Engineering World Health | Access Health Care Nepal

2017 Winter Project Report

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Health Care Infrastructure in Nepal

Access to quality, comprehensive health care services is important for the achievement of health equity and for ensuring the quality of a healthy life. Access to health services means the timely use of personal health services to achieve the best health outcomes. Access to health care impacts factors such as, and not limited to, overall physical, social, and mental health status; Prevention of disease and disability; Detection and treatment of health conditions; and life expectancy.

Disparities in access to health services affect individuals and the society, and may be viewed from two perspectives. In regard to supply, effective and optimal quality health care may not be offered. Adversely, individuals may not utilize services from which they could benefit. Limited access to health care impacts people's ability to reach their full potential, negatively affecting their quality of life. Some barriers to services include lack of availability and high cost, which can lead to unmet health needs, delays in receiving appropriate care, inability to get preventive services, and consequently, hospitalizations that could have been prevented had the initial been readily available. Provision of health care services in Nepal, particularly in rural areas, are constrained by inadequate government funding, availability of medical professionals, gaps in public health education within communities, and other factors that were named above that hold relevance.

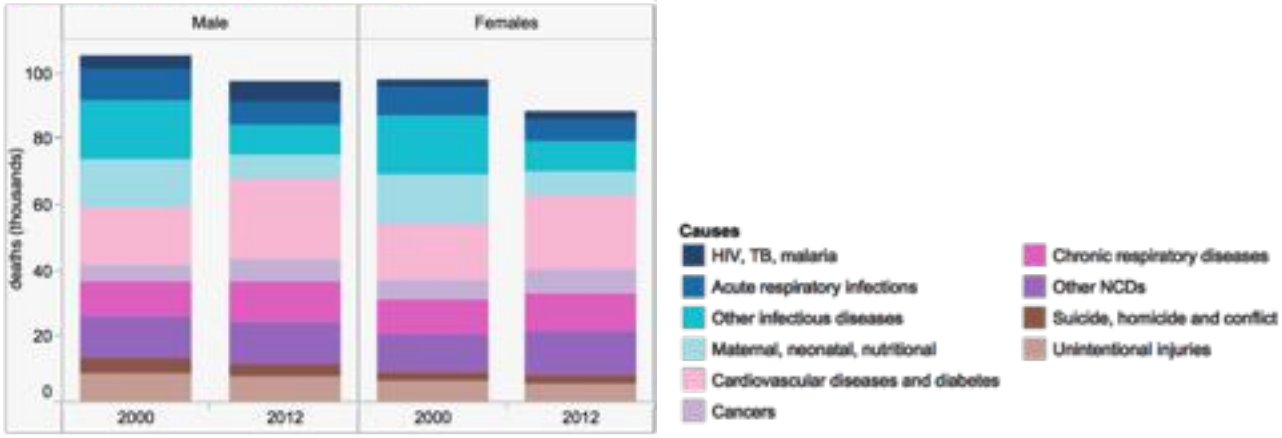


Figure: Deaths by broad cause group, WHO Statistical Profile January 2015

Per the latest Department of Health Services Annual Report, and as a result of the active participation of international organizations, substantial progress is being made in the arena of public health. Some indicators of this include:

Indicator / Year of Survey	1950	1991	2011
Infant Mortality Rate (per 1,000 live births)	200	107	46
Maternal Mortality Rate (per 100,000 live births)	1800	850	170
Average Life Expectancy	32	53	68.8
Children under age of 5 Mortality Rate (per thousand)	280	197	54
Immunization of Children (%)	70	87	88

Table: Nepal Health and Demographic Survey 2011

Solving the problems listed above will take significant time, financing, the investment and support of the local communities and government in implementation of policies. It is the aim of this report to shed light on the steps that are currently being taken by Engineering World Health and Access Health Care Nepal, and to instill the importance for these organizations to be able to continue their work.

About I Engineering World Health

Engineering World Health (EWH) is a dynamic global organization serving engineering students, healthcare professionals, communities around the world and, most importantly, patients in need. EWH inspires, educates and empowers young engineers, scientists and medical professionals from more developed parts of the world to use their engineering skills to improve global health.

EWH offers young professionals an eye-opening, life-changing experience that encourages life-long engagement with global health, and enables them immediately to provide meaningful service to patients in the developing world. EWH also supports training programs in Asia, Africa and Latin America that are building a workforce of in-country biomedical engineering technicians and instructors. Working in partnership with local hospitals, educational institutions and governments, EWH is improving local capacity to run efficient hospitals up to international standards now and in the future.

EWH design competitions encourage innovation in lifesaving medical equipment for under-resourced parts of the world. From its university chapters to its K-12 STEM education programs, from its engagement of exceptional students in the developed world to the education of newly empowered technicians in Africa, Asia and Latin America, EWH builds a global engineering community of knowledge development and exchange.

Left: Anastasia Ray troubleshooting infant incubator in Rwanda, Right: Mads Gleitze Smith and Mathias Nørbæck Johansen diagnose an oxygen concentrator in Nepal.

About I Access Health Care Nepal

Access Health Care Nepal (AHCN) was founded in November 2014 with the aim to mobilize health care workers and medical resources in regions of developing countries isolated from the reach of health care services. The mission of AHCN is to improve health care in rural, resource poor areas by finding innovative solutions through translational field research. The organization has members in various areas of expertise in Nepal, Denmark and USA.

AHCN is composed of international and multidisciplinary academics in the fields of biomedical engineering, public health and medicine. It is a core value of AHCN to preserve unique cultures of rural areas without fundamentally altering their ways of life. To this date, AHCN has conducted five health care projects in rural areas. In addition, research is being conducting in Nepali health care and technology development to meet key challenges in Nepal.

Without access to basic health care, both infectious and non-communicable diseases are highly prevalent. AHCN's Phase 1 project in Tarkughat and Rukum uncovered cases of malnourishment, late stages of infectious disease such as pneumonia, skin infections, and hypertension, and orthopaedic conditions. A large percentage of infectious disease cases can be treated in AHCN's primary health care outreach camp setup.

In the case of chronic disease, AHCN's main strategy has been to give advice on appropriate life style adjustments. This approach has been deemed the most appropriate solution at this time given four limitations:
1) the short duration of the AHCN health camps, 2) economic status of the patients requires AHCN to provide free medications, 3) a 30% literacy rate in these areas limits the ability for patients to follow long course treatments, 4) AHCN's lack of resources to provide a surgical health camp, which could address a number of orthopaedic conditions.

