Amna Ahmad

Green Hope High School

Cary, North Carolina, United States

Ethiopia, Malnutrition

Electronic Diagnosis and Treatment Application for Severe Acute Malnutrition in Ethiopia

Severe Acute Malnutrition (SAM) is estimated to be the cause of death for 1-2 million children per year ("For Every Child, Nutrition!"). The majority of these deaths are concentrated in the Sub-Saharan African (SSA) region, which includes the country of focus, Ethiopia. While SAM is a treatable disease, mortality rates are unnaturally high due to several factors, one of the most significant being access and availability of adequate and thorough treatment. This paper discusses the implementation of a novel AI-powered, offline, SAM diagnosis and treatment application used by community health workers (CHWs) to spread healthcare coverage and decrease mortality rates. While this paper specifically examines Ethiopia, conclusions can be generalized to the entirety of SSA, where many countries within the region share similar healthcare profiles and resources.

Ethiopia is located in Sub-Saharan Africa, with a population of approximately 130 million people, with around 80% being rural (Macrotrends). An average family size in rural Ethiopia would be 5-7 people (Global Data Lab). Rural Ethiopians' primary income source is usually farming or something agriculturally related (Bluffstone et. al). Dependence on favorable crop seasons and sufficient rainfall leaves families in rural Ethiopia highly vulnerable to food insecurity. Frequent droughts can worsen this situation, significantly increasing the risk of Severe Acute Malnutrition among children in the region.

Severe Acute Malnutrition is a life-threatening condition that primarily affects children under five. Children with SAM generally have a very low weight for their height and are at high risk of deadly infections, permanent growth damage, as well as death. In Ethiopia, malnutrition affects more than 40% of children under five.

Healthcare coverage for Severe Acute Malnutrition in Ethiopia and surrounding SSA is a critical issue. Ethiopia currently has 0.104 physicians per 1000 people, which is 25x lower than the United States (World Bank Group). The situation is further compounded by the extreme difficulty of accessing healthcare in rural areas, where most children with SAM reside. This lack of access contributes to undernutrition being a leading cause of mortality, responsible for 45% of deaths among children under five in Ethiopia ("For Every Child, Nutrition!"). Researchers studying treatment access for SAM in Africa found that major barriers to treatment included

caregivers' limited knowledge about the illness and the significant distance and financial constraints associated with accessing health facilities (Pilar et al.).

To help combat this issue, governments and NGOs have come together to implement a treatment model referred to as Community Based Management of Acute Malnutrition (CMAM). The CMAM model allows for children diagnosed with SAM to be treated in an outpatient setting, within their communities. Members of the community are trained on the treatment protocols for SAM (Maleta and Amadi). In theory, this allows rural Ethiopians to have the care that they need, within their villages, removing the barrier to access towards life-saving treatment. The trained members are referred to as Community Healthcare Workers (CHWs), and the CHWs screen children for SAM, and provide the necessary treatment and resources needed to nurse the children back to health (Aguu and Amagnya).

However, there have been pressing issues with the current implementations of CMAM programs around Ethiopia and surrounding SSA. Inadequate training and knowledge, high workload and burnout, and inconsistent monitoring and evaluation have led to an unsuccessful delivery of care by many CMAM programs (Njaru et.al). CHWs are generally not trained in, nor have the resources to handle complicated cases of Severe Acute Malnutrition (Tehran and Manary).

Many children afflicted with SAM don't just suffer from undernutrition. They often suffer from anemia, and severe diarrhea, and are at risk of going into shock (Karunaratne et.al). Treating complicated cases of SAM requires sufficient knowledge and adherence to multi-step treatment protocols (Ireen et.al). When CHWs cannot treat complicated cases of SAM, it leads to higher mortality rates, as well as negative long-lasting effects on the child, due to inadequate care being delivered (Akuu and Amagnya). Oftentimes CHWs will refer children with complicated SAM to hospitals, which places families back to square one. Even if they reach hospitals, the case fatality rate is often high with providers being overworked and unknowingly using practices that are suitable for normal children but highly dangerous for SAM patients ("Inter-country collaboration to building capacities on Inpatient Management…").

