Engineering World Health Summer Institute
Rwanda 2019
Final Report

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Executive Summary

This year was Engineering World Health's seventh Summer Institute in Rwanda. The 2019 Institute, run in partnership with Texas A&M University, hosted 20 participants from four different countries. These participants were joined throughout the program by 10 IPRC BMET Students. Due to impressive recruitment efforts by Dr. Michael Moreno, 12 of these participants came from Texas A&M.

The participants stayed with homestay families for the first month, and mostly in guest houses for the second month. During the first four weeks of the program, the group underwent intensive technical and language (Kinyarwanda) training conducted at IPRC, a technical school in Kigali. Their technical training included both lab and lecture, with once weekly visits to a Kigali hospital to provide the participants with hands-on experience before beginning their hospital placements.

After their training, participants were transported to one of our partner hospitals, located throughout Rwanda, to work in groups of three. This summer, we were able to work with 11 hospitals in Rwanda. During their 5-week placements, **the participants repaired 274 pieces of equipment worth approximately US $548,000[1] and completed 10 secondary projects.**

The participant feedback was very positive. All reported enjoying their time working in their hospitals, a few cited this as the most fulfilling part of the program. This group completed many secondary projects and an above-average number of equipment repairs, resulting in a very successful summer in Rwanda.

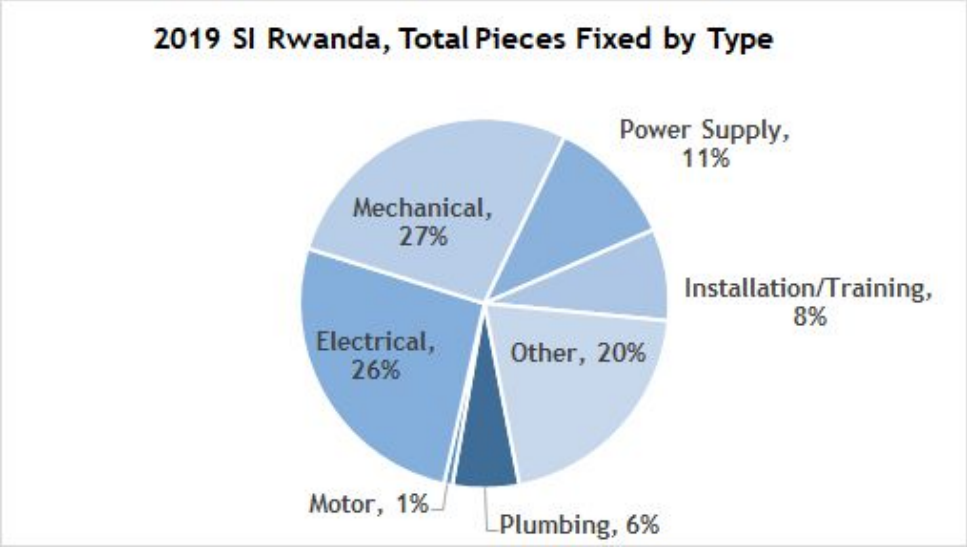
Medical Equipment Repair

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 30 participants in Rwanda encountered 353 pieces of broken medical and hospital equipment and repaired or completed preventative maintenance on **274 of those pieces**, totaling approximately US $548,000[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. This chart only summarizes data from successfully repaired equipment.



Repairs/Maintenance by Type of Equipment

The table below summarizes the types of equipment participants completed repairs on. Blood pressure devices, both automatic and manual, and scales make up the greatest percentage of successfully completed repairs. “Other” also makes up a large percentage, which is typical, as participants often encounter a number of devices not included in our provided list, or may be unsure how to classify an item.

Type of Equipment	**Total Pieces**	**Type of Equipment**	**Total Pieces**
Air Compressor	1	Microscope	5
Anesthesia Machine	5	Nebulizer	9
Aspirator/Suction Machine	22	Operating Table	2
Autoclave	8	Ophthalmoscope	2
Bed, delivery	5	Oven, Lab	1
Blood Electrolyte Analyzer	2	Oxygen Concentrator	25
Blood Pressure Device, Automatic	2	Patient Monitor	14
Blood Pressure Device, Manual	1	Phototherapy	7
Centrifuge (electric or hand operated)	1	Pulse Oximeter	3
Computer	3	Scale (laboratory and in wards)	7
Distiller	2	Thermometers	15
ECG	3	Ultrasound machine (imaging)	4
Electrosurgery Machine*	3	Ventilator	1
Fetal Stethoscope	10	Washing Machine	1
Furniture	22	Water Bath (laboratory)	1
Incubator (infant)	20	X-Ray Film View Box	1
Infant Warmer (Radiant or other)	9	Other	56
Lamp, examination	1		

*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	46	41	5	89%
Hospital 2	28	20	8	71%
Hospital 3	50	46	4	92%
Hospital 4	54	46	8	85%
Hospital 5	33	17	16	52%
Hospital 6	20	14	6	70%
Hospital 7	18	16	2	89%
Hospital 8	15	12	3	80%
Hospital 9	44	31	13	70%
Hospital 10	23	15	8	65%
Hospital 11	22	16	6	73%
Total	**353**	**274**	**79**	**78% 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 $100 per person to use in a creative way to provide for that need.

