from SaLTS Committee meeting discussions within each facility.

Barriers to Implementation

1. **Staff turnover**

"Considering the positive outcomes in the operation theatre, the program becomes institutionalized to other departments of the hospital except the inpatient and emergency units. In the latter two units, turnover of the staff is a barrier."—CEO, Tigray, Hospital 5

Providers identified the frequent replacement of surgical team members as an implementation barrier as it prevented sufficient transfer of knowledge.

2. **Insufficient resources**

> *"Absence of important laboratory services (hemoglobin test, blood grouping, blood chemistry analysis) lack of blood availability due to the central bank system. Still we are referring patients due to interruption of blood supply."*—IESO, Tigray, Hospital 3

Interviewees often reported a lack of equipment, supplies, and diagnostic services as a major barrier to the implementation of SS2020 trainings. While many surgical system issues were effectively addressed with limited resources, others appeared to be outside the surgical team's control.

3. **Lack of commitment from surgical team members**

> *"Lack of commitment from seniors, particularly the surgeon, and irregular schedule for meeting of the surgical team."*—CEO, Tigray, Hospital 2

An additional reported barrier to implementation was the lack of commitment of the senior surgical team members, which was evident in the irregular scheduling of SaLTS Committee meetings and limited motivation to improving safe surgical practices.

b) Mentorship Program

Areas of Mentor Support

1. **Progress evaluation and experience sharing**

   "They were visiting the hospital every month, sharing their experiences, and guiding and providing ideas to the mentee about how to accomplish activities. During their visit, the mentors were evaluating whether performance standards are being met."—OR nurse, Tigray, Hospital 1

   "The mentors are the most respected and senior people and are trying to transfer their experiences to these hospital team members. They give onsite feedback not only to the clinicians, but also to administrative staffs."—CEO, Tigray, Hospital 2

   The multidisciplinary mentors supported the surgical teams by evaluating their progress across on-site visits and providing feedback to both administrative and clinical staff members. Mentors offered not only technical and organizational recommendations, but also clinical skills training when time allowed.

2. **Problem-solving**

   "The mentors are supportive. They show our gaps and we try to fill the gaps that are within the scope of the hospital. Sometimes they become part of solution for gaps that could not be solved by the hospital. For example, catheter and chest tubes (of different sizes) were among the barriers identified as gap during their visit. We tried to buy these materials but could not found in the local market. Knowing this gap, the surgeon brought these materials from his private clinic. Re-structuring of the operation theater was also made after the mentors' suggestion."—Quality Officer, Tigray, Hospital 3

   The mentors played an important role in problem-solving within the SS2020 intervention facilities. Their efforts were two-fold: 1) identification of surgical system issues and 2) devising of creative solutions. Mentors often procured equipment and supplies on their own, demonstrating a strong commitment to improving resource availability within the facilities.

3. **Patient consultations and case discussions**

   "Mentors of different composition-surgeon, gynecologist, nurses and anesthetists – visit the hospital every month. They are scheduled; communicate us through phone before their arrival. The mentors are open minded, empathetic, committed, and quite organized as well. The relationship we had is of family type. They are committed even to support out of their schedule. They give us feedback through different ways: through email, mobile phone and face to face. We get phone consultation when face complicated cases that need consultation during surgery."—IESO, Tigray, Hospital 3

The mentees reported frequent communication with their assigned mentors, which proved to be largely beneficial for case consultations. Mentors have not only been available by phone to address time-sensitive patient questions, but they have also facilitated on-site discussions of retrospective cases.

Perceived Impact

1. Improved practices

> *"Previously we were giving preoperative prophylaxis to patients at least 60 minutes before surgery. During mentoring, we have been told by the mentors that it is outdated and the current recommendation is 30 minutes. Therefore, now we are applying the recommendation given by the mentors."*—Unidentified provider, Tigray, Hospital 4

Mentors' experience sharing during on-site visits reportedly improved surgical practices among the surgical team members.

2. Empowerment

> *"It is clear that the mentorship will not only improve knowledge and technical skills of mentees, but also patient clinical outcomes. In this regard, referral rate and surgical volume is increased due to the improved communication between the mentors and mentee, clinical proficiency, and the decision-making ability of mentees."*—IESO, Tigray, Hospital 1

The knowledge imparted by the mentors improved confidence in providing quality patient care among the surgical team members. The frequent communication demonstrated from case consultations likely decreased unnecessary surgical referrals, thus increasing surgical volume and empowering surgical providers in primary facilities.

Barriers to Implementation

1. Mentor/mentee qualifications

> *"It is an opportunity to share knowledge between parties so it is good if scaled up to others. However, what is common in our country and what we practically faced was senior physicians do not want to be mentored by senior of the same status. The mentee (the surgeon) was not happy because when the mentor was giving comments instead of accepting his comments positively considered him as faultfinder. Thus, it is better to aware the mentee and the mentor on the purpose of mentoring program. In fact, the mentor can also learn from the mentee if there is mutual understanding on the aim of the program."*—CEO, Tigray, Hospital 2

> *"At the beginning of this program, there was disagreement between the two surgeons (mentor surgeon and the mentee surgeon) on the definition given to minor and major*

operation. The argument was whether the type of anesthesia or the type of case that determines the category. Then onwards, while other team members are available the surgeon is not part of the mentoring group; he was appearing only one or maximum of two times so far. There is also lack of skill transfer."—Anesthetist, Tigray, Hospital 1

One provider reported challenges with being mentored by a surgical provider with the same degree qualifications. Surgeon specialists in the general facilities may contribute to the mentorship program by guiding mid-level surgical providers in primary facilities or serving as mentors for their own surgical teams. Receiving mentorship from fellow surgeons in specialized facilities did not prove to be effective.

Areas of Improvement

1. Increased accountability of and engagement with RHB

"The mentorship program did not include people from regional health bureau. That is why sometimes the same type of problems, which actually are beyond this hospital level, are identified as gaps repeatedly in every visit of the mentors because of lack of a person to take the assignment."—CEO, Tigray, Hospital 1

"Officers from regional health bureau are not involved during the mentoring group program. Therefore, the identified gaps that are beyond the scope of the hospital often do not get solution timely, because for some of the problems the regional health bureau could be responsible in alleviating the gap."—IESO, Amhara, Hospital 1

Facility issues outside the control of surgical team members must be addressed by the Regional Health Bureau (RHB). It is therefore imperative that RHB personnel are engaged in the mentorship program to allow the mentors to escalate issues when necessary.

2. Consistency of On-site Visits

"Despite working with many partners have advantages, the partners of the SS2020 lack coordination among themselves. For instance, during the mentorship and supervision program instead of coming together they often come separately. This creates unnecessary workload on the providers and patients as well. Moreover, as an IESO I did not benefit in skill acquisition from senior mentors because they are waiting for a short period, during which emergency cases are not available. Undeniably, however, seminars on selected surgical cases are conducted."—IESO, Amhara, Hospital 1

One area of improvement that was repeatedly mentioned by the interviewees was the inconsistent scheduling of mentor visits. Mentors reportedly conducted on-site visits more frequently when the program was first established. Providers requested more visits, scheduled visits to allow them time to prepare, coordinated visits among SS2020 partners, and longer visits.

