Content for the Project's Online Platform

Project: Improve diagnostics of typhoid through Open Science: An Artificial Intelligence-based technique

Content 1: What is the Project about?

Project Goal: Improve diagnostics of typhoid through Open Science: An Artificial Intelligence-based technique.

Project Relevance

Typhoid fever is one of the infectious human diseases in Cameroon and Africa. Outbreaks of typhoid fever caused by Salmonella typhi remains a serious health problem worldwide. There are a number of tests available presently, from molecular to immunological and biochemical to microbiological. **Microbiological cultures:** The isolation of the causative organism, Salmonella enterica serovar Typhi (Salmonella Typhi), is the gold standard for the diagnosis (WHO, 2018). But, the use of bacteriological cultures for the diagnosis of typhoid infection is cost-intensive and technically difficult, hence the need for other diagnostic tests. **Antibody detection tests:** are rapid serologic tests designed for early and easy point-of-care use. **The Widal Test**

is based on the measurement of antibodies (agglutinins) against somatic (O) and flagellar (H) antigens of Salmonella typhi in the sera of patients. Widely used in many developing countries because of its low cost, **Widal test is limited by lack of standardized methods of assay and misinterpretation of results.** This has led to the overestimation of the number of patients presenting with acute febrile illnesses diagnosed with Typhoid fever. A systematic review by Mengist and Tilahun (2017) revealed poor reliability, low sensitivity and specificity of the Widal test. **There is therefore a strong need of a method which will help diagnosing typhoid fever with a better efficiency (reliability) and low cost.**

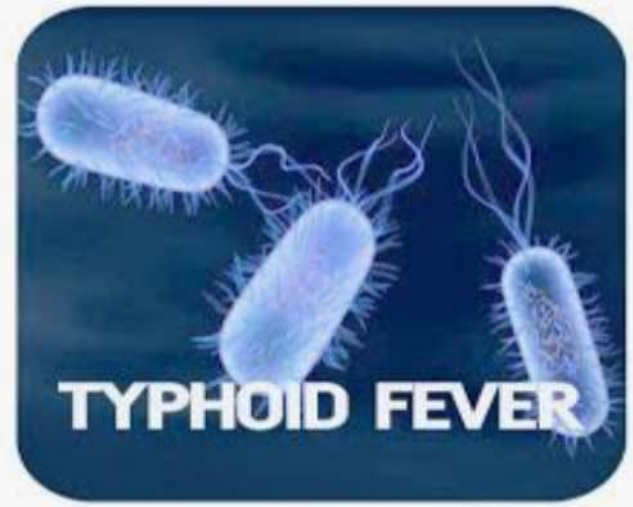
Innovative proposed Solution

Augmented intelligence makes more sense than artificial intelligence, especially in tropical diseases such as Typhoid. This is because it highlights the enhanced capabilities of a human when augmented with the right tools and technologies. In a sensitive industry such as healthcare, human intelligence cannot be replaced. Augmented intelligence specifies systems that augment human intelligence rather than attempt to replace them**. Combining AI systems with an irreplaceable human clinician can advance better diagnosis.** *We propose to use the micro cultures test with the blood which seems to be the best accepted by the laboratory technicians. We will use CNNs as algorithms on the collected images to train the algorithm.*

Project Objectives

1. Design interviews for practitioners in order to collect the associations of symptoms that confirm the disease and its level of severity.
2. Images collection taking into account the different ethnic groups, gender and age in order to have a heterogeneous dataset to allow us to avoid the biases that may arise and undermine the use of our solution.
3. Design the Convolutional Neural Networks to train images and Decision tree to train structured data.

Content 2: Typhoid Fever: What you need to know



Typhoid fever is caused by *Salmonella typhi bacteria*. Typhoid fever is rare in developed countries. It is still a serious health threat in the developing world, especially for children. Contaminated food and water or close contact with an infected person cause typhoid fever. Signs and symptoms usually include:

- High fever
- Headache
- Stomach pain
- Constipation or diarrhea

Most people who have typhoid fever feel better a few days after they start antibiotic treatment, but a small number of them may die of complications.

Symptoms

Signs and symptoms are likely to develop gradually — often appearing one to three weeks after exposure to the disease.

Early illness

Signs and symptoms include:

- Fever that starts low and increases daily, possibly reaching as high as 104.9 F (40.5 C)
- Headache

- Weakness and fatigue
- Muscle aches
- Sweating
- Dry cough
- Loss of appetite and weight loss
- Stomach pain
- Diarrhea or constipation
- Rash
- Extremely swollen stomach

Later illness

Without treatment, you may:

- Become delirious
- Lie motionless and exhausted with your eyes half-closed in what's known as the typhoid state

Life-threatening complications often develop at this time. In some people, signs and symptoms may return up to two weeks after the fever has subsided.

