Applications of Wood's Lamp Technology to Detect Skin Infections in Resource-Constrained Settings

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Abstract- **Skin diseases such as Tinea Capitis, Scabies and Erythrasma are serious and common problems in developing countries. Unfortunately they are often overlooked and left untreated, causing extreme discomfort to those afflicted. Their contagious nature is also compromising to community health as a whole. Early detection of opportunistic infections often leads to the diagnosis of more serious immuno-compromising diseases such as HIV. This article investigates the feasibility of using a UV light source called Wood's Lamp to detect the presence of select fungal, bacterial and parasitic skin infections. A Wood's Lamp is based on fluorescence – the phenomenon by which light excites valence electrons in certain fungi and bacteria and results in a fluorescent emission visible to the naked eye. Traditional Wood's Lamps use UV tube lights that are fragile and unsuitable for the harsh operating environments of developing countries. The recent emergence of UV LED-based lamps has led to compact, ruggedized and low-cost devices with good contrast that can be used by low-skilled health workers. This article synthesizes the capabilities and applications of this proven effective yet underutilized technology and illustrates how it can be integrated into fledgling healthcare systems in developing countries.**

Keywords—Wood's Lamp; community health workers; skin infections; fluorescence

I. INTRODUCTION

The World Health Organization estimates that approximately 25 percent of the global population is currently living with a superficial skin infection [1]. Certain factors can cause this percentage to be even higher in isolated areas. These factors include, but are not limited to: higher temperatures, lower socio-economic status, and immuno-comprised populations. Fungal infections tend to thrive in temperatures of 25-28 degrees Celsius – this includes most areas of the tropical band, which is the area of the globe between the Tropic of Capricorn and the Tropic of Cancer. This region contains much of the developing world. These areas of lower socio-economic status struggle to combat skin infections partially due to the fact that these populations tend to live in closer quarters and do not prioritize hygiene [1]. Many skin infections are opportunistic pathogens, meaning they may not affect someone with a healthy immune system, but could cause a severe affliction in an individual with a weakened immune system. HIV/AIDS weighs heavily on the burden of skin disease by weakening the immune system of infected individuals. In fact, skin infections are frequently the first sign of the conversion of HIV to AIDS. Approximately 90 percent of individuals who are HIV positive will develop a skin infection at some point in their lifetime [2]. All three of these characteristics pertain to the developing world where skin infection rates can be as high as 87 percent of the population [2]. Despite this, skin infections are rarely recognized as a major public health problem.

Skin infections are not only a major burden to the population as a whole, but they also significantly impact the infected individual. These infections significantly reduce quality of life due to disfigurement and disability. Incorrect classification of skin infections, by individuals themselves, inhibits the screening and treatment of these infections due to confusion and misconceptions. Many of those interviewed in Nyeri, Kenya, while fieldwork was being conducted, incorrectly cited both allergies and sunburn as skin infections. Misconceptions such as these can lead to incorrect treatment or lack of treatment at all, resulting in more serious complications.

For the purpose of this article, the term, skin infection, will be limited to superficial skin issues caused by bacteria, fungi and parasites. These infections can have uncomfortable symptoms such as intractable itch, open sores, hair loss, skin discoloration and even permanent nerve damage. They can result in decreased productivity at work or school, as well as more severe consequences such as social isolation. This isolation is not without reason, considering that many superficial skin infections are highly transmissible through contact. Due to a lack of knowledge and ineffective healthcare systems in these areas, treatment is typically hard to come by and unsuccessful. Currently in the developing world, skin infection treatments have failure rates greater than 80 percent [3] - and many more go without treatment at all.

Due to a lack of trained health professionals in the developing world, an increasing number of community health workers (CHWs) are present in these areas to increase local accessibility to healthcare. CHWs are leaders within the community who provide basic, pre-primary healthcare to residents of their villages. They are especially available in rural areas, where primary care settings may be non-existent. These health workers have established positive relationships within the community built heavily on trust. CHWs strive to provide services in maternal and diabetic care as well as basic health education associated with living a healthy lifestyle.