There are two main identifiers for the unnaturally high mortality rate for SAM in Ethiopia and surrounding SSA. One, the low availability of trained physicians leads to many children dying at home without care ("Community-Based Management of Severe Acute Malnutrition" 2). Two, inadequate training and protocol adherence by CHWs results in suboptimal treatment and mismanagement of severe cases, where CHWs, who should be equipped to handle these

complications, are often unable to provide the necessary care, leading to preventable deaths (Beck et.al). This shows the urgent need for better training, stronger protocol adherence, and support systems to empower CHWs to effectively manage even the most severe cases of SAM in the community.

North Carolina-based nonprofit Tatera Health is dedicated to making this a reality. After seeing the lack of resources for CHWs, Tatera Health was inspired to help their mission, to reduce mortality rates and increase access to healthcare. Tatera Health was founded in 2023, by Amna Ahmad.

Tatera Health wanted to strengthen CHWs to treat cases of SAM with better protocol adherence and proper management. To do that, they created an offline application that uses state-of-the-art AI models to generate step-by-step treatment plans for cases of SAM, both complicated and uncomplicated. The app is translated into Oromo, one of the major languages spoken in Ethiopia, ensuring comprehension.

How does it work?

CHWs first begin by adding a new patient. The patient tracking system within the app allows for a single CHW to manage the treatment plans of multiple patients without mixing up information. The application provides visual representations of common steps that need to be taken to diagnose the patient, such as measuring Middle-Arm-Upper-Circumference (MUAC) as well as checking oedema on the body. The CHW records the data within the app as it follows the diagnosis steps. Once the CHW has followed all the necessary diagnosis steps, the application generates a multi-week treatment plan, trained on official WHO guidelines, as well as hundreds of case studies.

Attached below are some examples of how the application could look like. It is a work in progress, and the text is in English, so it can be understood for the sake of the paper. Visual displays still have to be added, to better aid the CHWs as they navigate through the application.

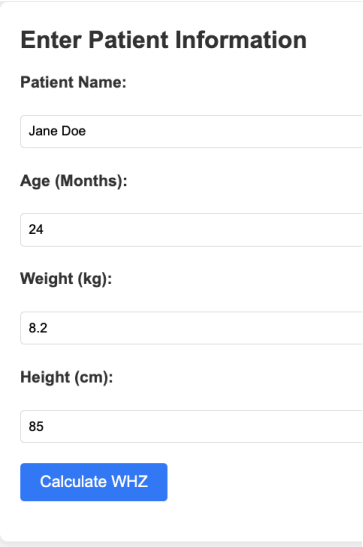

Figure 1.1

Patient Intake Form. Here, the CHW can enter the height and weight of the child, to get an accurate Weight-Height-Z-score measurement. WHZ is commonly used to measure how severe the child's malnourishment is.

*Everything was designed and coded by Amna Ahmad, with intellectual property belonging to Tatera Health

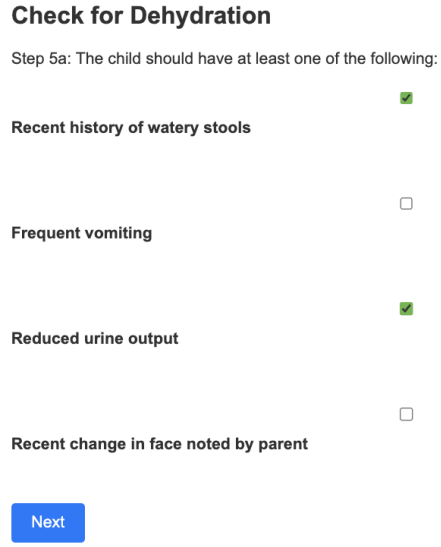

Figure 1.2

Checking for Associated Symptoms. This is an example of one of the steps that CHWs complete, to get an accurate health profile of the child. Dehydration is a common side effect of children who have SAM, and it is important to identify it so that the correct treatment can be given.