3. Increased clinical skills training

> *"I do not think that the hospital staffs are benefited in skill transfer from their supervisors. Surgery is believed to be a combination of art and theory. Hence, a surgeon must know what he does and conversely he must do what he knows. Unfortunately, the clinical mentors wait for a short period and it is unlikely to get emergency cases during their visit."*— Anesthetist, Amhara, Hospital 1

Providers often requested more clinical skills during the mentorship visits. Longer mentor visits would provide more opportunities for OR training.

4. Videoconferencing

> *"The waiting time of the mentors is short, only one day. As a solution, it is possible to establish telemedicine/video conference so that the mentors can support the mentee while they are at their site of residence."* —CEO, Tigray, Hospital 3

One proposed compensation for the short duration of mentor visits was mentor videoconferencing as a significant portion of the mentors' time is spent traveling to the facilities.

c) SPECT

Perceived Impact

1. Improved knowledge and skills

> *"Because of [the] program many staff members are paying closer attention to how they clean, wrap, sterilize and stored instruments. Avoiding chlorine solution prevents the materials from damage. Highly recommends using sterility indicators inside the instrument, but before training the indicators were put outside. This helps to ascertain on the sterility of sterilized equipment."*—OR Nurse, Tigray, Hospital 3

Despite the challenges faced during implementation of the SPECT program, surgical staff felt that the training improved their knowledge and skills related to sterilization. Training was simple to understand and enabled trainees in several hospitals to share new knowledge and practices with hospital staff outside of the surgical department.

2. Improved hospital and patient-level outcomes

While the SPECT curriculum was not fully integrated into most hospitals for reasons noted in the next section, there was still a general perception among staff that the program improved sterilization practices in the SS2020 intervention facilities, which then reportedly helped improve outcomes, including: reducing the rate of surgical site infections, sterilization-related cancellations, and unnecessary referrals, and decreasing adverse events.

Barriers to Implementation

1. Lack of high-level support

> *"Unless we receive any legal document from regional health bureau, we are frustrated to use the new technology because we do not want to be accountable if something wrong happens to either patients or providers related to sterilization."*—CEO, Amhara, Hospital 1

At the time of the SPECT training, recommendations for sterilization and decontamination did not align with FMOH guidelines, and staff members of some hospitals reported being told directly by RHB representatives to discontinue implementation of SPECT practices in order to adhere to these guidelines.

While the FMOH informed the Amhara and Tigray RHBs about pending changes to the national guidelines (changes that were streamlined with the SPECT curriculum), surgical team members that were interviewed were largely unaware of these updates. In Amhara, most notably, the lack of an official letter of support from the RHB prohibited hospitals from implementing SPECT practices. RHB support for SPECT training was reportedly higher in Tigray, as a number of hospitals reported receiving a letter from the Tigray RHB clarifying recent updates to the FMOH guidelines.

2. Staff resistance

> *"I think attitude of health workers is the main barrier. They are not happy to avoid chlorine solution because they perceive that decontamination of instruments using bleach solution before handling makes it safer than just cleaning of materials with hot water and detergent, which is recommended by the SPECT program."*—CEO, Tigray, Hospital 1

Resistance from staff members proved to be a major barrier to full implementation of SPECT training in almost all hospitals in Tigray and Amhara. Staff were reportedly not convinced of the validity of sterilization techniques introduced in the training (i.e. use of boiling water for decontamination), which contradicted national guidelines that existed at the time of training (i.e. use of chlorine solution). Limited, delayed support from the RHB and hospital management was a major contributor to the skepticism among hospital administration and surgical staff members.

3. Inadequate resources

Implementing and maintaining SPECT decontamination processes was challenging due to limited infrastructure and a lack of necessary equipment and supplies. It was particularly difficult for staff to adhere to aspects of the decontamination process that involved the use of boiling water and detergent, both of which are not readily available in most facilities due to a lack of necessary equipment and inability to easily procure the detergent required.

Areas of Improvement

1. Alignment with national guidelines

To ensure implementation of best practices and sustainability at the hospital level, focus group participants recommended that national guidelines be updated to align with the SPECT curriculum. They reported that this misalignment limited buy-in at all levels of the health system, from surgical staff members to the RHB, and inhibited hospitals from fully implementing practices learned in training. This recommendation reflects the singular opinions of interview participants, and does not

accurately reflect activities at a high-level, most notably the ongoing communication between FMOH, RHB, and SPECT.[13]

2. Training and follow-up time

It may be useful to increase the length of training and including additional follow-up should be considered in the future, as staff felt that more time was needed to fully integrate new sterilization practices at their hospital.

[13] During implementation, the SPECT team was made aware of this area of improvement and began working with the FMOH to rewrite the infection prevention and control guidelines to ensure that national standards are up to date with current WHO standards. The FMOH sent a letter of endorsement of SPECT recommendations to the Amhara and Tigray RHBs.

d) WFSA

Perceived Impact

1. Increased knowledge and awareness

> "*The training let us become alert. Our readiness ahead of undertaking surgery also improved. Complete assessment of the patient and assuring availability of blood and resuscitation material is becoming our habit ahead of surgery. As a result, anesthesia related complications become decreased. Our capability of timely responding to complications, if happened, is also becoming improved*." —Anesthetist, Tigray, Hospital 2

WFSA training was perceived to increase the general knowledge and awareness of safe anesthetic practices. Staff who attended WFSA SAFE courses reported having an increased understanding of anesthetic procedures and potential complications. Training allowed anesthesia providers to improve their scope of clinical practice and empowered them to being implementing lessons learned in their daily practice. Case management reportedly improved across the surgical team and anesthesia providers were better able to prepare for, recognize, and handle anesthetic complications post-training.

2. Improved organizational culture

> *"Apart from independent activities of the anesthetists, I learnt about the rationales behind and necessities of multidisciplinary team working, more particularly surgeons and nurses. With this in mind, I found that patients are the center for every [activity] of all the team members... The training increases our team spirit; now we are starting to think and work together as a team, where we did not have that some two years back before the start of the project in our hospital."*—Anesthetist, Amhara, Hospital 1

WFSA training positively impacted organizational culture in regards to performing safe surgery by helping to increase team commitment and collaboration. Participants felt that the training contributed to improved working relationships between team members, while also increasing professional accountability.

Barriers to Implementation

1. Anesthesia staff turnover and shortages

> *"There were events in relation to the limited number of providers. Once upon a time the anesthetist became unconscious because of exhaustion and loss of energy while we were*

performing caesarean section. We were in the middle of the procedure and the skin was not sutured while the anesthetist was falling down. The team members (the IESO and nurses) became shocked and in trouble to manage both the patient and the anesthetist. We shouted and called other staff members to manage the anesthetist while the nurse and the IESO continued working on the remaining surgical service of the patient. The patient was so fortunate that surgery was done with spinal anesthesia, but if it was done using general anesthesia, it could not be possible to handover the anesthetist's activity by other team members."—IESO, Tigray, Hospital 1

High turnover within the anesthesia workforce coupled with ongoing workforce shortages made implementation difficult. There were limited opportunities to share anesthesia-specific knowledge and practices within each hospital, as most employ only a single provider. One hospital reported having no anesthesia provider at the time of interview; two other anesthetists were newly employed and did not have the opportunity to learn from the previous provider that had participated in WFSA training.