This article focuses on the feasibility of integration of Wood's Lamp technology in order to detect skin infections in

the developing world. It addresses the capabilities of Wood's Lamp, its current applications, and the proposed pathways and challenges that are associated with successful integration into fledgling healthcare systems. In order to validate these applications, field work was conducted over a three week span in Nyeri, Kenya. Extensive interviews were carried out with Community Health Workers, nurses, physicians, and members of the community that are affected by skin infections. Health professionals were targeted as the possible users of Wood's Lamp to aid in diagnostics and to help the community members that they serve. This article synthesizes the insights gained through these interviews.

II. Wood's Lamp

Dermatological offices utilize a multitude of methods and equipment in order to diagnose patients with skin infections. One type of device, a Wood's Lamp, can screen for a few of these skin infections using fluorescence. The major applications of Wood's Lamp technology are discussed in this section.

A. Technology

Wood's Lamp is a long-wave ultraviolet light (black light) source that can stimulate fluorescence and is currently used as a screening procedure in dermatology offices across the United States. It was invented by Robert Williams Wood in 1903, but the light was not originally created for dermatology. It wasn't until 1925 that a Wood's Lamp had a dermatological application when Margarot and Deveze used the light to detect fungal infections in the hair [4]. The lamp itself is composed of a high-pressure mercury arc with a compounded filter of barium silicate with 9 percent nickel oxide. The filter has a peak at 365 nm and a complete band between 320 and 400 nm [5]. When the wavelength hits auto-fluorescent tissue in an infection, electrons in the skin absorb energy that causes them to jump to higher, unstable energy levels. When they fall from these higher energy levels, radiation of longer wavelengths is emitted in the form of visible light. When this device is held approximately four to five inches from the skin in a dark room, it can excite these electrons in areas of the skin where the infection is present. Normal skin will not glow under the lamp, but infected skin will fluoresce. Wood's Lamp is a common, first-step method towards diagnosing skin infections in the United States.

B. Current Use in Dermatology

Wood's Lamp is currently used in dermatology offices in the United States as a way to screen and verify various skin infections. However, Wood's Lamps in dermatology offices are bulky, expensive, and rely on a power cord, which make them difficult to integrate in healthcare systems in resource-constrained settings. In the United States, there are now more advanced methods and tests for diagnosing most infections, such as KOH tests and microscopic samples, which are not feasible to conduct in the field. Due to the fact that Wood's Lamp testing is non-invasive and quick, it can be easily implemented in many contexts.

C. Detectable Infections

Table I. displays common skin infections that fluoresce under ultraviolet light and are also prevalent in Sub-Saharan Africa. Their causes vary from bacteria, fungus and parasites. Table I specifies the color that these common infections emit while under the UV light.

TABLE I: Prevalent Infections

Infection	Cause	Color
Tinea capitis	Fungal	Blue-green
Tinea (Pityriasis) versicolor	Fungal	Yellowish green or orange
Erythrasma	Bacterial	Red
Scabies	Mites	
Vitiligo	Cell death	White
Porphyria cutanea tarda	Genetic or exposure	Red-pink
Pseudomonas infections	Bacterial	Green
Information taken from: [6]–[8]		

1) Tinea capitis

Tinea capitis is a fungal infection of the scalp that is more commonly known as ringworm. The infection can develop if someone does not bathe or wash his/her hair often. People who have this itchy infection normally present with areas that appear to be bald or have suffered hair loss. Tinea capitis is normally treated with either an antifungal topical cream, which is applied to the infected area or medication that is taken orally for four to eight weeks [9]. The infection can spread easily so it is important to clean any items that may have come in contact with the infected areas, such as bedding and towels, to reduce the risk of transmission.