In severe cases, such as with long lasting pneumonia, dehydration, and malnourishment, we have referred patients to a central hospital to ensure proper treatment. AHCN has assisted in these treatments by covering transportation and admission costs. Mothers with malnourished children were assisted financially and logistically when sent to a Nepal Youth Foundation Nutrition Center.

Left: David Kovacs, Co-founder of AHCN, testing the vision of a patient in Tarkughat, Right: Nurse taking patient vitals in Tarkughat.

Executive Summary

Between the dates of December 31, 2016 - January 13, 2017, volunteers were sent to Damauli District Hospital — Anastasia Ray, Leah Putman — and Amppipal Community Hospital in Gorkha— Sam Warner, Andreas Lipphaus. Sunil and Laxman were program coordinators assisting to get spare parts, communication, organizing and much more. Dinesh Rajbhandari, not present for conference, of Volunteer Society Nepal (VSN) assisted in planning program logistics, transportation and language training. Reece Stevens worked on clinically evaluating the FreePulse patient monitor and was joined by Madeleine Dunaway, who photographed and documented their work. David Kovacs joined the program only for the last four days to meet the program participants and take part in the final conference of the program.

- Damauli District Hospital: A total of 16 pieces of equipment were recorded for repairs, 7 were successfully repaired (including 2 installations), 9 were abandoned.
- Bhimad Health Center: A total of 36 pieces of equipment were recorded for repairs (30 of which were blood pressure cuffs), 14 blood pressure cuffs were returned to service, 4 other pieces of equipment were also returned to service, and 2 were not repairable.
- Amppipal Community Hospital: A total of 17 pieces of equipment were recorded for repairs, 11 were successfully repaired, 6 were abandoned.

Introduction

Working in Nepal is challenging — especially once one leaves the Kathmandu City center and ventures to remote areas of the country. Students experience a different working environment within the hospital, and get to experience first-hand the problems faced by the communities residing there. There are multiple factors that affect the availability of standard and consistent healthcare, including limitations in environment, transportation and general location within the country, demographics of the population being serviced, access to government funding — which incorporates things such as the equipment donated, distribution of medicine, and general funding.

Although this may discourage some, this is the essence of bringing programs such as Access Healthcare Nepal and Engineering World Health to these isolated areas — to bring the student volunteer to expand their practical engineering knowledge and to couple problem solving, design, and cross cultural skills thus far developed in order to improve the well-being of those needing it most.

Upon arrival, the volunteers were greeted by representatives of Volunteer Service Nepal (VSN) and Access Health Care Nepal (AHCN) at Kathmandu airport and taken to their accommodation that would serve as the location of language and culture training. Throughout the first few days of the program the participants had a very busy schedule filled with Nepali language and culture classes, tours of different historical and beautiful places in Kathmandu and general preparation for departure to their hospital placements. After this brief orientation the students departed for their respective hospital placements for two weeks.

Left: Patan Durbar Square, Right: Anastasia Ray with VSN representative Gelu at airport arrival.

Damauli District Hospital

Damauli District Hospital is situated in the Tanahun district, roughly 2 hours outside of Pokhara and 7 hours from Kathmandu (152 km). Main mode of transportation is by bus and/or car. Flights are available to Pokhara as well.

Left: Map of directions from Kathmandu to Damauli, Right: View from the bus on the way to Damauli

The volunteers lived with Ram Bahadur Gurung — in charge of logistics at Damauli District Hospital — his family, and other hospital staff (primarily all nurses in-training) for the duration of their stay in Damauli. They were provided a safe place to live, food, and sanitary environment. They were also provided phones and/or SIM cards by VSN. Upon arrival in Damauli, the volunteers set out to see if they could meet with anyone at the hospital but found that they were observing a festival. Naturally - they joined in on the festivities! (See pictures below)

Work in Nepal begins on a Sunday and lasts through Friday, although the working hours are slightly different from what most are accustomed to in western culture. Depending on the day, hospital staff would sometimes arrive between 9-10:00, took lunch between 12-13:00 and left for the day between 15-16:00. This also varied due to the frequent observed holidays and festivals. This took some getting used to and extra communication on behalf of the volunteers to ensure they could meet with the people they needed to.

Left: View of Damauli on an evening walk home from the hospital, Right: Parade through Damauli on the first day of a big local festival

Hospital Overview

The hospital is public and serves an estimated population of 300,000. There are 6 physicians and an estimated 25 nurses. There were a total of 38 beds counted in the hospital. Most common health issues identified in the summer include Malaria, Typhoid, Infectious diseases, Hypertension. In the winter it has been observed that there is a higher amount of COPD and Influenza cases. The hospital charges a very small fee upon arrival of patients (10 rupees), and virtually is able to provide low cost/free services unless the condition requires extensive care, and thus is usually sent to Pokhara.

The services offered include:

- a comprehensive obstetrics/gynecology program which includes regular pre and post natal care and monitoring, free delivery, and immunizations;
- dental;
- mental health; Dr. Leepa Vaidya - Consultant Psychiatrist that comes in every Sunday (3x a month). Works in Pokhara as well.
- emergency department (but no operating theatre dedicated to trauma);
- dialysis;
- HIV and anti-retroviral testing in addition to other important tropical and infectious disease testing and treatment capabilities;
- eye clinic and pharmacy located on the same grounds but are not officially apart of the hospital.