2. Lack of resources for anesthesia

Insufficient equipment, materials, and supplies reportedly made implementation of practices challenging for anesthesia providers. Notably, a lack of pharmaceuticals was reported to be a major barrier to performing certain procedures that were discussed in WFSA training.

Areas of Improvement

1. Include non-anesthesia staff in training

"For me it could be good if the training had involved either the IESO, the medical director, or any other bodies. However, since only one person was trained without backup and the trained person unfortunately become unsuccessful the entire surgical program become collapsed."—IESO, Tigray, Hospital 3

Due to staff shortages and turnover, focus group participants indicated that it could be useful to include additional members of the surgical team in future WFSA trainings.

2. Training and follow-up time

Participants felt that three days of training with limited follow-up was not adequate. By increasing the length of the training, the program may benefit from allowing participants more time to discuss, practice, and ask questions.

e) FAF

Perceived Impact

1. Improved surgical service delivery

> *"We do have three ultrasounds in this hospital but the unique feature of the ultrasound donated by the FAF program is that it continues working for at least four consecutive hours after electric power is off. Since the main electric power is frequently interrupted, we use this U/S often than others. Because of the availability of the ultrasound, we have decreased the number of referral cases and surgical volume is increasing as a result. Due to the existence of the ultrasound, this hospital is becoming reference center for the health facilities within and out of the catchment area."*—IESO, Amhara, Hospital 5

The FAF program positively impacted service delivery at SS2020 intervention facilities by funding improvements and equipment that helped reduce service interruptions, increase the availability of surgery, and improve the quality of care.

2. Increased opportunities for advocacy

> *"We are using this machine for advocacy purpose. We arranged visiting program for the hospital management board members (composed of people from different sectors) how the machine was helpful for the community. At the same time, we were asking them to communicate [to] the community for the existence of surgical services to advocate in using the service."*—CEO, Tigray, Hospital 1

The projects completed through FAF enabled surgical teams to better advocate for support for surgery within their hospitals as well as their communities. By developing action plans, surgical providers reported being more proactive about finding ways to address internally recognized issues. Equipment procurement and construction projects funded by FAF were used by the surgical team to garner interest from the community, as well as motivate hospital administration to budget for more equipment in the future.

Barriers to Implementation

1. Need for additional equipment management training

> *"After availing the accessories, the anesthetist failed to make the machine functional. While he was trying to test the machine, the oxygen sensor of the machine became dysfunctional due to his improper management. In another time, even trainers from Addis*

Ababa came and gave training to the anesthetist. However, he was not successful in using the machine. Still the machine is idle because of the skill gap of the trained anesthetist."— IESO, Tigray, Hospital 3

Inadequate training on the utilization and long-term management of newly procured equipment reportedly prevented usage in some hospitals. As described in the above quote, a lack of training resulted in machines becoming unusable at times. This issue was discussed most often in regards to FAF-provided anesthesia machines.

Areas of Improvement

1. Engage governing bodies in program implementation

Though the FAF program is able to help surgical teams address some of the issues identified at their hospitals while developing action plans, focus group participants suggested that it may be useful to engage local governing bodies (hospital administration and RHB) throughout FAF implementation. In this way, the hospitals and regions may be better equipped to continue building on improvements made through the FAF program. This recommendation reflects the singular opinions of interview participants, and does not accurately reflect activities at a high-level, most notably the ongoing communication between FMOH, RHB, and Assist International.[14]

[14] It should be noted that local governing bodies (both hospital administration and RHBs) were engaged prior to implementation to approve and sign FAF agreements, which corresponded to specific requests from each hospital. Mentor hospitals and clinicians were also involved to continue clinical user training on donated equipment after the initial two-day training.

f) KPI Data Intervention

Perceived Impact

1. Improved Data Collection, Reporting, and Analysis

> *"To me KPI is a comprehensive program because there are added indicators that are missed from HMIS such as; blood availability, postoperative mortality, and anesthesia adverse effects. The comprehensiveness of the program helps in clinical auditing, that is it helps to know the status of the hospital with respect to surgery. The program is also important in creating awareness of the staffs on the outcomes of their activities because most of the 16 indicators are focusing on padtient outcome."* – IESO, Tigray, Hospital 2

> *"There is increased number of registration books in different units and the available registration books are easy to use, clear and time saving. Moreover, important key performance indicators that were missed from the previous registration books are included."* – Surgeon, Tigray, Hospital 4

Perceived impact of the KPI Data Intervention focused primarily on how the newly implemented registry system facilitated improved data collection, reporting, and analysis in the hospitals. The registers being distributed to each area of the hospital that has surgical patients made the collection of the data easier and provided clear paths to understanding where the data is and how to use it. The indicators themselves were also guiding this process, providing direction to understand the importance of data and improve the use of data to inform quality in the hospitals.

2. Improved Awareness of Data Quality and Patient Outcomes

> *"This is one of the SS programs best practiced in this hospital. Awareness level of the staffs on the advantage of data is improved and recording and reporting of data is improved."* – CEO, Amhara, Hospital 1

> *"The value people are giving to data is improving. For example, before training we perceived that we were doing good, the number of surgeries per surgeon reported to regional health bureau was low even sometimes lower than the primary hospitals, where there is no surgeon and gynecologist. After training, we were questioning why it was low despite doing good and we found that the hospital did not report cases managed by IESOs. Rather, only the number of cases managed by surgeons and gynecologists was included."* – Medical Director, Tigray, Hospital 4

The understanding of the importance of surgical data through the lens of the Key Performance Indicators was critical to the success of this intervention. The hospitals reported that this increased awareness of data quality and the value placed on data has helped improve the quality of the services provided and overall patient outcomes. This not only informs emphasis on the collection and use of data, but also the implications data has in making decisions for the hospital. Understanding that we

need to collect and report high quality data in order to fully know what is happening in the hospital was critical, as reflected in the second excerpt.

3. **Improved Role Definition, Relationships, and Communication within and outside the Surgical Team**

> *"Every referral is discussed before referring the patient so unless the reason is convincing, unnecessary referrals are reduced and patients are managed at our hospital."* – Unknown, Tigray, Hospital 1

> *"It also defines the role of each team member. For example, the program helps us in establishing liaison office and assign liaison officer. The presence of this officer helps to manage the referral system of this hospital through one central referral system. Before implementing the program, however, patients were referred from every department, so it was difficult to appreciate the type of referral and the reason for referral."* – CEO, Tigray, Hospital 1

Discussing the data and methodology of collection built cohesion within the surgical teams and between the surgical team and the other departments where surgical data is kept. Understanding each individual's roles in the data collection increased the perceived impact and facilitated the collection and reporting of the KPI's. The providers elucidated that, particularly through the example of unnecessary referrals, having pre-defined roles and being committed to collecting data allows the entire surgical team to better communicate and work together in order to ensure that their patients are getting the best possible care they can provide.