2) Tinea versicolor

Tinea versicolor, a fungal infection, occurs when yeast that is normally present on one's skin grows out of control. This infection normally clears up on its own in cool, dry months, due to the fact that yeast prefer hot and humid environments. For people who live in tropical and subtropical climates, the constant humidity inhibits the infection from clearing. Tinea versicolor is enabled by sweat and oily skin. It is also more common in people with weakened immune systems. Some of the symptoms include spots that are lighter or darker than the surrounding skin. These spots are normally dry and scaly, grow slowly, and can combine to make patches. Treatment methods consist of medication that can be applied to the skin, medicated cleansers, or anti-fungal pills [8].

3) Erythrasma

Erythrasma is caused by the bacteria *Corynebacterium minutissimu.* This infection is more likely to develop in warm

climates and in people who are overweight or have diabetes. The infection appears as reddish-brown, slightly scaly patches on the skin that are normally itchy. These spots normally occur in the folds of the skin. Treatment consists of antibacterial soap or erythromcycin gel [10].

4) Scabies

Scabies is caused by a mite that burrows under the top layer of the skin. Once the mite burrows, it could take 2-6 weeks for symptoms to occur if the infected person has never had scabies before, and only 1-4 days if he/she has previously had it [11]. Scabies often causes raised bumps on the skin that are extremely itchy. A more serious form of scabies, referred to as crusted scabies, consists of thick crusts that form on the skin. The severe itchiness of both types of scabies often results in open sores. These leave the patient at a much higher risk for a secondary bacterial infection. If these secondary bacterial infections are left untreated, they can enter the blood stream – causing sepsis. [11]. Scabies is transmitted through prolonged skin-to-skin contact, so anyone who regularly comes in contact with the infected person must also get treated. Sharing of household items, such as towels, bed sheets, or clothes, is an example of this regular contact. The most common treatment is the use of a topical cream.

5) Vitilgo

Vitiligo is a condition where melanocytes die. Melanocytes are the cells that contribute to someone's skin and hair color. The death of these cells causes the affected areas to lose all pigment. There is not one demographic that has a higher number of these infections, but many people with vitiligo also have an autoimmune thyroid disease [7]. Once the skin has lost its pigment it is very rare for it to regain its color. Therefore, treatment methods are not used to cure vitiligo but instead are utilized to try to help restore the lost skin pigment. These methods consist of cosmetics, medicine that is applied to the skin, light treatment or therapy, and possibly surgery.

6) Porphyria cutanea tarda

This condition is due to an enzyme deficiency that is normally acquired but can be genetic. The symptoms consist of blisters that develop in areas that are exposed to the sun, increased hair growth, and darkening or thickening of the skin. The current treatment methods aim to remove the factors that activate the disease and the most common way to do so is by removing blood [12].

7) Pseudomonas infections

Pseudomonas infections are caused by the bacteria *Pseudomonas aeruginosa*. Healthy people normally carry these bacteria but when someone is weak or ill the bacteria can cause an infection [13]. These bacteria can cause many types of infections all over the body depending on which area is the most vulnerable to infection at the time. This infection can cause rashes on the skin if the area is exposed to a moist environment. Treatment can be difficult because the bacteria is resistant to many types of antibiotics. Because of this, different antibiotics may be used until one is proven to be effective.

D. Other Applications of UV Light

Wood's Lamp can be utilized for a multitude of purposes in addition to dermatological uses. It is often used in forensics to detect serum and blood, as well as in hard water detection and fraud detection of currency. Wood's Lamp can also be used in the food industry to test if some products have been contaminated. Pseudomonas can infect milk through infected water that comes in contact with it when the equipment is being cleaned. The bacteria can dominate the surface and cause discoloration and release volatile compounds. A Wood's Lamp can detect the presence of these bacteria on the surface of cheese [14].