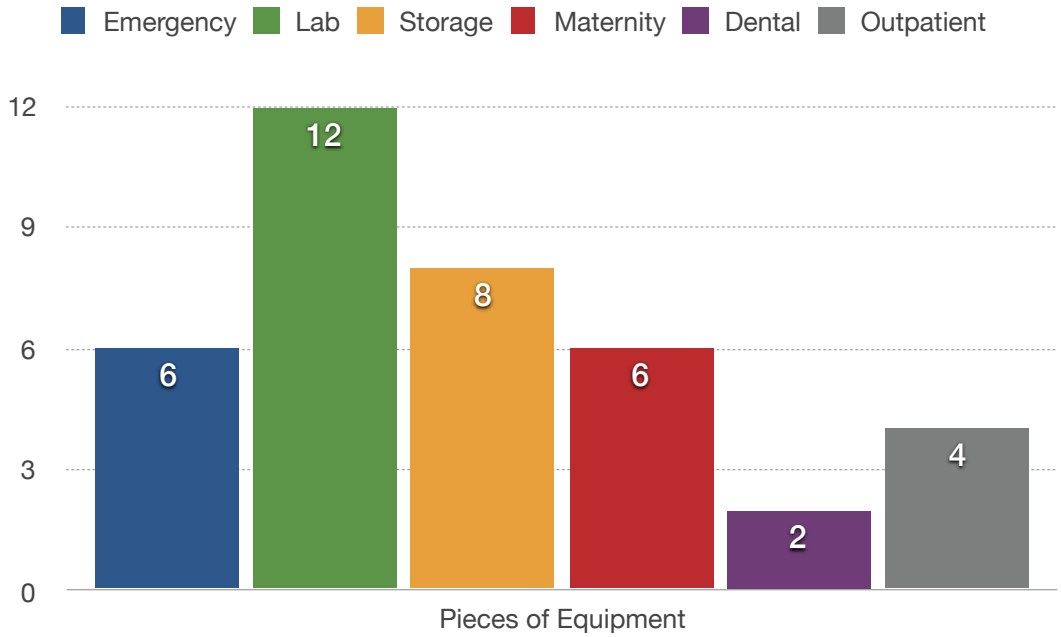
The equipment in the hospital comes mainly from the government of Nepal. In addition, the hospital has received considerable amounts of donated equipment from Japan. There is no biomedical engineering department and hence no preventative maintenance or technicians available for repairs are available unless requested from Kathmandu. When necessary, biomedical equipment technicians can be accessed, however the service is generally too expensive for the hospital to use. Furthermore, there is no documented and tracked inventory system of hospital equipment which further creates a problem among the staff. Many times things are lost or broken because they are not stored in the right place.

A common issue identified within the hospitals was a lack of general training in equipment usage. Training was completed for infant warmers, ECG, and phototherapy unit. Although it is not specifically a teaching hospital, the students found that during their stay there were many nurses completing their temporary post-nursing school graduation training. This is an example of a western hospital expectation for there to be an established level of understanding on basic equipment use by the nurses, prompting the volunteer engineers to proactively respond with training. It is not established if that will once again be the case in future programs, however there is an advisement for future volunteers to be prepared to do the same.

Left: Hospital Department information at entrance , Right: Exterior of Damauli Hospital

Inventory and Department Notes

The inventory taken at the hospital (that of which was found) included 38 pieces of major equipment, not including patient beds, and accounts for the repaired/assembled equipment. Various pieces of equipment such as the ECG's were shared between multiple departments and thus are only noted in one section.



The following is a summary by department including equipment and brief notes. The inventory data is attached in spreadsheet format in the Appendix.

Maternity

As one of the busiest departments, the hospital has an average of 60 births per month. Infant and/or mother mortality rate data was not taken.

There are two operation rooms — 1 dedicated for natural births and a second for cesarean section operation. We were not given access to the latter, as every time we asked no hospital staff would have keys and would emphasize that equipment was not inside the room.

There is one head nurse with proficient english (Jamuna Sharma), the other nurses were able to understand brief english conversation and instruction but not reply. We would recommend having a translator from the hospital present for any imperative communication.

Quantity	Equipment Type	Notes
2	Infant Warmer	1 newly assembled, 1 within '1 year' of assembly
1	Phototherapy Unit	Newly installed and training provided
1	Autoclave	Operational
1	Oxygen Concentrator	Operational
1	Patient Monitor	Operational

Outpatient

Within the outpatient department one of the most prominent activities we saw were pre and post natal check-up of mothers, immunizations, ultra-sound and then general health concerns of the population (i.e. COPD, influenza, hypertension, lab testing, etc,.).

Quant ity	Equipment Type	Notes
1	Ultrasound	2 years in operation with no problems
1	Stationary X-Ray Unit	2 years in operation with no problems
2	X-Ray View Boxes	Not Operational, notes provided in Appendix.

Image: Inside of X-Ray View box

Dental

Quantity	Equipment Type	Notes
1	Dental Chair	2 years in operation and in dire need of recurrent maintenance. There is severe leaking within the main housing of the accessory unit. There is also mold developing on some of the hosing. Although we were able to find and repair one leaking hose and clean up some of the water and mold, we recommend future students to develop a more long-term solution
1	Autoclave	Operational

Images: Leah Putman working on main housing of Dental chair accessory unit

Inpatient

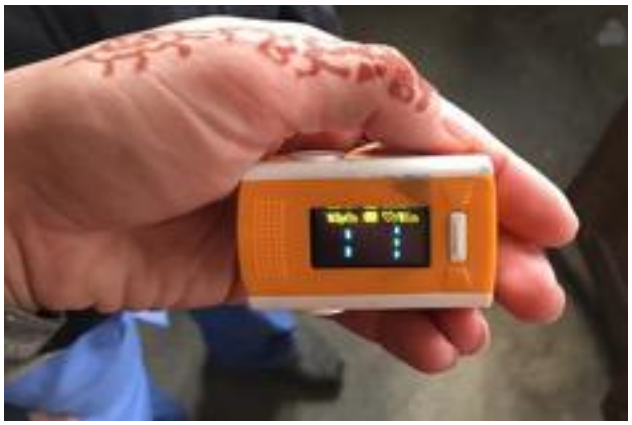
Inpatient department equipment was very limited, we are under the impression it is moved from various areas of the hospital when necessary. The most vital equipment we were requested from this department (along with emergency, inpatient, and maternity) were the ECGs.

Emergency

The emergency department was one of the busiest in the hospital, and is also where we arranged our work area.

Quantity	Equipment Type	Notes
2	ECG	Returned to service and provided training
2	Pulse Oximeter	1 returned to service, 1 not able to fix
1	Autoclave	Operational
1	Infusion Pump	Not returned to service, and when asked, no one there said they use it or know how to use it. Perhaps an idea for future volunteers to assess this question. The unit was giving an air alarm

Left: Disassembled Pulse Oximeter, Right: Figuring out how to use the ECG leads



Left: Repaired Pulse Oximeter, Right: Infusion Pump

Left: Broken ECG, Right: Repaired ECG!

Laboratory

The lab has an impressive amount of equipment and are able to perform a good amount of testing including HIV, Malaria, TB, Hep A, B, and C. During our interview, Dr. Rayamajhi mentioned the rapid rise in malaria testing due to equipment availability. A general observation is that not all of the equipment was connected to a surge protector.