Barriers to Implementation

1. **Increased Workload and Inefficiency of Data Collection**

> *"It is good to have different registration books for different units but it increases workload because we are recording and reporting what the Regional Health Bureau and the SS2020 project want us to report..."* – Anesthetist, Tigray, Hospital 4

> *"It could be possible to increase the quality and save time if the registration system had been automated and computer assisted. Unfortunately, the recording system is manual and is not automated, yet; to overcome these problems, electronic devices such as tablets or laptops are required but we are in shortage."* – Anesthetist, Tigray, Hospital 4

Many hospital providers cited increased workload as a barrier to implementation. The KPI Focal People often had other duties in the hospital as many were providers as well as the point person for data collection. Further, depending on surgical volume and overall hospital caseload, the day-to-day collection of patient level data proved to be very tedious in some of the intervention hospitals. While tablets were used for data quality checks of the paper registries, many providers reported that if the whole system could be electronic it would be easier and more efficient, yet they understand how that currently is not feasible.

Areas of Improvement

1. Registration Book Improvements

> *"They are not labeled well so we are obliged to label manually; it is detached easily as there is a problem in binding."* – IESO, Tigray, Hospital 1

The registers printed for use in the hospital notably had some issues. The providers mentioned that of note was their fragility and general nature. While they were not made incredibly specific on purpose, for hospitals with multiple sections to their wards, where they may have two of the same registries in the same place for different areas, having to manually label them felt tedious. Further, the bindings were coming undone on many of the registries, reflective of subpar assembly. Further iterations of the registries should remedy these issues and provide registers that are more stable to help facilitate long-term data collection without the need for replacement.

2. Refinement of KPIs

> *"Differences in the definition of surgical site infection (SSI) between the WHO standard and in this program is another problem. According to WHO definition, SSI is considered if the patient complains signs of infection within one month after surgery or one year after implanon (modern contraceptive type) insertion. In this program, however, SSI is limited only up to the time of discharge. The difference in the definition lowers the number of reported cases. For the consumption of the program, we are reporting according to its operational definition but we are also trying to trace patients as per the WHO definition and huge gap in the number of cases is appreciated between the two data types."* – IESO, Amhara, Hospital 3

The definitions provided for the KPIs were a matter of discussion for many of the providers. Some KPIs, like Surgical Site Infection, were of primary concern as there were discrepancies between the WHO definition and the definition for the purpose of this intervention. This difference, as shown in the preceding excerpt, was a function of limitations of the hospitals to follow-up on patients after discharge. Further discussion needs to be had on the definitions to make sure that the context in which the KPIs are being collected lends itself to accurate data. SSIs were seen as very low because of the narrowness of the definition. However, the fact that the providers brought up these concerns emphasizes the impact of this program, as they are critically engaged with making sure the indicators are proper for their context, furthering the understanding of the importance of these indicators and the need for data overall.

3) Overall Perception of SS2020 Impact

Focus group data showed a largely positive perception of the impact of SS2020 in both Amhara and Tigray intervention hospitals. While there were a number of barriers to implementation for most programs, there was almost unanimous agreement that each program had potential to sustain positive impact post-SS2020. Most respondents felt a national-scale up of interventions could tremendously benefit other hospitals in similar need of improved surgical services. Throughout each focus group, there was enthusiastic discussion from participants about potential areas of improvement for each intervention; with these improvements addressed, they felt SS2020 could be even more impactful.

There are a few key themes that repeatedly emerged during discussions about specific interventions and as well as the general impact of SS2020. These are:

Profound increase in communication and teamwork. All 10 hospitals unanimously highlighted this as one of the more positive effects of SS2020. Largely unmeasured, anecdotal evidence shared by participants point to a more cohesive surgical team in each respective hospital, an effect that has also reportedly trickled into other non-surgical units.

Need for additional equipment and technical training. This theme emerged as relevant to the WFSA, SPECT, and FAF programs. Hospitals mentioned the inability to adequately implement protocols learned in training due to lack of supplies or equipment. Some hospital staff were in need of additional training for use of anesthesia machines donated through the FAF, due to high staffing turnover and/or lack of practice in use of the machines. This was especially relevant in Tigray. This issue is actively being mitigated by SS2020 by organizing additional training at hospitals reporting turnover.

Need for more substantive clinical skills mentorship. This theme touched on both the overall objective of the mentorship program as well as the frequency and efficiency of mentorship visits. While the program was seen as generally favorable, many participants expressed a desire for hands-on clinical mentorship and training, which would require a more significant time commitment and adjustment in objectives of the program. Similar areas of improvement were noted specifically for anesthetists that participated in WFSA. Nine of 10 hospitals discussed this gap on varying levels.

Lack of communication between governing bodies. An implementation barrier for a few programs was the lack of adequate communication between and within the RHB and MoH. For instance, while the Ministry of Health submitted letters to the leaders of RHB informing them of their endorsement of updated sterilization and decontamination guidelines that matched SPECT's curriculum, in Amhara, the RHB reportedly did not relay this information to the regional hospitals. This likely resulted in RHB staff being unaware and actively directing hospital staff to ignore the training curriculums. SPECT staff responded to these issues by working directly with the FMOH to rewrite the infection prevention and control (IPC) guidelines to ensure that national standards are up to date with current WHO standards.

Need for proactive involvement of RHB and FMOH for sustainability. To ensure that positive impact of SS2020 can be sustained long-term, not only does the communication between the RHB and FMOH need to improve, but these governing bodies should also be more heavily involved in implementation. For instance, for the KPI Data Intervention, the RHB and FMOH should be proactive in adopting and printing the new clinical registries that were piloted in SS2020 intervention facilities in 2018 and were proven to be successful in capturing high-quality surgical data. Further, almost all hospitals (8 out of 10) reported that additional program-specific training and equipment training were needed; to ensure sustainability, future training gaps should be addressed by RHBs and the FMOH/SaLTS team.

Perception of positive impact on surgical volume and referrals. Participants in a number of hospitals reported an increase in surgical volume and a reduction in referrals out as markers of positive impact of SS2020. However, this perception is not entirely validated by the available hospital data, as noted in *Section G* on KPIs. This is likely pointing to the lack of quality data available prior to the data intervention, and how perceptions of improvement for these KPIs are largely influenced by personal experience.