Another application of Wood's Lamp is in food sciences. Vitamin D is a vitamin necessary to maintain bone health and regulate the immune system. It can be found in common foods, such as fatty fish, fortified cereals, milk and orange juice. People often do not consume recommended amounts in their diet, although exposure to the sun's ultraviolet rays can solve this. The UV light sparks a conversion of cholesterol in the skin to convert to vitamin D. Michael Kalaras, a post-doctoral scholar in the Food Science Department at The Pennsylvania State University, is doing research on using UV light exposure to increase the concentration of vitamin D2 in mushrooms [15]. Three main groups of wavelengths were tested and all three resulted in an increase in vitamin D2 levels. In pulses lasting as little as one second, mushroom vitamin D content can be increased from almost none to 600 IUs, or the daily recommended amount. The mushrooms will also maintain this amount of vitamin D for up to a week after UV exposure if refrigerated. It is possible to get sick from too much vitamin D, but researchers assure that worrisome levels are extremely high and people are unlikely to reach them accidentally. Many skin infections that plague the developing world are opportunistic infections. Therefore, increasing intake of vitamins that regulate the immune system could be very beneficial to the decrease of such infections.

III. APPLICATION OF WOOD'S LAMP IN DEVELOPING COUNTRIES

In the developing world, there is a general lack of physicians. Although there are a multitude of reasons for this, one is due to "brain drain," - educated doctors leaving the country to seek a better standard of living and pay elsewhere [16]. Furthermore, specialized physicians, such as dermatologists, are even more difficult to come by. In South Africa, one of the most developed African countries, there is only one dermatologist for every three to four million people, and most of these dermatologists reside in urban areas [17]. This lack of professionals impacts how and if a patient gets diagnosed or treated for a skin infection. Currently patients are obtaining treatments solely based on their observed symptoms and without a diagnosis from a medical

professional. This system of diagnosing can be inaccurate and lead to mistreatment of the infection, if it is treated at all. The most common types of medication for skin infections include a broad span of antibiotics and antifungals. One antifungal may treat a variety of fungal infections and, similarly, one antibiotic may treat various bacterial infections. Although each type of treatment can be used for various infections, it is extremely important that an antifungal treatment is not used on a bacterial infection and an antibiotic is not used on a fungal infection. If a patient were to incorrectly take an antifungal when they needed an antibiotic it could lead to liver damage, and if the inverse occurs they could develop antibiotic resistance, increased susceptibility to fungal infections, and damage to good bacteria [18]–[20]. The issue of skin infections in the developing world is so extensive that it will be hard to find one solution that resolves it, but a method of proper diagnosis is a promising start.

A. Stakeholders' Perspectives

The following sections detail information gathered through discussions with 15 households, 5 chemists, 115 CHWs, 5 clinics (often nurses who worked at these clinics), and 2 specialized physicians who were all located in Nyeri, Kenya.

1) Households

Local households were interviewed regarding skin infections and associated knowledge. All fifteen verified that clinics and doctors were only visited when someone was ill. The concept of yearly, or regularly scheduled, check-ups did not exist. The number of visits to clinics and doctors also varied with income levels. The wealthier households interviewed had a proficient understanding of the importance of receiving a diagnosis from a medical professional. Herbal remedies were mentioned as possible treatment methods, but this was not an overly common response. Others of lower income admitted to self-diagnosing and visiting chemists, often citing financials as a reason. One household admitted to having never visited a physician. Though some of these lower-income households understood the idea of transmission through contact, members of the house shared many items on a regular basis. Many children end up sharing bedding and clothes, which exponentially facilitates the spread of infections.

Overall, the knowledge level about skin infections was low. Multiple households claimed knowledge through experience. Once members of the family had been affected by a specific infection, they felt comfortable obtaining treatments for seemingly similar infections without consulting a medical professional. There also was a lot of confusion associated with the definition of a skin infection. Households named sunburn, dandruff, spider bites, chicken pox and allergies when asked about common infections.

It was concluded that a screening tool that provides visual confirmation of an infection would be beneficial to push members of the community to seek proper care. Due to a lack of education on the topic, it would be important that visual confirmation occurs for a large variety of infections. Wood's Lamp provides visual feedback for a select few infections present in the area. Using such a tool in the community could easily lead to confusion and a false sense of security if an infection was present, but did not fluoresce.

