Engineering World Health Summer Institute
Tanzania 2019
Final Report

Engineering World Health CEO:
Leslie J. Calman, PhD
EWH Student Programs Director:
Ben Fleishman
EWH Summer Institutes Manager:
Megan Lavery
EWH Communications Manager:
Jessica Baker
Instructor:
Michael Smith, PhD
On the Ground Coordinators:
Ashley Heida and Maddie Manning
Program Partners:
Duke University
MS-TCDC
Report written by **EWH Operations Manager**:
Victoria Pace

Executive Summary

The 2019 Engineering World Health Summer Institute in Tanzania was a great success. This program, run in partnership with Duke University, hosted 20 participants, 13 male and 7 female, from 5 different countries.

The participants stayed with homestay families for the first month, and in a mix of guest houses and homestays for the second month. During the first four weeks of the program, the group underwent intensive technical and language (Swahili) training conducted at MS-TCDC, a training centre in Usa River. Their technical training included both lab and lecture, with weekly visits to Arusha hospitals to provide the participants with hands-on experience before beginning their hospital placements.

Participants worked in groups of 2 or 3. This summer, we were able to work with 10 hospitals in Tanzania. During their 5-week placements, **the participants repaired 310 pieces of equipment worth approximately US $620,000[1].** Nearly all groups completed a secondary project for their hospitals, working with a budget of $100 USD per person, to address a hospital need outside of equipment repair.

When asked if they would recommend this program, the participants gave a unanimous "yes." The participant feedback gathered was very helpful to us as we continually work to improve this program. Many impactful, high-need repairs were made, and participants appreciated the challenges that come with working in a different culture.

We are grateful to all who helped make this program not only possible, but a success in the eyes of our participants and our partners in Tanzania.

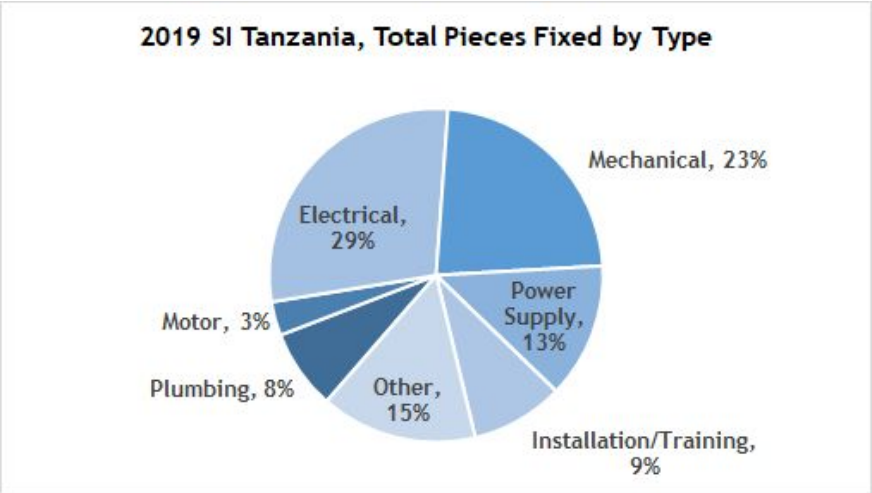
Medical Equipment Repair

Our participants' main objective during the Institute program is to complete hospital equipment repair and maintenance. The training portion of the program prepares them to complete these repairs in a low-resource setting. Once the training is complete, participants are placed in small teams in our partner hospitals with EWH-provided toolkits to complete as many repairs as possible. Participants do not repair every piece of broken equipment that they encounter, which is to be expected, as there are many barriers to equipment repair. The most common barriers we see are lack of parts and repairs which require more advanced knowledge.

The 20 participants repaired or completed preventative maintenance on **310 pieces** of medical and hospital equipment, totaling approximately US$620,000[1] of equipment repair service. We ask participants to complete a "Work Summary Form" during their time in the hospital to document the pieces of equipment they encounter, the reason the piece of equipment is broken (e.g, power supply issue, blown fuse, etc.), and if the repair is successful. Their repair work, as taken from the Work Summary Forms, is summarized below.

<u>Repairs by Type of Fix</u>

Participants indicate the main reason for the item being out of service from the following categories. This year, mechanical and electrical issues were the main issues seen in the broken equipment (which is common across our programs). This chart only summarizes data from successfully repaired equipment.