Quantity	Equipment Type	Notes
2	Hot air oven	Operational
1	Incubator	Needing a new adapter plug; See Appendix 1.
1	Centrifuge	Operational
1	Rotator	Operational
2	Microscope	Operational; one is stated to have poor power supply; See Appendix 1.
1	Electrolyte Analyser	Operational
1	Biochemistry Analyser	Operational
2	Refrigerator	Operational
1	Photometer	Operational

Left: Incubator needing new adapter plug type,

Right: Microscope that is experiencing poor power supply and flickering of light at times.

Storage

The storage at the hospital is very disorganized, however we were able to easily locate the equipment that had been previously tended to by the EWH 2016 Summer participants which included suction machines and autoclaves. They had not been moved.

Quantity	Equipment Type	Notes
2	Infant Warmer	1 abandoned +2 years ago and “not in need of repair”, 1 not able to be assembled due to main circuit board problem
2	Oxygen Concentrator	Not Operational
2	Autoclave	Operational
2	Suction Pump	1 Abandoned, 1 Operational

Left: Leah Putman troubleshooting an oxygen concentrator, Middle: Error on Oxygen Concentrator being worked on photo on the left, Right: Leah Putman troubleshooting another oxygen concentrator

Concluding remarks

We strongly recommend a more thorough inventory to be taken upon start of work for the next group of volunteers and for there to be more emphasis on hospital personnel not being afraid to bring forth broken equipment. We noticed that a lot of equipment was often locked up after being broken and forgotten about. Two such pieces of equipment that we were not able to be located (after conversation with Dr. Rayamajhi) were a ventilator and defibrillator.

Repair Summary

There were 16 pieces of equipment worked on in the time of the volunteers placement at Damauli Hospital, 7 of which were successfully repaired/assembled and 9 of which were abandoned or were incomplete due to not enough time.

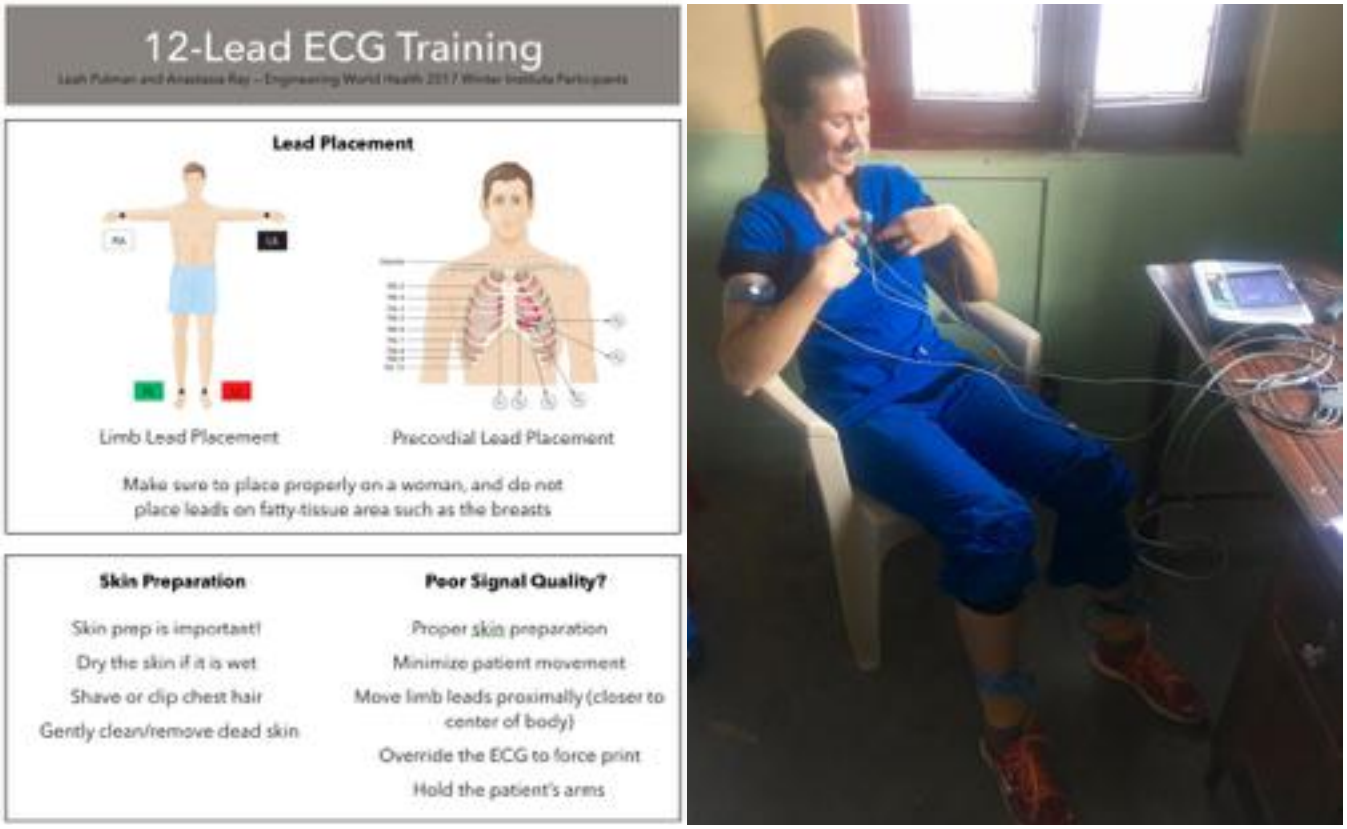
	Type	Problem	Status	Notes
1	ECG	Would not turn on	Complete	No adapter was with the unit so it was not charged. There was also a problem with printing, so that was fixed. Tested the unit on both of us with a nurse. Labeled both adapter and ECG with labels so the two are not separated.
2	ECG	Would turn on but could not hold charge	Complete	New adapter needs to be purchased from either Pokhara or Kathmandu. 12V
3	Pulse Oximeter	Pulse Oximeter	Complete	Replaced batteries
4	Pulse Oximeter	Will not turn on	Complete (and then not repairable)	We fixed it, it was working and was verified by a few nurses in the emergency department, and then 2 days later a nurse brought it and it would barely work. We are not sure what happened, we tried to work on it again but it does not work now.
5	Infusion Pump	Air alarm is being set off	Incomplete	Need a bag to test. The nurses here do not use it and do not know how to. We asked a lot of them in different departments. This infusion pump has not been used in a long time and we are not sure of its complete history here.
6	Dental Chair	Was identified at time of inventory. Leak in basin/body of accessory unit	Incomplete	Repaired one hose that had a hole and cleaned/dried the inside of the unit. We think there are leaks and in general the inside of the accessory unit needs to be cleaned and electrical all closed off from hosing. There is mold developing and a serious hazard for fire.
7	X-Ray View Box	Flickering	Incomplete	The wiring inside is very odd, we think it might need a new bulb and also a more reliable power outlet. They rigged up an “extension” of the cable and it doesnt look the most reliable.
8	X-Ray View Box	Will not turn on	Incomplete	We think it is the same as above
9	Infant Warmer	Assembly	Not repairable	Problem in main circuit board, it will not activate the warmer. Tested by replacing warmer with other that works and it did not turn on. Tested connections and compared to circuitry of the one that works and were not able to figure out the problem.
10	Phototherapy Light Stand	Assembly	Complete	Assembly completed, training completed, quick reference guide currently being made
11	Incubator	Needs new outlet connector	Incomplete	220/230 AC V, 2 prong plug. Tell Laxman to bring a replacement outlet connector
12	Microscope	Low power supply	Incomplete	Light inside microscope is said to flicker sometimes
13	Infant Warmer	Assembly	Complete	Assembled, training completed, quick reference guide currently being made
14	Oxygen Concentrator	No oxygen output and burning smell	Not repairable	Compressor is dead
15	Oxygen Concentrator		Not repairable	Low oxygen concentration, not able to check/verify concentration %
16	Suction Pump	Would not turn on	Complete	Turns on, new hosing, pressure is a bit low but it works