2) Chemists

Chemists, businesses that provide medications, that were interviewed in the area provided medications for all types of medical ailments. For skin infections, specifically, they had both topical creams and oral medications. These included both general antifungal and general antibiotics. Personnel behind the counters were rarely trained in the health profession. Because of this, their primary focus was to sell medications, regardless of a correct prescription. Personnel did specify a great need for skin infection treatments in the community. Through research it was found that they most often recommend topical creams to customers before oral medications. In all cases, the creams are inexpensive compared to oral medications and fees associated with visiting a clinic or hospital.

3) Community Health Workers

Community health worker education sessions were conducted throughout the time spent in Kenya. Presentations that focused strictly on the causes, symptoms and prevention of common skin infections were given to over three hundred community health workers. These provided access to talk to many CHWs about skin infections in their local communities. Most said skin infections were very common in the areas where they worked. While some community members presented them to the CHWs, many more did not, even though they were clearly visible. CHWs speculated that social stigmas played a role in a community member's willingness to acknowledge and treat skin infections. Furthermore, they described how some community members do not believe that skin infections exist.

The knowledge levels varied greatly between CHWs. While some had a comprehensive understanding of symptoms, transmissions and the need for a correct diagnosis, others admitted to having no training on skin infections making them unable to provide education to community members. A lack of knowledge was an even larger issue that arose in rural locations. Similar to the data collected from the visited households, many CHWs incorrectly cited skin-related conditions as skin infections. Regardless of knowledge level, CHWs unanimously agreed that they would refer infected patients to local clinics and dispensaries, and all CHWs expressed interest in obtaining more information about skin infections.

Currently, CHWs have no tools to detect or screen for skin infections. Many are working in areas well below the poverty line, where infections such as scabies run rampant due to the ease of transmission. The CHWs voiced repeatedly that poor hygiene played a large role in this issue. Though they could educate the communities on cleanliness, the

community members lack the financial means and resources, such as clean water, to improve their conditions. Because these areas are financially restricted, they also struggle to seek care from medical professionals when sick. Therefore, CHWs are a very valuable intermediate source of healthcare, and the community would benefit greatly from the CHWs having a method to detect or screen for skin infections.

The device, a handheld form of Wood's Lamp, was introduced to the community health workers in order to gauge understanding, potential usability, and feasibility of integration. CHWs agreed that the device's metrics were appropriate for the context and that the community would be interested in being screened. However, their varying levels of knowledge proved to be too wide for the device to be feasible, as it would be extremely difficult to effectively train those with little understanding of infections. Furthermore, because the device only detects a select few infections, confusion could easily arise and hinder correct care. Although these CHWs have desirable access to communities with the greatest need for proper healthcare, there are too many variables that could lead to the failure of Wood's Lamp technology being successfully integrated into this system.

4) Clinics/Nurses

Nurses at clinics across the region provided information on the prevalence of skin infections in the area. Many mentioned a large variety of infections over a wide age range of patients. Across all demographics, nurses explained that intractable itch and infections in visible areas, such as the face, neck and arms, contributed to the likelihood of seeking care at the clinical level. They also often saw patients who had first attempted to self-treat infections which led to worsened conditions. If a patient's condition were too severe, these clinics directed them to seek care at local hospitals.

Diagnoses are made at clinics based off of observations, symptoms, and history if applicable. While this yields better results than self-diagnosis due to higher education levels than the general public, there are currently no tools being used to aid or verify diagnosis. Due to the wide range of infections presented, Wood's Lamp technology would be too specific to be of use. Therefore, a more general tool to aid in diagnosis would be beneficial in this context.