Repairs/Maintenance by Type of Equipment

The table below summarizes the types of equipment on which participants completed repairs. Patient and delivery beds, manual blood pressure devices, and oxygen concentrators made up the greatest percentage of successfully completed repairs. "Other" also made up a large percentage, which is typical, as participants often encounter a number of devices not included in our provided list, or are unsure how to classify an item.

Type of Equipment	**Total Pieces**	**Type of Equipment**	**Total Pieces**
Aspirator/Suction Machine	12	Lamp, surgical	7
Autoclave	3	Microscope	6
Automatic Voltage Regulator	1	Nebulizer	2
Bed, delivery	61	Operating Table	2
Blood Bank Refrigerator	1	Oven, Lab	1
Blood Pressure Device, Automatic	19	Oxygen Concentrator	25
Blood Pressure Device, Manual	27	Patient Monitor	13
Centrifuge (electric or hand operated)	2	Phototherapy	2
ECG	3	Pulse Oximeter	11
Electrosurgery Machine*	1	Scale (laboratory and in wards)	15
Fetal Stethoscope	2	Stethoscope	5
Furniture	1	Television	3
Glucose level kit (or glucometer)	1	Ultrasound machine (imaging)	4
Incubator (infant)	2	Washing Machine	2
Infant Warmer (Radiant or other)	1	X-Ray Film View Box	1
Lamp, examination	8	Other	66

*User training and/or low voltage and peripherals repairs only

Repairs by Hospital

The below chart breaks down the repairs by hospital group.

Hospital	Items Touched	Repaired	Abandoned	Repair Percentage
Hospital 1	47	36	11	77%
Hospital 2	39	28	11	72%
Hospital 3	40	35	5	88%
Hospital 4	38	28	10	74%
Hospital 5	106	95	11	90%
Hospital 6	73	37	36	51%
Hospital 7	36	26	10	72%
Hospital 8	34	25	9	74%
Total	**413**	**310**	**103**	**75% avg**

Secondary Projects

Each team is encouraged to complete a secondary project for their hospital during their placement. Through interviews with hospital staff, the participants identify a need in the hospital, then are given a budget of US$100 per person to use in a creative way to provide for that need.

Hospital 1

This group's hospital has several functional yet unused digital blood pressure machines that can be powered using either AA batteries or wall power. The hospital staff prefer to use chargers instead of constantly incurring the cost of buying new batteries. However, the original chargers that came with the blood pressure machines are either lost or have been stolen. Although the head nurse has tried to buy new chargers, the chargers have outdated connectors that are no longer sold online. Thus, this group's project was to find/make a power supply that can be used to power the digital blood pressure machines.

Cady working on the rechargeable battery charger

In addition to the blood pressure machines, the participants discovered that other devices, such as pulse oximeters and blood glucose meters, require battery power. After talking with hospital staff, they came up with the idea of using rechargeable AA/AAA batteries and a battery charger to substitute dry batteries.

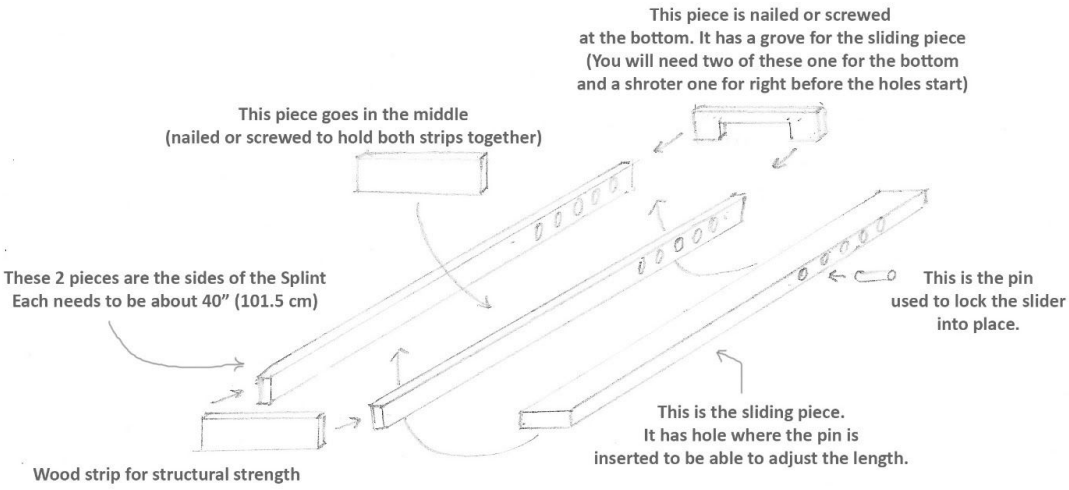
Their first attempt involved buying compatible chargers that can be used to directly power the BP machines. In regards to the rechargeable batteries, with the help from participants at a nearby hospital, the group bought one battery charger and several rechargeable batteries in Moshi. However, the price for rechargeable batteries is very high compared to those in the US. Also, after testing several of the batteries, they discovered that they were in very poor quality.