Hospital Personnel Training

Something the volunteer engineer should be prepared to encounter and work to overcome is the lack of English language proficiency outside of Kathmandu. Physicians and hospital administration will be the most reliable when it comes to communicating in English, however the same cannot be said of the majority of hospital staff (including nurses). We recommend finding someone at the hospital that the participants may utilize as a translator for their entire trip, as it will make the entire situation a lot easier.

In response to a repetitive discrepancy in ECG operation (both the Allengers Pisces A 103 and the Kenz Cardico 306 models), a thorough training was given to the nurses in the Damauli Hospital Emergency Department on ECG handling including lead placement, patient physical characteristics and orientation, settings, printing, and importance of not losing adapters.

A visual and verbal demonstration was completed to a team of nurses in the emergency department, with the assistance of our translator Rosan.



Left: ECG Operation Guide, Right: Testing of ECG lead placement

It is recommended that the students in the next program check to ensure the hospital staff responsible for using such equipment are continuing best operation measures, as primary reason for equipment breakage appears to be due to user error.

In addition, training was given on operation, maintenance, and basic repair on the infant warmer and new phototherapy unit. In regard to the infant warmer, it was noted that the temperature shown on the unit was 2 degrees Celsius higher than actual (tested vs multi-meter). This was brought to the attention of the nurses to ensure they do not set the warmer too high. Laryngoscope, oxygen flow rate meter, thermometer, additional probe, and other accessories were shown and properly labeled and stored within the unit.

Left: Training on use of infant warmer unit (phototherapy training was also conducted but no pictures were taken unfortunately), Right: Temperature probe testing to verify correct measurement

Concerning the phototherapy unit, a thorough introduction to importance of phototherapy as primary treatment in neonates with unconjugated hyperbilirubinemia (jaundice) was given to the nursing staff the same day of infant warmer training.

This is the first phototherapy unit to be assembled at the hospital. It was stressed that infants should not be clothed (apart from diaper/cloth) during treatment, should have proper eye protection, rotation of infant body should be observed and maintained to ensure proper coverage, breast feeding should continue as normal, and duration of treatment per degree of jaundice, explained.

Image: Assembly of Phototherapy unit

Interview

In an effort to gain further understanding and insight into the obstacles being faced by Damauli hospital, neighboring health posts, and moreover formulating a general awareness of the limitations of the current Public Hospital infrastructure in Nepal, the volunteers interviewed key hospital staff including Damauli Hospital Superintendent Dr. Rayamajhi, Head Nurse Jamuna Sharma, Dr. Suman Parajuli, and staff statisticians with the aim of giving direction to AHCN and EWH for future planning of programs. Interviews with staff at Bhimad Health Post is included in the respective section.

The meetings contributed significantly to understanding the hospital within a broad public health context, demographics, needs assessment, inventory and equipment availability/status, outlining future opportunities, and more. The nature of some of the concerns are beyond the scope or responsibility of AHCN/EWH, but are listed nonetheless.

The needs noted include:

- Citizens of all communities do not yet have reliable and affordable access to health care as aspired by the government.
- Despite the continuous effort of the state, about a half of children under the age of 5 and women of reproductive age are undernourished whereas the problem of obesity is growing among urban population.
- Prevalence of cancer, hypertension, diabetes, and illnesses related to the heart, kidneys, liver, and lungs, along with other non communicable diseases like mental illnesses and dental problems are on the rise.
- The government has not been able to provide priority on primary health care programs in urban areas, health of senior citizens, attention to mental disorders, genetic and congenital diseases, environmental health, occupational hazard, sexual and reproductive health of adolescents and health promotion of school-age children. Adequate programs should be created.
- Access to quality medicine for people, including the production, distribution, and use of essential drugs should be addressed
- Laboratory services and medical equipment are not yet up to a quality standard.
- There are issues involving a standard in the required skill-sets of health and hospital administrative professionals, including job retention and transfer. Additionally, there has been difficulty in effectively regulating the laws set forth by the health sector as there is a lack of harmony between organizations producing health personnel and those utilizing them.
- Appropriate implementation of a two way referral system in order to improve the quality standard of health care services.
- Immediate management of highly infectious diseases or potential new diseases, and emergency preparedness, for the goal of minimizing human casualty due to earthquakes and other natural disasters, and as such, retrofitting of hospitals and other health institutions accordingly.
- In order to reduce newborn, child and maternal mortality rate, there is a need for maximizing the effectiveness of controlling diarrhea, acute respiratory infection, malaria, kala azar, encephalitis, filariasis, dengue, tuberculosis, leprosy, HIV, and/or other diseases that can be prevented through immunization.
- Vertical integration and strengthening of health institutions with the establishment of a social health insurance system so that health services, health education and information are equally available for all citizens.
- Increasing the government's investment to the health sector in proportion to population growth.
- Promote investment in providing all necessary health services to the people with blindness/visual impairment, hearing impairment, mental impairment, and physical impairment.
- Empowering local governments and holding them accountable for health services along with improving community participation in rural health programs.