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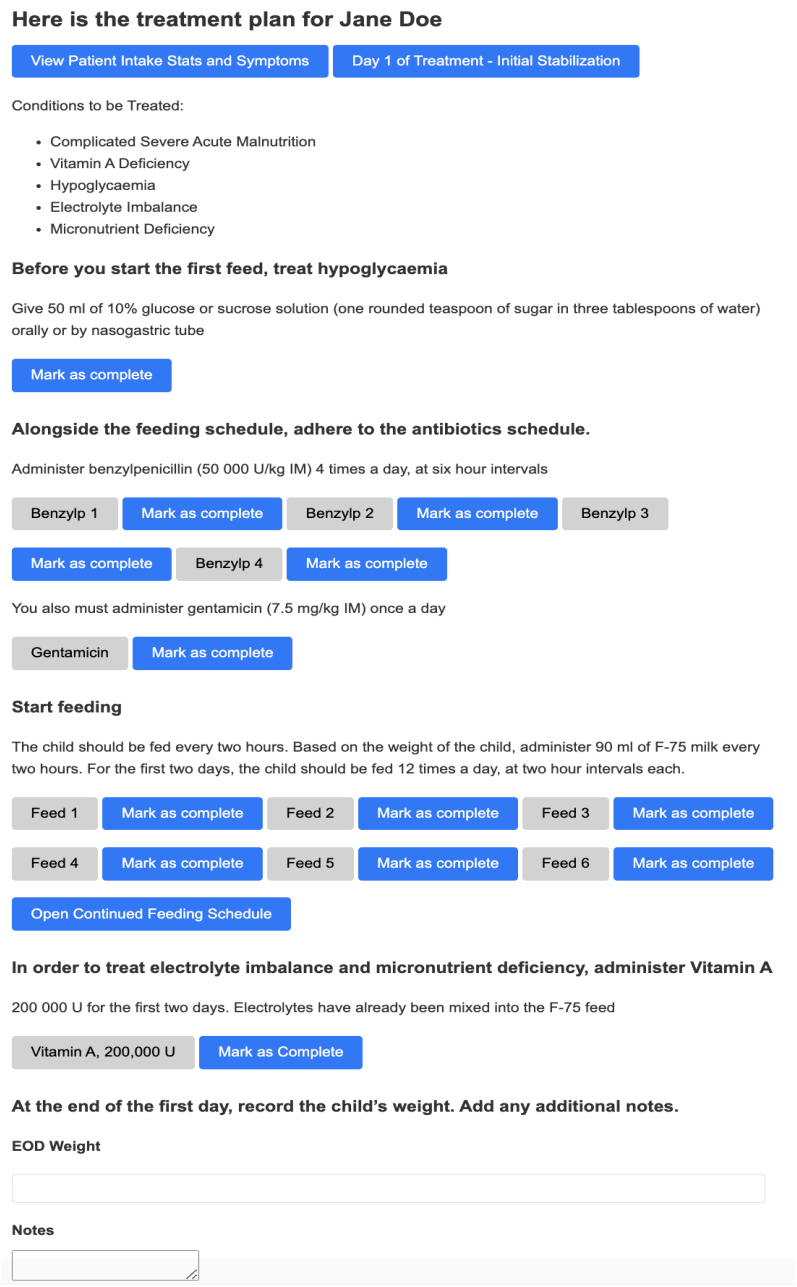

Figure 1.3
Generated Treatment Plan
Here is an example of how a treatment plan would look like for a child, once the CHW has completed all diagnostic steps. The algorithm matched symptoms to diagnoses, as seen with the "Conditions to be Treated" label. On the top right, it can be seen that this is the plan for "Day 1" of treatment. CHWs are provided with every single protocol to follow, from treating conditions such as hypoglycemia, as well providing the necessary antibiotics, before starting the feeding. The application makes it easy for CHWs to keep up with feeding schedules, as well as antibiotic administrations, with the "Mark as complete" buttons. At the end of the day, they weigh the child again to track progress. CHWs can also add notes, to record any other important information.
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This application plays a crucial role in reducing mortality rates by enhancing the ability of CHWs to deliver timely, effective, and standardized care, particularly in the management of complicated cases of severe acute malnutrition (SAM). By enabling early detection and intervention, the app allows CHWs to promptly identify and address signs of SAM before they escalate into life-threatening conditions. It ensures strict adherence to evidence-based treatment protocols, providing step-by-step guidance for both uncomplicated and complicated cases, which