Hospital 1

This group's secondary project was to help the Director General make a data accountability room for the hospital. The group made a poster of the major medical devices and equipment that are available in the hospital and purchased six white boards to be used by different departments to record daily data. Metrics include the equipment that does not work, deaths and causes, how goals are being achieved, and the active participation of partners in the hospital.

The group reported that the project went really well because of the involvement of the BMETs and Director General throughout the process.

Board in Use

Group with the project

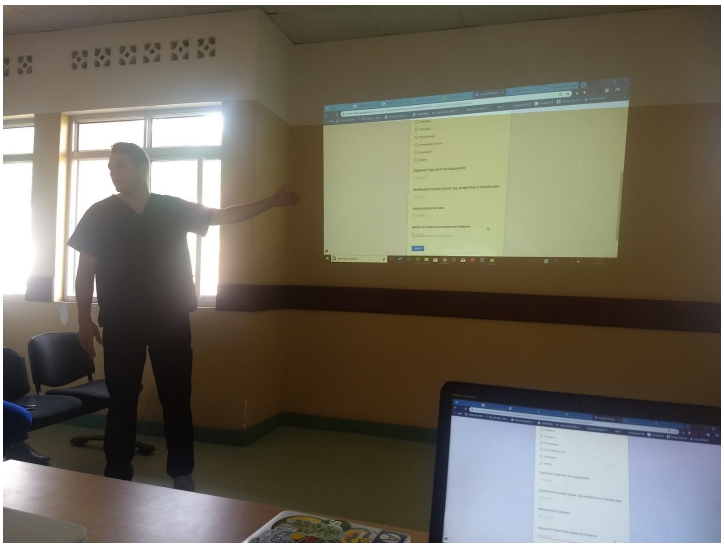
Hospital 2

This group had three secondary projects, all focused on helping the hospital's BMET. First, they helped create an electronic system for broken equipment repair requests, which allowed the BMET to keep better track of the devices and expedite their repair. Formerly, hard copy request forms were used, which the BMET found tedious. The

group set up a system using Google Forms; now all requests come in electronically and progress can be tracked.

They also developed a preventive maintenance plan for the BMET and synced that plan with Google Calendar to notify the BMET when preventive maintenance is required and in which department.

The final secondary project was cleaning the BMET's workshop. When they first arrived, the workshop was very cluttered and full of broken medical equipment. They moved the equipment and tidied the entire space.



Blake presenting the new form to hospital staff

Hospital 3

This group's secondary project was reorganizing and revamping the BMET workshop. They worked to provide a safe and comfortable space to work and improve the accessibility of equipment, tools, and other materials within the workshop. A wooden and metal shelf was built by the team to create extra space. They found and labeled boxes to ease organization.

Thomasina sweeping after the new shelves are installed; the storage closet after

Hospital 4

This group had two secondary projects. For this first, the hospital's BMET requested the participants obtain covers for 10 pieces of medical equipment that are stored in the Maintenance Workshop. One of the main issues that the hospital faces is equipment being susceptible to damage from dust and debris while waiting in the maintenance workshop.

To complete this task, they hired a local tailor to make the cloth coverings. They assisted the tailor in getting the correct measurements, then ensured each cover fit once the tailor had finished them. Before placing the covers on the machines, they deep-cleaned each device, internally and externally.

The second project idea came to the group while they were taking inventory during their first week at the hospital. They went to the pediatric unit and saw that it did not look like a pediatric unit at all. There were no kid-friendly items such as toys, a play area, or colorful paintings. Thus, they decided to develop an area for the kids to be kids, even when they are being treated at the hospital. To accommodate these ideas, they decided to make animals out of tires and PVC pipes and put them in the courtyard next to the pediatric unit for the kids to enjoy.

They constructed a zebra and a giraffe out of tires and PVC pipes and placed them in the courtyard of the pediatric unit. By using the tires, the animals should be durable and able to withstand any bad weather. They also put the tires in a shaded area, so

when there is a lot of sun, the tires will not overheat and the children will still be able to enjoy them. The group reported that this project was fairly inexpensive and just required some physical labor but overall it was a success.


McKenzie with a new cover; Amanda, Alodie, and McKenzie with the new play animals

Hospital 5

This group had two main secondary projects. First, they bought a large, fairly fast water filtration system for the pharmacy department to use. The other secondary project has two parts to it- a cart and a program.