Fortunately, Machame hospital has an American director who often travels between Tanzania and the US. As a result, the group decided to order two chargers (one for AA/AAA batteries and one for 9V batteries), a 16-pack of AA batteries, and a 8-pack of AAA batteries. They shipped them to the director's office in the US, and he will bring them when he returns to Tanzania.

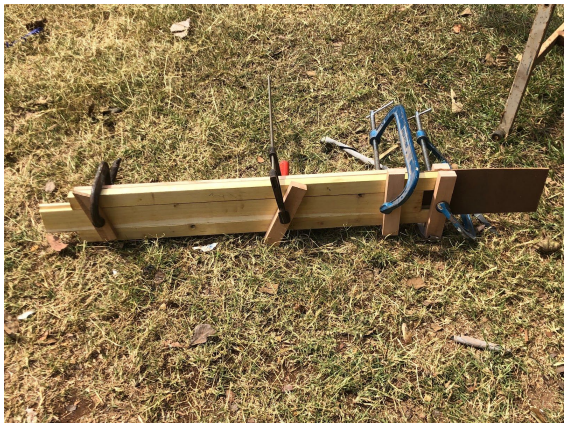
They also wanted to prevent new chargers and batteries they purchased from being lost or stolen. In their interviews with hospital staff, the head nurse showed them a logbook where she keeps a record of all the equipment that is borrowed, and she agreed to add the chargers to the list. They also labelled all chargers so that hospital staff could better keep track of them and hopefully prevent any of them from going missing. The group also set up a charging station for rechargeable batteries in the head nurse's office. In this way, the head nurse can keep track of the location of each battery whenever they are brought to her office for charging.

Hospital 2

This group's secondary project was to design a portable traction splint constructed of wood. Currently, patients with lower extremity fractures (mainly femoral), who cannot afford surgery are placed on traction as therapy. This setup involves an elevated bed, and a metal bar insert under the knee tied to a bag of sand hanging off the foot of the bed. This setup prohibits patients from receiving x-rays, which would allow doctors to observe whether the traction has properly aligned the bones. This group's splint design was aimed to allow patients to be removed temporarily from their permanent setup to be transported to the x-ray room and back.



The portable traction splint was successful. The participant's worked with the hospital's head carpenter to optimize the dimensions of their design and build it to ensure the splint was as durable and lightweight as possible. They also discussed our design with both the head doctor, doctor of St. Francis ward, and the BMET before they began building it. After they finished building the splint, they demonstrated it to the doctors who expressed gratitude and asked the participants to build two additional splints. This would be a relatively simple and impactful project to complete in other hospitals.




Hospital 3

This group's secondary project was fixing and renovating the wheelchairs of the hospital. During their first week in the hospital, the participants realized that all the wheelchairs in the hospital were in need of repair. Out of 9 wheelchairs, 4 were sitting in the workshop and the rest had some problems which included broken breaks, flat wheels, and broken front wheels. Also, the majority of wheelchairs were missing foot pedals, and the hospital staff had tried to manufacture new ones using cloth. However, they were not very stable and they broke very easily, so the participants decided to design new foot pedals that were sturdier.


The participants had to perform different fixes in order to return fully functional wheelchairs, which were: filling flat tires with air, replacing the front wheels with either recycled bed wheels or new ones, adjusting the breaks, designing new foot pedals (which they did purchasing rope, braiding it and attaching it to the front of all the wheelchairs), as well as other mechanical fixes (adjusting screws, designing broken pieces, etc).

After the fixes, each wheelchair was returned immediately and the participants were able to see the patients using them. The hospital staff expressed their satisfaction and the participants noted that the wheelchairs were being used much more now that they are fixed and have foot pedals.

Hospital 4

105 of this hospital's 292 patient beds that the participants found were broken or not fully functioning. This group aimed to fix as many of those patient beds as possible, thereby increasing the patient comfort and improving transportation between wards of the hospital.