is essential in reducing treatment errors and improving patient outcomes (Chanani et.al). Since the model generates a treatment plan for each patient's individual symptoms, it ensures that each child is receiving the correct care steps for the symptoms that they are afflicted with. For complicated cases of SAM, which often involve co-morbidities like infections, dehydration, or organ dysfunction, the application equips CHWs with advanced decision-making tools that guide them through complex treatment pathways. This includes recommendations for the management of co-existing conditions, the proper administration of therapeutic feeds, and the adjustment of treatment plans based on a patient's response to care. By empowering CHWs to manage these challenging cases locally, the application reduces the need for referrals to distant healthcare facilities, ensuring that patients receive critical care without delay. Additionally, the application supports continuous monitoring of patient progress, allowing CHWs to track and respond to signs of deterioration promptly.

Is this solution feasible?

Previously, digital health apps have shown signs of success when implemented in low-resource countries such as Ethiopia. In 2012, the humanitarian aid organization World Vision created a digital application that could aid CHWs with the treatment of SAM. The app could be installed on a mobile phone or tablet, and walk the healthcare worker through the steps of first diagnosing the child, and then treating the child (Frank et.al, 2). While it showed an improvement in treatment methodology in CMAMs, the use of the application was discontinued after a year because of a lack of internet access. The application required a steady internet connection to work, and with power outages occurring constantly, CHWs found the application a hassle to use (Frank et.al, 3). CHWs were using the application on mobile phones, which created complaints of small screen sizes.

For this reason, Tatera Health has designed its application to be used without internet access. This means that no matter where CHWs are, they can use the application, regardless of whether there is steady access to power or not. CHWs will also be provided with tablets to use, allowing them to input information more easily and have a larger screen size. Tatera Health's app also introduces a groundbreaking AI-powered treatment plan, uniquely designed to tailor care to each child's specific needs. By being trained on an extensive dataset of real-world cases alongside standard protocols, the app ensures that CHWs receive highly personalized treatment recommendations.

Barriers/Roadblocks to Implementation

While Tatera Health has already removed some barriers, such as internet access and language, there are still other roadblocks that need to be considered. The first is that such a

solution would require closely working with verified NGO's and local/national government in Ethiopia, for it to be successfully implemented. If the use of the application is set into national as well as local guidelines, usage of it would be widespread. There also needs to be dedicated training sessions with the CHWs to teach them how to use the application. While it is fairly easy to use, they should become as familiar with it as possible. This year, The MENTOR Initiative spent five days training 60 CHWs in different communities and health facilities in Paoua, Central African Republic (Johnson). Tatera Health could coordinate with NGOs such as The MENTOR Initiative to roll out their application to CHWs.

Another barrier is sufficient supplies to carry out treatment. Lack of supplies is a main barrier to the delivery of care (Pilar et.al). Even if CHWs know what to do, and have the correct protocol in front of them, it is meaningless if they do not have the correct medicines and feeds. For this solution to work effectively, there must be consistent delivery of supplies to the CHWs and health centers around Ethiopia.

Impacts and Effects

With the widespread implementation of Tatera Health's treatment application, we would certainly see decreased mortality rates of children with SAM. Families can feel confident that the CHW can treat their child effectively, regardless of whether the child has complicated or uncomplicated malnutrition. This solution efficiently solves the two-pronged problem discussed earlier- lack of well-trained physicians and inadequate care by CHWs. Since the application provides treatment that adheres to the international guidelines set by WHO, families do not have to worry about the quality of care. The application also makes it easy for CHWs to have treatment guidelines at their fingertips, ensuring that the correct protocols are adhered to. It provides life-saving care in rural Ethiopia and strengthens the existing CMAM model in Ethiopia. Since using the application would decrease the training efforts of CHWs by NGOs and local/national governments, they would save money, allowing them to implement more identical models across the country. If this application is used successfully, it would make great progress in creating a healthier generation of children in Ethiopia, as well as surrounding Sub-Saharan Africa.

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