Bhimad Health Post

Health Posts that refer patients to Damauli Hospital are Bhimad, Porundihi, and Bandipur Hospital. The volunteers were not communicated the details of these locations until late in the second week of the program and thus time was only made to visit Bhimad Health Post. It is highly recommended that either a coordinator or future students contact the health posts upon arrival in Damauli in order to assess amount of work and prioritize accordingly. Details on logistics of each placement will be communicated clearly to the students and applicable coordinators. (Expect 2 hours of transit time in one direction to either of the locations, thus an overnight stay is recommended)

Hospital Overview

Bhimad Health Post is a public clinic, located 1.5 - 2 hours outside of Damauli on route to Pokhara (30 minutes from Pokhara by bus). The health post serves approximately 3-4,000 people, has 4 beds (1 in emergency and 3 in maternity) and offers the following services:

- comprehensive obstetrics and gynecology (the same as in Damauli),
- minimal dental,
- emergency,
- malaria testing and other lab diagnostics (less capabilities than in Damauli).

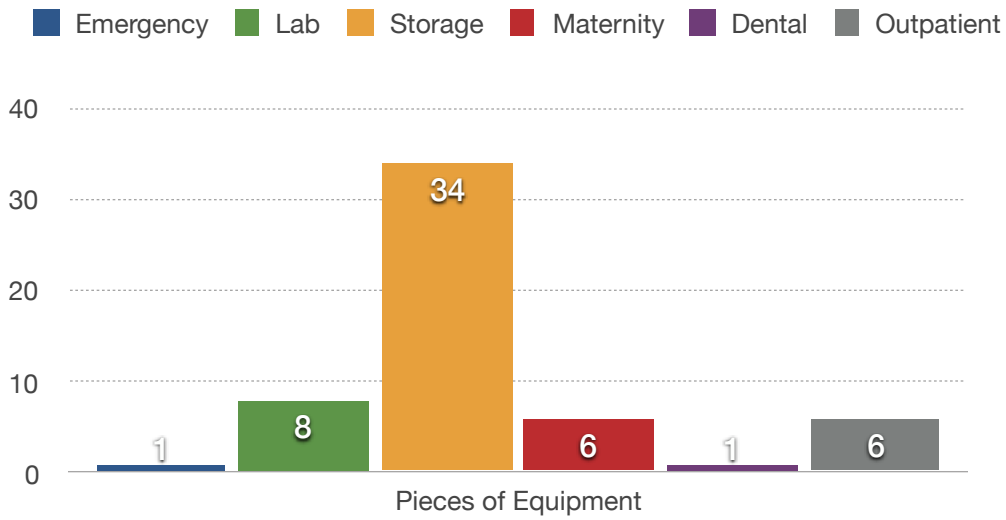
Images: Bhimad Health Post Complex

General information on the health post and surrounding area:

- Physician in charge is Dr. Bonu Goudel - she is fluent in english and was very helpful. She is looking forward to having students come in future programs.
- Housing options: 1 female student can live with Dr. Goudel in a guest house right above the health center. Other cheap options are available in Bhimad at ~ 500 rupees/night. Might be able to arrange homestay as well
- Reliable wifi is available at the health post
- It is very safe, no problems

As observed at Damauli Hospital, the equipment in the health post comes mainly from the government of Nepal (local and central supply) but there seems to be a misalignment in needs versus supply. The last equipment to have been installed was an infant warmer 2 months prior (October 2016), but besides that nothing had been donated within 2+ years. There is no biomedical engineering department and hence no preventative maintenance or technicians available for repairs are available unless requested from Kathmandu. There is also no inventory system.

Inventory and Department Notes



There were 56 total pieces of equipment accounted for, not including beds. The following is a summary by department including equipment and brief notes. The inventory data is attached in the Appendix.

Maternity

As one of the busiest departments, the hospital has an average of 25-30 births per month. Infant and/or mother mortality rate data was not taken. There is one operation room, dedicated for natural births and cesarean section operation. The nurses have some basic proficiency in English.

Quantity	Equipment Type	Notes
1	Infant Warmer	Installed 2 months ago
1	Oxygen Concentrator	Operational
1	Infant Scale	Operational
1	Foot Suction Machine	Operational
1	Suction Machine	Repaired
1	Pressure Regulator	High vaccuum, low flow

Image: Repaired suction machine

Outpatient

Within the outpatient department one of the most prominent activities we saw were pre and post natal check-up of mothers, immunizations, ultra-sound and then general health concerns of the population (COPD, influenza, hypertension, lab testing, etc,.) This health center has a very limited outpatient department and most severe health conditions are referred to Damauli or Pokhara. The Otoscope has no battery, as the rechargeable battery was thrown away due to a misunderstanding that it could be charged.

Quantity	Equipment Type	Notes
1	Compressor Nebulizer	Repaired
1	ECG	Repaired; powers on and showed how to print
1	Otoscope	Not operational; Needs battery, look at picture
2	Stethoscope	Operational
1	Nebulizer	Repaired

Left: Repaired Nebulizer, Right: Broken Otoscope

Dental

Quantity	Equipment Type	Notes
1	Dental Chair (basic)	There is one dental technician that can do basic check-up and care, however all complex dental procedures are referred to Damauli or Pokhara. There was no dental equipment accounted for.

Laboratory

The lab can test for TB, Malaria, screen for HIV, and test for Hep B and C. A general observation is that not all of the equipment was connected to a surge protector.

Quantity	Equipment Type	Notes
1	Serological Water Bath	Operational
1	Water Bath	Operational
1	Hot air oven	Operational
1	Centrifuge	Operational
1	Centrifuge	Not repairable unless someone is able to fix the motor
1	Colorimeter	Operational
2	Micropipette	Operational, 1 repaired

Image: Specifications of broken centrifuge

Storage

Quantity	Equipment Type	Notes
1	Refrigerator	Operational
1	Refrigerator	Would like repaired. It does not turn on. Has been broken for 1 year
1	Refrigerator	Would like repaired. It does not turn on. Has been broken for 1 year
1	Medical Oxygen Cylinder	Not Operational, needs to be refilled or replaced
30	Blood Pressure Cuffs	Returned 14 to service

Left: Blood Pressure Cuffs, Right Images: Oxygen Cylinder (and set-up)

Repair Summary

A total of 56 pieces of equipment were accounted for as out of service (30 of which were blood pressure cuffs). 14 blood pressure cuffs were returned to service, 4 other pieces of equipment were also returned to service, and 2 were not repairable.