To provide further insight into the surgical teams' opinions, immediately after the focus groups all participants completed a Likert scale survey on the perceptions of SS2020 impact on 8 different categories. While all categories received high marks, the results showed notable differences. Participants most strongly agreed with the following statement: *Data Quality has improved since the Safe Surgery project began* (mean=4.51), and least strongly agreed with the following statement: *The hospital's infrastructure has improved since the Safe Surgery project began* (mean=3.85). (Table 6)

Summary Metrics		**Clinical Knowledge Has Improved**	**Clinical Skills Have Improved**	**Infrastructure Has Improved**	**Surgical Team Has Grown**	**Surgical Volume Has Increased**	**Surgical Quality Has Improved**	**Patient Safety Has Improved**	**Data Quality Has Improved**
Amhara (n=36)	MEAN SCORE	4.28	3.92	3.61	4.08	4.06	4.11	4.31	4.58
	# AGREE	32	28	21	30	30	32	32	35
Tigray (n=39)	MEAN SCORE	4.44	4.31	4.08	4.15	4.21	4.51	4.41	4.44
	# AGREE	38	39	31	34	36	37	36	35
Amhara & Tigray (n=75)	MEAN SCORE	4.36	4.12	3.85	4.12	4.13	4.32	4.36	4.51
	# AGREE	70	67	52	64	66	69	68	70

Table 6. Post-Hat Likert Survey: Perceptions on SS2020 Impact – 2018 Endline

While the themes and anecdotes that emerged in this qualitative assessment are largely subjective, effort was made to include only participants who could were actively involved in SS2020 and could provide valuable insight into its strengths and weaknesses. Several areas of improvement were noted and should be considered in any future scale up of SS2020 and/or SaLTS programs. These suggestions are especially important to not only affect positive impact on surgery in Ethiopia, but to ensure its sustainability.

Appendix

Supplemental Figures, Graphs, and Tables

1) Additional Baseline—Endline Analysis

Pharmaceuticals: All hospitals in Tigray reported always having access to sedatives and vasopressors at both baseline and endline (no response at baseline from one primary hospital).

WHO Checklist Use: At baseline, 40% of hospitals reported 'always' using the WHO Safe Surgery Checklist; at endline, 100% of hospitals reported 'always using the Checklist'. Please note that 'always' using the Checklist includes all answers reported as 'always' on the 3-part scale or used '76-100%' of the time on 4-part percentage scale.

Recovery Beds: Total number of recovery beds reported from nine hospitals (data missing from one primary hospital) increased from n=17 at baseline to n=26 at endline.

Record Keeping Methods: Of the ten hospitals, 80% reported using paper-based methods while 20% reported no method of record-keeping at baseline. At endline, 60% of hospitals reported using both electronic and paper-based methods while 40% reported using only paper-based methods.

2) Additional Midline—Endline Analysis

Table A1. Change in the number of operating rooms (ORs) and OR tables available and in use.

	Equipment (n)			
	Major ORs	Minor ORs	OR Tables	OR Tables Used
Midline	13	11	18	12
Endline	15	10	21	15
Change (n)	2	-1	3	3

Change in the availability of ORs and OR tables was aggregated from all 10 facilities surveyed (2 general, 8 primary). Change is defined as the difference in the reported equipment availability between midline and endline. Facilities reported a total addition of 2 major ORs and 3 functional OR tables, and a total loss of 1 minor OR.

Table A2. Change in the number of imaging diagnostic and sterilization equipment available and in use.

	Imaging Diagnostic and Sterilization Equipment (n)							
	X-ray	X-ray Used	Ultrasound	Ultrasound Used	Central Sterilization Room	Central Sterilization Room Used	Autoclave	Autoclave Used
Midline	9	9	12	8	7	5	15	10
Endline	9	8	16	13	12	11	14	13
Change (n)	0	-1	4	5	5	6	-1	3

The total availability of imaging diagnostic and sterilization equipment was aggregated from all 10 facilities surveyed (2 general, 8 primary). Change is defined as the difference in reported equipment availability between midline and endline. Facilities reported a total addition of 5 functional ultrasounds, 6 functional central sterilization rooms, and 3 functional autoclaves, and a total loss of 1 functional X-ray machine. Please note that the data available and presented from only 9 facilities (2 general, 7 primary).

Table A3. Change in mean number of hospital beds available by department.

	All Hospital Beds	Surgical Beds	OBGYN Beds	Recovery Beds	ICU Beds	Emergency Beds
Midline	50.2	10.8	12.3	2	0.2	3.8
Endline	56.8	12.1	10.5	3	0.1	5.3
Change (n)	**6.6**	**1.3**	**-1.8**	**1**	**-0.1**	**1.5**

The mean number of beds were calculated from all 10 facilities surveyed.

Table A4. Change in percentage of facilities with pharmaceuticals for surgery.

	Midline Mean (%)	Endline Mean (%)	Average % Change
Available	46.7	47.5	0.81
Not Available	53.3	52.5	-0.81

Mean availability was calculated using aggregate responses from all hospital surveyed (2 general, 8 primary) to a list of 56 pharmaceuticals approved by the FMOH.

Table A5. Change in the percentage of facilities that reported offering primary surgical services.

	Surgical Services			Surgical Referrals		
	Midline (%) (n = 10)	Endline (%) (n = 10)	**Change (%) (n = 10)**	Midline (%) (n = 10)	Endline (%) (n = 10)	**Change (%) (n = 10)**
SaLTS Primary Surgical Services						
Airway procedures tracheostomy and cricothyroidotomy	70	90	20	30	10	-20
Tube thoracostomy for air and fluid collections in the pleura	70	80	10	20	20	0
Basic wound management including thorough saline washing, irrigation and debridement	100	100	0	0	0	0
Repair of lacerations	100	100	0	0	0	0
Repair of facial and scalp lacerations	100	100	0	10	0	-10
Splinting of fractures (include POP)	100	100	0	0	0	0
Dislocation: traction and closed reduction	90	90	0	10	10	0
External fixation application	0	0	0	100	100	0
Irrigation and debridement of open fractures	90	100	10	10	0	-10
Initial management of burn cases like resuscitation, oxygen delivering, pain management	100	100	0	0	0	0
Advanced burn management: escharotomy and fasciotomy	67	70	3	33	30	-3
Skin graft and flap	0	20	20	100	90	-10
Exploratory laparotomy for Trauma	90	90	0	10	10	0
Cut-down for vascular access	100	100	0	0	0	0
Trauma related amputation	78	50	-28	22	50	28
Draining superficial abscesses	100	100	0	0	0	0
Male circumcision	100	100	0	0	0	0
Vasectomy	60	80	20	40	20	-20
Excision of small soft tissue tumors like lipoma, ganglion	100	100	0	0	0	0
Catheterization	100	100	0	0	0	0
Closed suprapubic cystostomy	100	100	0	0	0	0
Hydrocelectomy	100	100	0	0	0	0
Rectal tube deflation for sigmoid volvulus	100	100	0	0	0	0
Acute appendicitis	100	90	-10	0	10	10
Acute perforation	100	90	-10	0	10	10
Bowel obstruction	100	90	-10	0	10	10
Repair of hernias	90	70	-20	11	30	19
Septic arthritis, osteomyelitis	89	90	1	11	10	-1
Pyomyositis	100	90	-10	0	10	10
Surgical management of hand infection	89	100	11	11	0	-11
Extraction of primary and permanent tooth	50	50	0	50	50	0
Incision and drainage (periodontal and dental abscess)	40	90	50	50	10	-40
Dental caries treatments and scaling	10	30	20	80	70	-10
Foreign body removal from nose, ears, throat	100	100	0	0	0	0
Ear and eye irrigation	100	100	0	0	0	0
Orofacial infection management	100	90	-10	0	10	10
Cataract surgery	10	0	-10	90	100	10