The group designed a cart that could hold 4 oxygen cylinders so that the BMETs could deliver a lot of oxygen at once. Then, they made a computer program that has pop-up to alert when the BMETs should deliver oxygen. This should improve the efficiency and ease of oxygen deliveries: the program reminds BMETs to deliver oxygen on a schedule, and the cart makes large deliveries easier. This helps avoid the BMETs getting called as often as they do now (20-25 times a day) to deliver oxygen in the middle of the day. Instead, they can do it at the beginning and middle of each day and night shift.

Maya and Alex with the new oxygen cylinder cart

Hospital 6

This group organized the BMET workshop, including clearing the work table, building a supplemental bench, and purchasing consumables for the workshop (such as batteries and capacitors).

First, with the assistance of the BMETs, they pulled out all of the equipment and moved non-medical equipment to a separate storage room on the hospital's campus. The room was then cleaned and reorganized with the medical equipment. This freed space in the workshop to work on devices there instead of only in the respective departments.

With their remaining budget, they were able to install a few hand sanitizer stations. They identified this as a need and worked with administration to do a "trial run" to see if the system they implemented was successful. If it was, the administration will allot funding to expand the project. The group reported that hand sanitizer trial run was a success. After 1 full week post-installation and monitoring usage levels, they

determined that one full 500 milliliter bottle of hand sanitizer would last approximately 3-4 weeks in each department that holds one sanitizer dispenser.

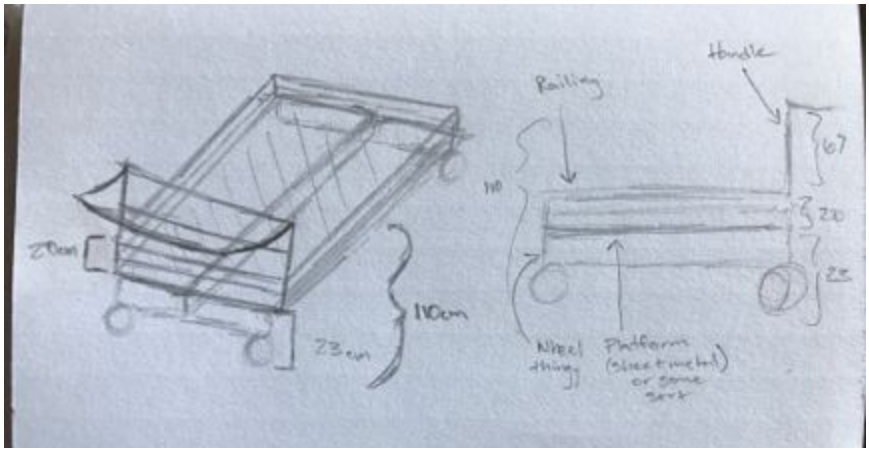
Pegboard for storage; hand sanitizer station

Hospital 7

The group worked with their BMET to come up with ideas for a secondary project. The BMET informed them that there were very few chains for oxygen cylinders and led them to the ER which had hooks installed but only one chain available (oxygen cylinders pose a huge hazard if knocked over). They observed a lack of oxygen cylinder chains in multiple departments: operating rooms, pediatrics, maternity, neonatal, and the male and female in-patient rooms. Their solution for this was to buy more hooks and chains to provide some additional safety to prevent cylinders from accidentally being tipped over.

Cylinder secured to wall

The group also observed how difficult it was to transport equipment throughout the hospital. When transporting equipment, they would have to manually carry the device across gravel or grass in order to take it to the workshop. This was tough in pairs, and likely even more difficult carrying devices alone. So they decided that an equipment cart would be a great addition for the workshop, as it would make things easier to transport. They salvaged wheels from a broken incubator in the workshop and created a design for the cart.



Drawings for cart

They designed the cart to be the proper arm's reach for the BMET. They also took into account the need for the railing around the cart to be low, so the equipment wouldn't have to be lifted very high to be placed onto the cart. They hired a welder in town who was able to fabricate the cart for a reasonable price.


Completed cart; cart with equipement

Hospital 8

This group's secondary project was developing a safer way for oxygen to be distributed throughout the neonatology and surgery wards of the hospital. When the group arrived at the hospital, the hospital was using oxygen cylinders directly in the OR and had oxygen cylinders freestanding next to incubators in neonatology. In the OR, the BMETs had secured the tanks to the wall with chain but did not have the resources to do the same in neonatology. The head BMET expressed the desire to implement an in-wall/ceiling oxygen distribution system so that the tanks do not have to be so dangerously close to patients. For their project, the participants researched and drew up the plans for oxygen piping to be installed into the neonatology and surgery building. With these plans, the BMET can begin to propose the idea to the hospital director and hopefully to the Ministry of Health.