#	Type	Problem	Status	Notes
1	Blood Pressure Cuff	Broken regulators, holes in hoses	Complete	I fixed 8, there was another worker helping me and I think he fixed 5-6. They had about 30 that were broken but when asked, the doctor said they only use about 5
2	Nebulizer	Would not turn on	Complete	Slight user error. Adapter is needed since plug doesnt stay in.
3	Suction Machine	Not sucking	Complete	User Error. They were putting a thinner hose into the patient side and it was losing all pressure that way. I showed the main nurse that uses it how to avoid the problem.
4	Micro Pipette	Part of it was broken off	Complete	Piece glued back on. They have two of these
5	ECG	Would not turn on and “would not print”	Complete	They were not charging the ECG and the printing problem was simple user error. The doctor mentioned she does not use the ECG much.
6	Centrifuge	Would not turn on	Not repairable	Dead motor, it is a really old piece of equipment in general (and they have had this one out of service for 2 years) and they have a new one that they use.
7	Oxygen Cylinder	No oxygen	Not repairable	No oxygen. Needs to be replaced or refilled. Explained to the doctor and nurse that it only had approx. 66 hours of lifespan.

Interview

After interviewing Dr. Bonu Goudel it became apparent that the general population in the area lacks education in basic healthcare and does not know when to come to the clinic or hospital, often waiting too late. Also, family planning has become a new priority to expand on as there has been improvement in infant mortality rate, however the average age for young women having children is ~15/16 years old.

Additional recommendations include the formation of programs that provide women’s hygiene items such as pads and tampons, nutritional supplements, and other necessary items for women in the stages of adolescent development and also for pre- and post-natal care.

Additionally, it was stressed that a common problem observed is patients arriving too late, resulting in the condition or disease at a progressed stage, thus harder to treat locally. There should be more community involved education programs that informs about the importance of coming to the health post/hospital at an earlier stage as well as other basic health information.

Amppipal Community Hospital

Amppipal Community Hospital is located in the district of Gorkha, Nepal. It is approximately 6 hours northwest of Kathmandu and may be reached easily by bus. The nearest biggest city, airport, and private hospital is located in Pokhara.

Left: Map of location, Right: View of Amppipal Community Hospital

The hospital is equipped with 55 beds, an ICU, 2 Operating Rooms, a delivery room, a dentist, X-Ray, and Physiotherapy. There are 2 staff physicians (one of which is a German Volunteer Physician) and 7 Nepali residents. There were 99 pieces of equipment recorded. There is a well established inventory system that is maintained, preventative maintenance that is completed and well marked and stored, and even some spare parts available.

A primary partner and supporter of the Amppipal Community Hospital is a german non-profit organization, Nepalmed. Nepalmed is focusing on helping in all aspects of medical life and services, investing financial resources as well as lot of time in the maintenance of existing hospital buildings. In order to modernize the entire infrastructure of the hospital Nepalmed organized many items such as: a photocopier, a micro centrifuge, 2 autoclaves, various medical instruments and implants, a new operation table, a delivery bed, an anesthesiological trolley including equipment, a repair kit for the generator, an ultrasound unit, new patient beds and warming quilts, a drinking water filter device, a warm water dispenser for the washroom in the operation unit, another modern incubator, a phototherapy unit for newborns, and a laboratory analyzer.

With a donation from the city of Warburg a new X-Ray unit from Siemens was installed at the hospital. In co-operation with the NGO "Dentists Without Limits" a complete dental unit including x-ray and mixer for fillings was installed. Furthermore, European dentists come frequently for short services in order to help the local staff with dental treatment.

Patient charges are moderate compared to other hospitals:

- Consultation charges are 25 NPR (OPD) and 250 NPR for emergency
- Hospital bed charges are 110 NPR per day while a bed in a private room costs 350 NPR per day
- Cost for a small operation amounts to 350 NPR whereas a large surgery can range up to 13,000 NPR including anaesthesia, operating theatre, consumption materials such as syringes, needles, gauze etc,.
- Delivery is free of cost.
- For patients older than 70 years the hospital grants a discount of 25% on bed charges.


Left: Physiotherapy Care Room, Right: Sam Warner, Andreas Lipphaus, Reece Stevens, Laxman Bushal

Repair Summary

#	Type	Problem	Status	Notes
1	Infant Incubator	Power Supply	Complete	Rebuilt with parts from two others
2	Surgical Lamp	Bulbs missing, voltage meter drawing power away from the circuit	Complete	Rewired and replaced bulbs
3	Oxygen Concentrator	Tube from canister disconnected, missing cooling fan	Complete	Reconnected tube and replaced fan from broken concentrator
4	Dental Drill	DC motor was stuck due to rust	Complete	Opened, cleaned, oiled, and tested
5	Phototherapy Unit	Missing lightbulbs and bulbs' sockets were corroded	Complete	Replaced bulbs and soldered new bulb socket connections
6	Pulse Oximeter		Complete	
7	Blood Glucometer		Complete	
8	Heating Unit		Complete	
9	Water Heater		Complete	
10	Fetal doppler		Complete	
11	Voltage regulator		Complete	
12	IV Warmer		Not Repairable	
13	Oxygen Concentrator		Not Repairable	
14	Autoclave		Not Repairable	
15	Calorimeter		Not Repairable	
16	Ultrasound		Not Repairable	
17	Wet Dressing Heater		Not Repairable	

Power Supply

It was identified in the Operating Room that during certain operations the power would fail. The engineers came to the conclusion after evaluating all draws of current in comparison to the supply, the X-Ray should be connected to a separate power grid.