5) Specialized Physicians

By speaking with specialized physicians, one in a hospital and one in a private setting, it was confirmed that the common skin infections in the area matched those found in research. While the Wood's Lamp device can detect some of these common infections, they are often not what patients visit these physicians for. The private dermatologist explained that people who come into his office have tried everything else prior to visiting him. He added that everyone in the area is a self-proclaimed doctor – meaning his patients consult family, friends and neighbors before actually visiting a health professional. This is due to financial constrictions, as the cost to visit a private physician starts at 3,000 KSh for a basic consultation. This cost can be as high as 10,000 or 15,000 KSh, which is out of the affordable range for a large percentage of the local population.

Many of the diagnoses made in these settings are based off of the history of the patient, examination and clinical suspicion. If these three factors are inconclusive, further tests such as skin smears and basic KOH tests are available. These tests can be carried out with ease in doctors' offices for a relatively inexpensive cost.

A Wood's Lamp device is too basic and specific to be of practical use in these settings. Both physicians were comfortable with the diagnostic methods currently used. When it was inquired what technologies would be of practical use, both physicians agreed that more advanced technology would aid in diagnosis. They voiced that many of these devices that would be helpful to them do currently exist, but financial restrictions limit their utilization.

B. Contextual Challenges

These contextual challenges relate to the culture and practices in resource-constrained settings like Kenya. Information found in this section was obtained through interviews with health professionals and community members in Nyeri, Kenya, as well as observations in the field.

1) Infrastructure Resource Limitations

In the developing world, communities lack resources such as electiricity and access to physical parts, which include lightbulbs and batteries. Because electricity is not as readily available in low-resource settings as in the United States, a device that does not rely on a power cord is imperative. Even in areas where electricity is most often available, such as Kenya, it is not practical for devices used in the field to be powered in this way.

Battery powered devices are a possible alternative to relying on a power cord. Unfortunately, due to poorly established, or nonexistent, supply chains, batteries remain expensive and somewhat difficult to obtain. Using a battery-powered screening tool would enable use in the field, but may not be sustainable in the long-term if income is insufficient to replace batteries when needed.

Diagnostic tools are nonexistent in healthcare settings due to lack of resources, supply chains and technological advances. While in more developed countries, there are high-tech diagnostic tools, no lab that was interviewed had a method of testing to verify specific skin infections. All health care professionals in Nyeri, Kenya that were interviewed diagnosed based on symptoms, observation and history. Outside of diagnosing the specific infection, healthcare professionals also lack a way to differentiate between different types of infections – bacterial, fungal or parasitic.

2) Lack of Expertise

Even among healthcare workers, there is a broad spectrum of knowledge. This broad spectrum could make training extremely difficult as one would need to gage current knowledge levels before introducing new information. While some workers would be capable of screening with a handheld

tool after appropriate training, others currently lack the needed knowledge.

This broad range of knowledge and lack of expertise among health workers also affects people within the community. A lack of knowledge in the community coupled with a high prevalence of skin infections can cause members to think that they have enough experience to choose treatment themselves. Once skin infections have been present on oneself or within one's family, he or she falls under false pretenses that they are knowledgeable about the subject as a whole. Of the households interviewed, approximately 25 percent claimed they had enough experience with skin infections to diagnose and treat themselves. Social stigmas also play a role in self-diagnosis. They facilitate individuals to treat a less serious, more socially acceptable infection instead of the correct one.

3) Privacy

Problems with privacy arise from discussions of gender-related health issues, such as STIs, UTIs, and pregnancy. After meeting with community health workers in the field, it was found that many of these issues only exist when relationships between CHWs and community members have not been fully established. Off those interviewed, gender roles do not seem to have a significant-enough impact on the comfortable interaction between CHWs and their patients. Because skin infections can affect most areas on the body, including sensitive areas, privacy must be taken into account with any tool being used to screen for infections.

In addition to occasional uncomfortable situations with CHWs, social stigmas in general are very prevalent and detract from people seeking proper care. People do tend to seek treatment for extreme discomfort such as intractable itch, or when infections are visible to the public, such as areas of the face, neck and arms. Individuals also seek treatment when infections are in areas that hinder sexual behavior.