As a temporary solution, the participants chained up all of the free-standing oxygen cylinders in neonatology and gynecology. They installed chains for 4 cylinders that are in the neonatology room, 2 cylinders that sit outside of neonatology, and 1 cylinder that sits in gynecology.

The participants reported that the project went well and that the BMETs were especially grateful that the participants had the time and resources to secure the tanks.

Hospital BMET and EWH Participant securing cylinders; EWH Participant installing chains

Hospital 9

After talking with the hospital's BMET, the participants decided to build a guard house and a barrier for the second entrance to the hospital, near the maternity wing.

Previous Guard "House"

Before they built the guard house, the guards had to bear the harsh weather conditions, including the hot sun and the pouring rain. Also, the barrier only consisted of an old electrical wire tied between the two sides of the fence.

Wire (in red), not a very secure barrier

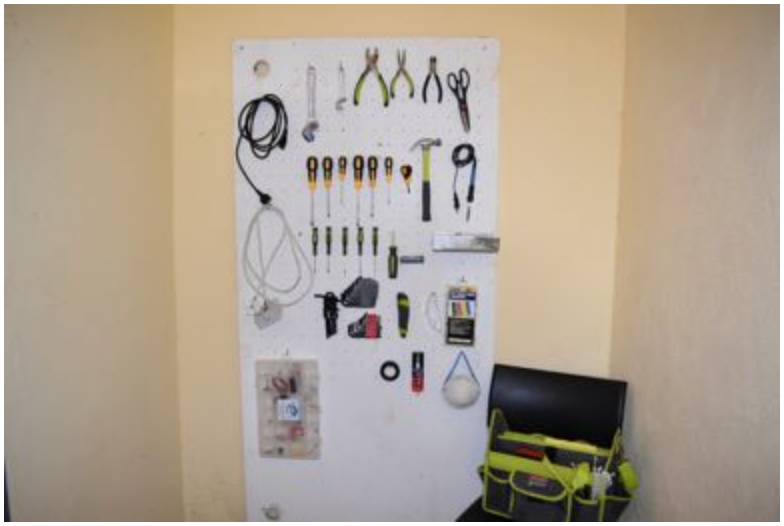
Building the guard house allowed for the guards to more easily protect themselves from the sun and rain, making their jobs more enjoyable.


Guards with EWH participants and new Guard House and the new barrier

Creating the barrier improved the security of the hospital and made it easier for the guards to inspect cars that pass. Additionally, it created a clear pathway for visitors to enter through.

Hospital 10

This group created a tool storage system as their secondary project. The hospital had just built a brand new workshop but had no tools and no way of storing tools. The participants donated their entire EWH tool bag and wanted to provide a way to keep the tools organized. The participants used an existing board that was in the old workshop and then purchased hooks and nails to hang the tools with. They also made a Sign Out Sheet for the tools so that all of the maintenance workers would need to sign when they take and return tools, increasing the likelihood of tools being returned. The participants installed the board in the new workshop with plenty of places to hang the tools.



Finished storage board

Participant Debriefs and Hospital Feedback

Engineering World Health seeks not only to assist the hospitals in which our participants work, but also to influence the volunteers' own development as engineers and as global citizens. The participants were proud of the work they completed in the hospitals and the number of repairs they achieved as a group. Many participants cited the culture shock as being the most challenging aspect of the program, but also a rewarding learning experience.

Below are some quotes from the participant feedback to give a brief snapshot of their takeaways from this program:

"My favorite experience was when we shadowed one of our BMETs for a day. We first went to the HIV department to change light bulbs and repair door locks, then we went to change oxygen for babies in the NICU and also pumped water in the Maternity and Neonatology building. After lunch, we went to hang curtains in the Isange One Stop center (A building in which they treat and counsel patients who suffered from sexual assaults and domestic abuse). Even though we only did one thing that was medically related, it was rewarding to see all the work we had done in a day. I learned that our BMET was always right when he said they were not only BMETs, but also carpenters, plumbers, and electricians. This was my favorite experience because it opened my eyes to the needs of the hospital."

"It was a great learning experience to work with people that do not necessarily see things with the same lenses as me."

“I think my biggest accomplishment was the secondary project. It took us awhile to find a secondary project that our BMETs cared about as much as we did, but working with them throughout every step of the process was a very meaningful experience and also guaranteed that the project would benefit the hospital in all the ways that we had intended.”

Acknowledgements

Our On the Ground Coordinators were Claire Atim and Rachel Glenn. The engineering courses were taught by Dr. Michael Moreno of Texas A&M University at IPRC in Kigali. Thank you to all who helped make this program possible.

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[1] EWH estimates the mean value of each repair at USD$2,000.