Tarsotomy (upper eyelid)	22	11	-11	78	89	11
Eye enucleation	33	0	-33	67	100	33
Caesarean Section	100	100	0	0	0	0
Abdominal Hysterectomy	90	100	10	10	0	-10
Repair of Uterine perforation, rupture (intractable PPH)	100	100	0	0	0	0
Normal delivery	100	100	0	0	0	0
Manual removal of the placenta	100	100	0	0	0	0
Vacuum-assisted delivery	100	100	0	0	0	0
Repair of Genital Laceration/Injury	100	100	0	0	0	0
Comprehensive abortion care	100	100	0	0	0	0
Surgery for ectopic pregnancy	100	90	-10	10	10	0
VIA	56	60	4	33	40	7
Cryotherapy for precancerous cervical lesions	50	40	-10	40	60	20
Cervical biopsy	20	10	-10	80	90	10
Endometrial biopsy	30	20	-10	60	80	20
Tubal ligation	80	100	20	20	0	-20
Incision of Hymen for imperforate hymen with hematocolpos and hematomata	100	100	0	10	0	-10
Basic traumatic life support (BTLS) training	90	50	-40	0	10	10
Advanced traumatic life support (ATLS), Pediatrics advanced life support (PALS)	50	0	-50	40	50	10
Local anesthesia	100	80	-20	0	10	10
General anesthesia with intubation	100	90	-10	0	0	0
General anesthesia without intubation	90	89	-1	20	0	-20
Spinal anesthesia	100	100	0	0	0	0
Peripheral nerve blocks	20	10	-10	90	20	-70
Procedural sedation	70	50	-20	20	20	0
SaLTS Primary Surgery	**79**	**77**	**-2**	**21**	**20**	**-1**

Change in the availability of SaLTS primary surgical services was estimated among all facilities and defined as the mean percentage of primary surgical services offered. Facilities reported offering an average of 79% of SaLTS primary surgical services at midline and 77% at endline, estimating an average decrease of 2% in the availability of SaLTS primary surgical services. Facilities reported referring an average of 21% of primary surgical services at midline and 20% at endline, estimating an average decrease of 1% of SaLTS primary surgical services referred to a higher-level facility for intervention. Non-responses were analyzed as missing data.

Table A6. Change in the percentage of facilities that reported offering general surgical services.

	Surgical Services			Surgical Referrals		
	Midline (%) (n = 2)	Endline (%) (n = 2)	Change (%) (n = 2)	Midline (%) (n = 2)	Endline (%) (n = 2)	Change (%) (n = 2)
SaLTS General Surgical Services						
Burr-hole and elevation of Depressed skull fracture for head injuries	100	50	-50	0	50	50
Vascular exploration and repair/anastomosis for trauma	0	50	-50	100	50	-50
Neck exploration for severe neck injuries	100	50	-50	0	50	50
Emergency thoracotomy for severe chest injury	0	50	-50	100	50	-50
Cholecystectomy	100	100	0	0	0	0
Cholecystostomy	100	100	0	0	0	0
Haemorrhoidectomy & Fistulotomies and drainage of perianal abscesses	100	100	0	0	0	0
Trans-prostatectomy (TVP)	100	100	0	0	0	0
Cystolithotomy	100	100	0	0	0	0
Common bile duct (CBD) exploration, biliary bypass procedures and T-tube insertion for hepato-biliary pathologies	100	50	-50	0	50	50
Constructing and reversal of colostomies, colon resection and anastomosis	100	100	0	0	0	0
Modified radical mastectomy	100	100	0	0	0	0
Thyroidectomy	100	100	0	0	0	0
Intussusception	100	100	0	0	0	0
Colostomy for anorectal malformation	100	50	-50	0	50	50
Management of foreign body swallowing/aspiration	100	100	0	0	50	50
Aspiration	0	50	50	100	50	-50
Cleft lip	100	0	-100	0	100	100
Cleft palate	50	0	-50	50	100	50
Tenotomy & Ponseti cast for club foot	50	100	50	50	0	-50
Management facial bone fractures and injury to dentition (interdental wiring, arch bar, IMF and open reduction)	0	50	50	100	50	-50
Myringotomy for otitis media	0	0	0	100	100	0
Tonsillectomy	50	0	-50	50	100	50
Surgical management of pelvic organ prolapse	100	100	0	0	0	0
Management of major benign and malignant gynecologic conditions	100	100	0	0	0	0
Epidural anesthesia	0	0	0	100	0	-100
Mechanical ventilation	0	0	0	50	50	0
SaLTS General Surgery	**70**	**67**	**-3**	**28**	**30**	**2**

Change in the availability of SaLTS general surgical services was estimated among all facility levels expected to be providing the respective services and defined as the mean percentage of general surgical services offered. General facilities reported offering an average of 70% of SaLTS general surgical services at midline and 67% at endline, estimating an average decrease of 3% in the availability of SaLTS general surgical services. General facilities reported referring an average of 28% of SaLTS general surgical services at midline and 30% at endline, estimating an average increase of 2% of SaLTS general surgical services referred to a higher-level facility for intervention. Non-responses were analyzed as missing data.

Table A7. Change in the percentage of facilities with Emergency and Essential Surgical Care (EESC) equipment and supplies and the readiness score (mean % of items).

	Midline (%) (n = 10)	Endline (%) (n = 10)	**Change (%) (n = 10)**
Suction pump (manual or electric) with catheter	80	90	10
Blood pressure measuring equipment	70	90	20
Scalpel with blades	60	100	40
Retractors	80	100	20
Scissors	70	100	30
Tissue forceps	80	100	20
Gloves (sterile)	90	100	10
Gloves (examination)	70	70	0
Needle holder	60	100	40
Sterilizing skin prep	80	89	9
Nasogastric tubes	70	80	10
Light source (lamp & flash light)	40	80	40
Intravenous fluid infusion set	100	100	0
Intravenous cannulas/scalp vein infusion set	100	100	0
Syringes with needles (disposable)	100	100	0
Sharps disposal container	89	90	1
Tourniquet	20	40	20
Needles & sutures	50	90	40
Splints for arm, leg	60	60	0
Waste disposal container	60	100	40
Face masks	80	90	10
Eye protection	70	67	-3
Protective gowns/aprons	50	90	40
Soap	78	80	2
Electrocautery	30	60	30
Adult Mcgill forceps	50	56	6
Pediatric Mcgill forceps	20	22	2
Chest tubes insertion equipment	10	30	20
Tracheostomy set	20	40	20
Vaginal speculum	80	90	10
Resuscitator bag valve & mask (adult)	80	90	10
Resuscitator bag valve & mask (pediatric)	50	70	20
Stethoscope	90	100	10
Thermometer	70	70	0
Oropharyngeal airway (adult)	60	100	40
Oropharyngeal airway (pediatric)	60	60	0
Endotracheal tubes (adult)	70	90	20
Endotracheal tubes (pediatric)	40	50	10
IV infuser bags	30	10	-20
Laryngoscope Macintosh blades with bulbs & batteries (adult)	80	100	20
Laryngoscope Macintosh blades with bulbs & batteries (pediatric)	60	80	20
Functional anesthesia machine	100	100	0
Anesthesia machine	100	100	0
Ambu bag	100	100	0
Oral airways	100	100	0
Nasal airways	10	20	10
Perfuser	0	10	10
Patient monitor	70	100	30
Patient monitor for transport	10	40	30
Esophageal stethoscope	10	0	-10