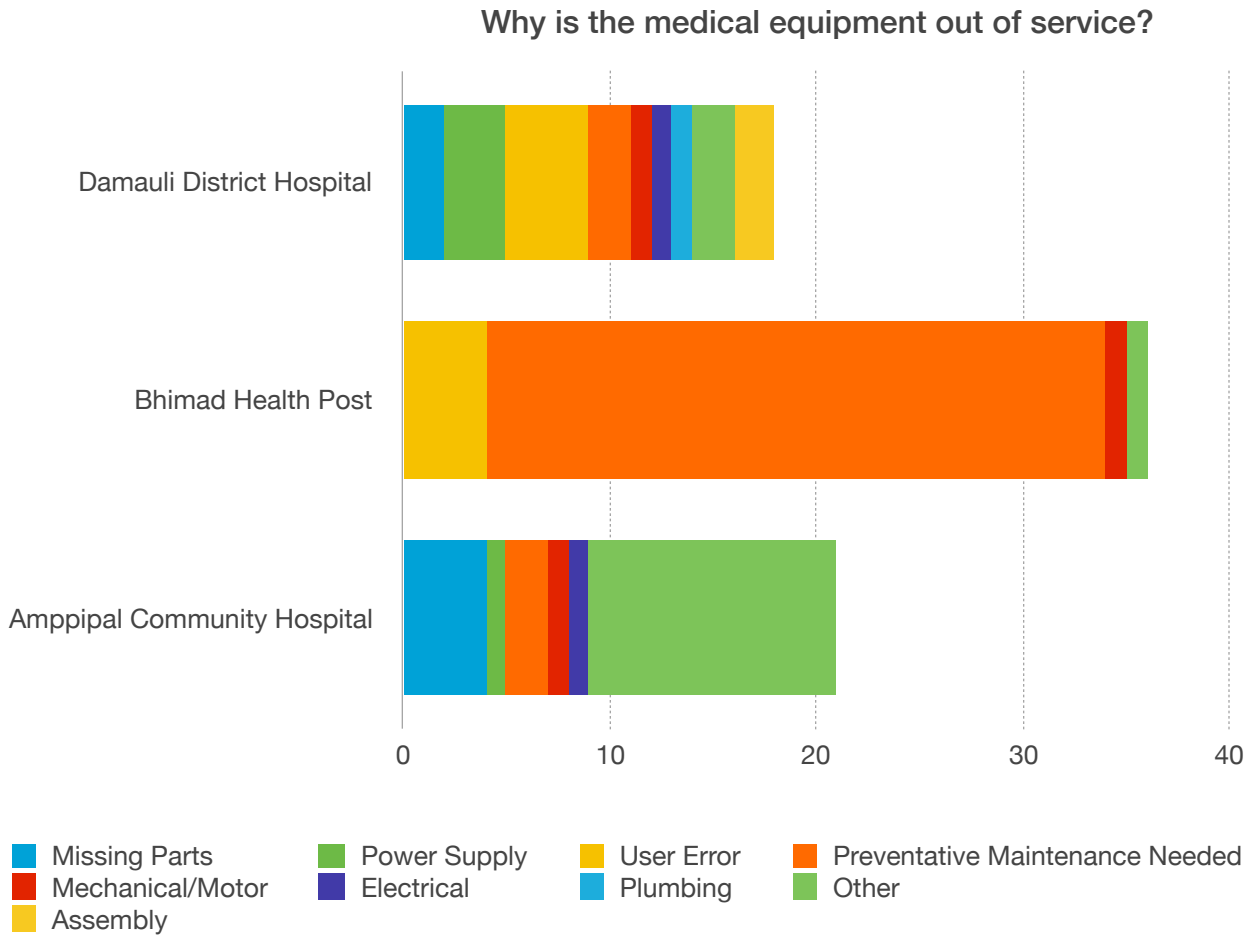
32 Amp Supply

Source	Current Draw (Amps)
X-Ray	27.0
Suction Machine	3.3
Oxygen Concentrator	1.3
Patient Warmer	4.0
Ventilator	6.5
Electrosurgery Unit	4.4
Hand Drill	2.7
Total Draw	49.2
Overdraw	17.2

Above: Andreas Lipphaus troubleshooting an infant incubator, Below: Andreas and Sam working on equipment

Conclusion

Data based on equipment repair between Damauli District Hospital, Bhimad Health Post, and Amppipal Community Hospital



Based on the above, a few basic correlations can be drawn between the sources of equipment failure:

- Rural area health posts (Bhimad) have a higher need for preventative maintenance (on basic equipment such as blood pressure cuffs).
- Larger hospitals (Amppipal and Damauli) have a higher technical/complex level of equipment which suggests there is more user training that should be involved.
- Adequate power supply and ensuring the sources are not overexerted, as well as implementation of surge protectors, can perhaps diminish the amount of related issues.

Recommendations and Final Thoughts

- Communication in form of meetings between hospital leadership and staff was recommended by the group to be increased in frequency from monthly to at least every two weeks to ensure that every day challenges of hospital staff are solved with less delay.
- Currently there is minimal communication and knowledge-sharing regarding correct use of equipment internally at the hospital.
- Staff may not be informed that the equipment they need might be available and unused in a neighboring department, thus organization of storage and equipment room recommended
- Inventory System for all medical equipment including frequent maintenance and update of the system recommended (this could also serve as a potential project for future EWH programs)
- Importance of preventative maintenance for all medical equipment and training of the user responsible conveyed to hospital administration
- Upon departure from Damauli, we received a call from Dr. Ram at Bandipur Hospital regarding a broken analyzer in their lab. Unfortunately it was too late for us to be able to visit them and this is a potential equipment repair opportunity for the next group of volunteers (if it is not repaired until then).
- Dr. Goudel mentioned their computer is in need of repair (to be verified before next program) in the case that there is a participant that enjoys working on computers
- Inventory of equipment and equipment needing service has been requested from Porundihi and Bandipur.

Opportunities for future participants could include developing:

- A locally designed and sourced solution to heating living spaces.
- There are only 2 infant warmers in Damauli, and one in Bhimad. Perhaps this could be a design project opportunity for infant incubator or warmer?
- Water distillation unit(s)
- Hand Sanitizer Dispensers
- Construction of designated Biomedical Engineering/Equipment Maintenance work area
- Training courses/guides for equipment repair and preventative maintenance

Contact Information

Location	Person	Phone Number	Email
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Damauli District Hospital	Rosan (translator, works in IT)	9846471662	
Damauli District Hospital	Ram Bahadur	9846092950	
Bhimad Primary Health Post	Dr. Bonu Goudel (Miss)	9846728304	bonugoudel@gmail.com
Porundihi Primary Health Post	Dr. Ashok Chapengyne	9845088536	
Bandipur Hospital	Dr. Ram	9841295964	
Amppipal Community Hospital			

Appendix: Inventory and repairs

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