The idea for this project came to them when they were speaking with the hospital's biomedical engineer technician (BMET), who was talking about the bad shape of the beds in current use of the hospital. The project was too large for the BMET to take on alone, so the participants decided to complete it for him.

Out of the 105 broken beds the participants fixed 60 of them. The beds are of different types and therefore had different problems. The fixes included: changing

the broken wheels on the beds, sawing the legs of the beds equally long, so that patients can sleep horizontally, and applying lubricant and missing bolts and nuts to beds that had problems regulating bed settings.

Hospital 5

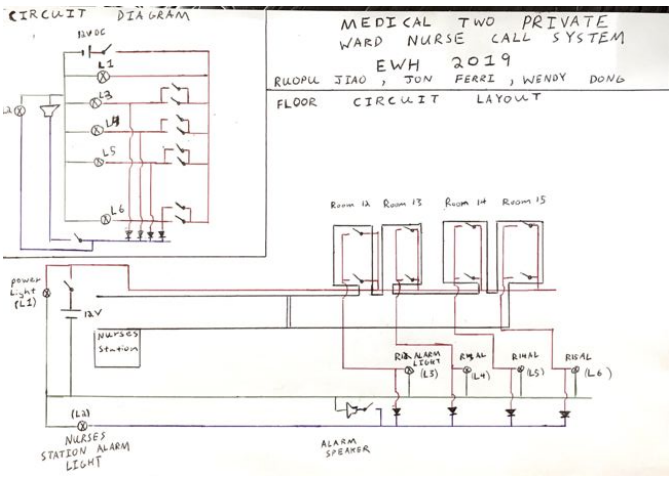
This group's project was with the maternity ward. They had a need for blankets for the mothers and babies. There also was a lot of rust on the beds and other furniture. The participant's original idea was to sand down and repaint this furniture, which they accomplished in part. To cover the needs of warmth, the participants set up a GoFundMe page, the proceeds from which they used to purchase 50 blankets and 200 bedsheets. All of these products were high-quality Tanzanian made, which the hospital was very grateful for.

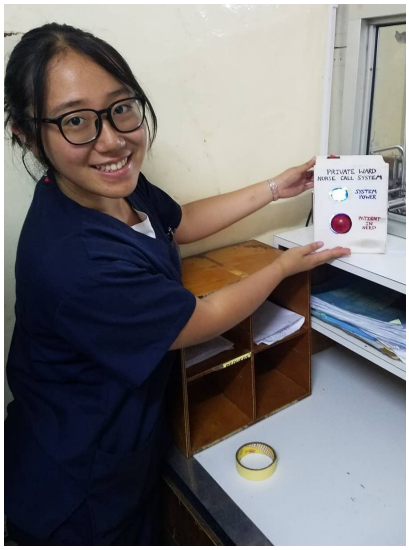
Hospital 6

From the multiple interviews conducted with the hospital's nurse officers, this group decided that one of the greatest needs in this hospital was an emergency nurse call system. A call system would ensure that the patients are able to get the attention of the nurses.

They installed the emergency nurse call system in the four private rooms of a medical ward. This involved having two separate alarm indicator boxes, one at a table outside the private ward rooms and one at the nurses station further down the hall. Patients in need can flip an emergency switch by their bed and an alarm will sound, along with a light corresponding to their room to alert nurses that a patient needs help. The

group reports they successfully installed a system and the nurses and doctors were very happy with it.





Hospital 7

This group's secondary project was replacing the lightbulbs in the surgical and dental rooms and putting up curtains in the Intensive Care Unit. While changing lightbulbs may seem like a minor project, it is actually quite impactful. Lightbulbs with correct voltage and wattage can be more difficult to find in Tanzania than one might expect, and of course, proper lighting is very important in a medical setting. The curtains also provide necessary privacy to Intensive Care patients.



Participant Debriefs and Hospital Feedback

Engineering World Health seeks not only to assist the hospitals in which our participant volunteers work, but also to influence the volunteers' own development as engineers and as global citizens. Overall, the participants' feedback was very positive. Some of the biggest challenges - as we typically see - were the culture shock and the language barrier. Participants had great things to say about their experience in the hospital and generally found their work rewarding, albeit challenging at times. Most participants said they were grateful for the confidence boost the Summer Institute gave them, especially through the hands-on applications of everything they've been learning through their coursework. Many participants reported that the hospital staff and administration were very pleased with their work and their contributions over the summer.

Acknowledgements

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[1] EWH estimates the mean value of each repair at USD$2000