Blood or fluid pumper	10	10	0
Warming blanket	0	10	10
Mechanical ventilator for transport	10	0	-10
Suction machine	80	100	20
Capnogram	22	50	28
Portable pulse oximeter	70	90	20
Blood warmer	10	0	-10
Stethoscope	100	100	0
Manual BP apparatus	90	100	10
Oxygen gauge	90	90	0
Oxygen cylinder	90	100	10
Bougie (adult)	10	50	40
Bougie (pediatric)	10	0	-10
Stylet (adult)	50	80	30
Stylet (pediatric)	0	30	30
Anesthesia trolley	30	70	40
Oxygen concentrator	20	50	30
Double lumen tube 35-42	0	10	10
Suction tip	70	70	0
Urinary catheter	100	100	0
Spinal needle 22-26	60	90	30
Epidural set	0	0	0
Tegaderm	10	0	-10
Insulated nerve block needles	0	0	0
Central venous catheterization set	0	0	0
Arterial line set with module	0	0	0
Defibrillator	10	30	20
Readiness score	**34**	**42**	**8**

Readiness for surgical services was assessed based on the presence of EESC equipment and supplies inquired about in the SAT. The readiness score is defined as the mean availability (‘always available’) of EESC equipment and supplies. Items were analyzed as ‘always’ available if providers reported them being ‘fully available’ on the 3-part scale or ‘available’ on the binary scale. Change in the readiness score was estimated among all facilities. Facilities reported an average availability of 34% of EESC equipment and supplies at midline and 42% at endline, estimating an average increase of 8% of EESC items. Non-responses were analyzed as missing data

Table A8. Surgical Volume & Referrals Out in Amhara, Jan 2017—December 2017, collected retrospectively.

	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
Hospital 1	15	48	32	48	24	39	37	22	49	22	25	34
Hospital 2	13	9	17	19	30	22	21	36	19	42	32	19
Hospital 3	14	19	24	21	14	16	20	27	21	29	23	25
Hospital 4	22	24	45	35	56	62	59	69	50	45	32	23
Hospital 5	8	8	16	15	8	17	15	22	15	25	26	19
Total Volume	**72**	**108**	**134**	**138**	**132**	**156**	**152**	**176**	**154**	**163**	**138**	**120**
Hospital 1	10	17	17	22	19	32	16	23	45	21	26	15
Hospital 2	27	25	40	28	38	28	34	32	21	26	23	44
Hospital 3	40	82	90	121	104	95	108	103	87	97	69	89
Hospital 4	120	171	109	155	163	209	279	177	218	173	167	176
Hospital 5	45	60	67	47	65	66	35	45	57	106	96	42
Total Referrals	**242**	**355**	**323**	**373**	**389**	**430**	**472**	**380**	**428**	**423**	**381**	**366**

Table A 9. Surgical Volume & Referrals Out in Amhara: Jan—Feb 2018 collected retrospectively; March 2018–Dec 2018 collected prospectively

	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18
Hospital 1	27	27	34	32	32	35	35	35	31	30	35	32
Hospital 2	28	25	36	35	26	27	32	15	18	23	22	18
Hospital 3	23	29	28	27	26	27	28	20	23	24	21	42
Hospital 4	38	45	50	55	42	32	14	32	49	50	51	49
Hospital 5	13	22	32	33	31	40	19	21	34	39	32	26
Total Volume	**129**	**148**	**180**	**182**	**157**	**161**	**128**	**123**	**155**	**166**	**161**	**167**
Hospital 1	23	25	46	46	70	121	129	81	82	82	125	72
Hospital 2	39	42	41	47	65	67	55	77	67	78	48	66
Hospital 3	91	143	54	53	76	36	30	59	85	72	76	48
Hospital 4	154	178	36	31	27	72	76	74	79	50	71	61
Hospital 5	106	88	102	97	95	111	82	90	91	102	99	74
Total Referrals	**413**	**476**	**279**	**274**	**333**	**407**	**372**	**381**	**404**	**384**	**419**	**321**

Table A10. Surgical Volume & Referrals Out in Tigray, Jan 2016—December 2016, collected retrospectively.

	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16
Hospital 1	8	4	3	2	0	3	6	10	10	13	13	6
Hospital 2							12	44	71	64	55	56
Hospital 3	15	24	17	11	12	12	17	15	12	17	15	11
Hospital 4	57	78	79	73	75	83	81	45	66	75	67	68
Hospital 5	10	16	2	8	7	4	8	8	7	1	8	3
Total Volume	**80**	**106**	**99**	**86**	**87**	**98**	**116**	**114**	**159**	**169**	**150**	**141**
Hospital 1	0	0	3	6	6	4	0	2	2	4	6	4
Hospital 2												
Hospital 3	2		1	1	2	0	1		1			1
Hospital 4	20	6	6	25	15	13	12	16	6	10	7	13
Hospital 5												
Total Referrals	**22**	**6**	**10**	**32**	**23**	**17**	**13**	**18**	**9**	**14**	**13**	**18**

Table A11. Surgical Volume & Referrals Out in Tigray, Jan 2017—December 2017, collected retrospectively.