4) Financial Limitations

Trends in income affect whether patients wait to receive a diagnosis from a doctor before going to a chemist. Households visited with higher incomes had a better understanding of the need for a clear diagnosis before obtaining treatment. People with lower incomes cited expenses as a reason to avoid visiting a doctor. These are valid concerns as the visit creates both travel and appointment costs, while also factoring in the cost of missing work and the medications that may be prescribed. In Nyeri, Kenya there is one dermatologist. A visit can cost upwards of 2,000 Kenyan-shillings. In comparison, most residents in this area make less than 250 Kenyan-shillings per day [21]. These lower-income individuals instead opt to obtain medications of their choice from a chemist, without consulting a health professional. This can be both ineffective and dangerous, leading to worsened conditions of infections, and in many cases causing further expenses in the long term.

C. Business Challenges

These challenges must be considered when attempting to integrate a handheld, skin infection-screening device as part of a business.

1) Employee Turnover

Health venture employment options in low-resource contexts are often time and labor intensive with low profit rates. This commonly leads to high employee turnover rates [22]. While there is a dense population of community healthcare workers and diploma nurses in Kenya to provide basic health services, this turnover rate can be detrimental to research being conducted as a part of international ventures. It can lead to a variation of data collection methods or even a complete lack of collection during turnover, with both having a negative impact on consistency of collection. Turnover can occur for a variety of reasons including new educational opportunities, medical ailments, disapproval of financial incentive from family members or marital trouble [23]. Addressing and reducing these issues when possible will result in more efficient delivery of healthcare.

2) Startup Costs

The preliminary device used for this venture was purchased from Amazon for $39.99 USD. Similar devices, if purchased in bulk, could be obtained for significantly less while still serving the same vital functions. Reducing the cost would allow providers to sell the device to users at an affordable cost, including a profit margin. Users could then sell the service to community members at an affordable price to generate revenue, eventually leading to a personal profit.

3) Scalablility

The main focus of the venture, currently, is the validation of the device in this context and verification of an appropriate level of ruggedization. Long-term viability, however, must also be a focus if the venture is to continue and be self-sustaining. In the initial pilot, the device was purchased from Amazon. While this provider ensured quality control and quick delivery, in the future there must be a transition to acquiring devices and parts from the local market in Kenya. Ultimately this may be more challenging, but will allow the venture to be more scalable.

D. Technological Challenges

These challenges arise from the specific technologies used for data collection and aggregation.

1) Technology Lifecycle

The ultraviolet lamp has an average lifetime of around two hundred hours, so the bulbs will need to be replaced periodically. In addition, the handheld Wood's Lamp runs on four AA batteries that will also need to be replaced.

2) Capability

The true capability of this device is not entirely understood, because it is uncertain as to what causes the

fluorescence in the infections. It is, however, known that infections such as ringworm and scabies will fluoresce under the proper lighting. It is important to recognize that a lack of fluorescence does not mean that an infection is not present, but that one of the select, detectable infections is not present. This tool is not meant to be used as a diagnostic, but rather as a screening tool for the developing world.

IV. Conclusion

Skin infections are a serious, yet often overlooked problem in developing countries where knowledge on the subject, specialized health professionals, and diagnostic tools are limited. Wood's Lamp technology can be used to detect select skin infections and is used in dermatology offices presently in the United States. These devices are bulky, costly, and require large power sources. In order to implement them in resource-constrained settings these devices need to be ruggedized for the context. It is presently unclear whether or not there is a market for Wood's Lamp in resource-constrained settings that will be sustainable. In theory, Wood's Lamp technology would be useful in the developing world due to its capabilities, size, ruggedness and simplicity. However, after conducting field work it is clear that this tool is not appropriate due to the wide range of infections, lack of expendable financials, and varying levels of knowledge that could potentially lead to failure.

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