	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
Hospital 1	7	4	3	3	3	3	7	7	0	0	4	7
Hospital 2	56	82	85	60	74	76	89	70	74	101	65	46
Hospital 3	5	11	8	12	16	12	7	16	17	20	19	20
Hospital 4	66	77	75	91	67	72	93	75	84	128	110	75
Hospital 5	5	9	14	5	10	9	6	2	10	10	12	13
Total Volume	**134**	**174**	**171**	**166**	**160**	**163**	**196**	**168**	**175**	**249**	**198**	**148**
Hospital 1	12	17	11	7	2	4	6	6	12	14	3	10
Hospital 2			13	9	5	5	3	8	11	4	0	7
Hospital 3	14	1	4	1	8	20	17	13	15	15	13	7
Hospital 4	18	16	11	17	15	14	11	4	7	15	5	7
Hospital 5												
Total Referrals	**44**	**34**	**39**	**34**	**30**	**43**	**37**	**31**	**45**	**48**	**21**	**31**

Table A12. Surgical Volume & Referrals Out in Tigray, Jan 2018–April 2018, collected retrospectively; May 2018–Dec 2018, collected prospectively

	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18
Hospital 1	9	1	5	12	5	9	4		8	1	0	0
Hospital 2	58	66	82	70	95	91	71	81	92	90	46	49
Hospital 3	16	11	11	3	5	9	13		19	15	27	10
Hospital 4	57	76	116	54	75	98	50		59	59	72	56
Hospital 5	11	11	7			13	12	12	10	5	11	11
Total Volume	**140**	**154**	**214**	**139**	**180**	**207**	**138**	**81**	**178**	**165**	**145**	**115**
Hospital 1	7	5	6	5	11	29	15		25	28	23	16
Hospital 2	9	9	8	8		47	30	18		25	35	26
Hospital 3	13	11	18	25	17	44	26		33	29	31	36
Hospital 4	8	12	11	10	18	37	11		34	13	15	16
Hospital 5			3	45		18	4	17	20	19	24	27
Total Referrals	**37**	**37**	**43**	**48**	**46**	**157**	**82**	**18**	**180**	**95**	**104**	**94**

3) Additional Resources/ Publications

National Policy Contributions

1. Federal Ministry of Health of Ethiopia. Saving Lives Through Safe Surgery (SaLTS) Key Performance Indicator Manual. (2018).
2. Federal Ministry of Health of Ethiopia. Saving Lives Through Safe Surgery (SaLTS) Data Intervention & Training Participant Workbook. (2018).
3. Federal Ministry of Health of Ethiopia SaLTS Monitoring and Evaluation Training Manual: Hospital Assessment Tool and Key Performance Indicators. (2017).
4. Federal Ministry of Health of Ethiopia Hospital Assessment Tool (HAT) for Situational Analysis to Assess Emergency and Essential Surgical Care in Ethiopia. (2017).

Publications in peer-reviewed journals

1. Burssa, D., Teshome, A., Iverson, K., et al. 2017. Safe Surgery for All: Early Lessons from Implementing a National Government-Driven Surgical Plan in Ethiopia. *World Journal of Surgery*, *41*(12), pp.3038-3045.
2. K. Iverson, I. Citron, D. Burssa, et al. 2018. Authors' reply: Safe Surgery for All: Early Lessons from Implementing a National Government-Driven Surgical Plan in Ethiopia. *World Journal of Surgery*.
3. KR Iverson, K Garringer, O Ahearn, et al, Mixed-methods assessment of surgical capacity in two regions in Ethiopia, *British Journal of Surgery*

Publications in peer-reviewed journals (In Progress)

1. Bari, S, Iverson, K, et al. *Results of a Surgical Key Performance Indicator Data Intervention in Rural Ethiopian Hospitals*. [In Progress]
2. Shehnaz, A, et al. *Developing mentorship in a resource-limited context: A qualitative research study of the experiences and perceptions of surgical teams and mentors in Ethiopia.* [In Progress]
3. Bari, S, et al. *A Mixed-Methods Assessment of Safe Surgery 2020 in Ethiopia*. [In Progress]
4. Ahearn, O, Iverson, K, et al. *Development of a Surgical Assessment Tool for National Policy Monitoring & Evaluation in Ethiopia*. [In Progress]

Conference presentations

1. Iverson K., Citron I., Ahearn O., Garringer K., Mukhodpadhyay S., Burssa D., Teshome A., Bekele A., Workneh S., Shrime M., Meara J.G. *Quantitative Evaluation of Surgical, Obstetric, and Anesthetic Capacity in Ethiopia*, Academic Surgical Congress, January 2018
2. Garringer K., Iverson K., Citron I., Ahearn O., Mukhopadhyay S., Burssa D., Teshome A., Bekele A., Esseye S., Shrime M., Meara J.G. *The Hospital Assessment Tool and Key Performance Indicators: Ethiopia's National Strategy for Surgical System Monitoring & Evaluation*, Consortium of Universities for Global Health (CUGH), March 2018
3. Drown L., Incorvia J., Bekele A., Beyene A., Garringer K., Ahearn O., Abate M., Mengistu A., Barash D., Iverson K.R. *Development of an Intervention to Improve Surgical Data Quality at Hospitals in Ethiopia*, Yale Global Surgery Symposium, April 2018 & Harvard Global Health Symposium, April 2018
4. Olivia Ahearn, Kaya Garringer, Katherine Iverson, Abebe Bekele, Atlibachew Teshome, Daniel Burssa, *Developing the Monitoring and Evaluation Pillar of Ethiopia's National Surgical Plan: Saving Lives Through Safe Surgery* COSECSA 2018, Kigali, Rwanda
5. O. Ahearn, K. Garringer, K. Iverson, et al, *SafeSurgery2020 in Ethiopia: Year One Results and Lessons Learned*, CUGH 2019
6. K. Garringer, O. Ahearn, J. Incorvia, L. Drown, K. Iverson, D. Burssa, S. Esseye, V. Smith, J.G. Meara, A. Beyene, A. Bekele, S. Bari, *Reasons for Surgical Referral in Rural Ethiopian Hospitals*, ASC 2019
7. S. Bari, J. Incorvia, L. Drown, K. Garringer, O. Ahearn, K. Iverson, A. Bekele, A. Beyene, J.G. Meara; *Data Quality Assessment of Surgical Registries & Electronic Data Entry in Rural Ethiopian Hospitals*; CUGH 2019
8. J. Incorvia, S. Bari, K. Garringer, L. Drown, O. Ahearn, K. Iverson, A. Beyene, A. Bekele, Daniel G/Michael, J.G. Meara; *Results of a Surgical Key Performance Indicator Data Intervention in Rural Ethiopian Hospitals*; CUGH 2019
9. Abate M, Iverson KR, Garringer K, Drown L, Incorvia J, Ahearn O, Shrime M, Meara J, Beyene A, Bitew Z, Gashaw B, Bekele A. *Assessment of Surgical Data Collection Systems in Five Primary Hospitals in Amhara, Ethiopia.* Yale Global Surgery Symposium, April 2018 & Harvard Global Health Symposium, April 2018

Case Studies & Book Chapters

1. K. Admasu, D. Burssa, A. Bekele, A. Beyene, K. Garringer, A. Teshome. (2017). Ethiopia Case Study. *World Health Organization Manual on Surgical System Strengthening*.
2. K. Iverson, A. Teshome, S. Esseye, A. Mengistu, A. Bekele, K. Garringer, O. Ahearn, I. Citron. Chapter Eight: Monitoring and Evaluation. *National Surgical, Obstetric, and Anesthesia Plan (NSOAP) Manual*. World Health Organization, Geneva, Switzerland, 2018 (In Progress)

Reports

1. Bari, S., Ahearn, O., Garringer, K., Incorvia, J., Meara, JG. (2019). *A Mixed-Methods Assessment of Safe Surgery 2020 in Amhara and Tigray, Ethiopia, 2016-2018.* Program in Global Surgery and Social Change, Harvard Medical School: Boston, Massachusetts, United States, 2019.