When to see a doctor

See a doctor immediately if you think you might have typhoid fever.

Causes

Typhoid fever is caused by dangerous bacteria called **Salmonella typhi.** Salmonella typhi is related to the bacteria that cause salmonellosis, another serious intestinal infection, but they aren't the same.

Fecal-oral transmission route: Most people in developed countries pick up typhoid bacteria while they're traveling. Once they have been infected, they can spread it to others through the fecal-oral route. This means that Salmonella typhi is passed in the feces and sometimes in the urine of infected people. If you eat food that has been handled by someone who has typhoid fever and who hasn't washed carefully after using the toilet, you can become infected. In developing countries, where typhoid fever is established, most people become infected by drinking contaminated water. The bacteria may also spread through contaminated food and through direct contact with someone who is infected.

Typhoid carriers: Even after antibiotic treatment, a small number of people who recover from typhoid fever continue to harbor the bacteria. These people, known as chronic carriers, no longer have signs or symptoms of the disease themselves. However, they still shed the bacteria in their feces and are capable of infecting others.

Risk factors: Typhoid fever is a serious worldwide threat and affects about 27 million or more people each year. The disease is established in India, Southeast Asia, Africa, South America and many other areas. Worldwide, children are at greatest risk of getting the disease, although they generally have milder symptoms than adults do. If you live in a country where typhoid fever is rare, you're at increased risk if you:

- Work in or travel to areas where typhoid fever is established
- Work as a clinical microbiologist handling Salmonella typhi bacteria
- Have close contact with someone who is infected or has recently been infected with typhoid fever
- Drink water polluted by sewage that contains Salmonella typhi

Complications

Intestinal bleeding or holes

Intestinal bleeding or holes in the intestine are the most serious complications of typhoid fever. They usually develop in the third week of illness. In this condition, the small intestine or large bowel develops a hole. Contents from the intestine leak into the stomach and can cause severe stomach pain, nausea, vomiting and bloodstream infection (sepsis). This life-threatening complication requires immediate medical care.

Other, less common complications

Other possible complications include:

- Inflammation of the heart muscle (myocarditis)
- Inflammation of the lining of the heart and valves (endocarditis)
- Infection of major blood vessels (mycotic aneurysm)
- Pneumonia

- Inflammation of the pancreas (pancreatitis)
- Kidney or bladder infections
- Infection and inflammation of the membranes and fluid surrounding your brain and spinal cord (meningitis)
- Psychiatric problems, such as delirium, hallucinations and paranoid psychosis

With quick treatment, nearly all people in industrialized nations recover from typhoid fever. Without treatment, some people may not survive complications of the disease.

Prevention

Safe drinking water, improved sanitation and adequate medical care can help prevent and control typhoid fever. Unfortunately, in many developing nations, these may be difficult to achieve. For this reason, some experts believe that vaccines are the best way to control typhoid fever. A vaccine is recommended if you live in or are traveling to areas where the risk of getting typhoid fever is high.

Vaccines: Two vaccines are available.

- One is given as a single shot at least one week before travel.
- One is given orally in four capsules, with one capsule to be taken every other day.

Neither vaccine is 100% effective. Both require repeat immunizations because their effectiveness wears off over time.

Because the vaccine won't provide complete protection, follow these guidelines when traveling to high-risk areas:

- **Wash your hands.** Frequent hand-washing in hot, soapy water is the best way to control infection. Wash before eating or preparing food and after using the toilet. Carry an alcohol-based hand sanitizer for times when water isn't available.
- **Avoid drinking untreated water.** Contaminated drinking water is a particular problem in areas where typhoid fever is endemic. For that reason, drink only bottled water or canned or bottled carbonated beverages, wine and beer. Carbonated bottled water is safer than non-carbonated bottled water.

Ask for drinks without ice. Use bottled water to brush your teeth, and try not to swallow water in the shower.

- **Avoid raw fruits and vegetables.** Because raw produce may have been washed in contaminated water, avoid fruits and vegetables that you can't peel, especially lettuce. To be absolutely safe, you may want to avoid raw foods entirely.
- **Choose hot foods.** Avoid food that's stored or served at room temperature. Steaming hot foods are best. And although there's no guarantee that meals served at the finest restaurants are safe, it's best to avoid food from street vendors — it's more likely to be infected.
- **Know where the doctors are.** Find out in advance about medical care in the areas you'll visit, and carry a list of the names, addresses and phone numbers of recommended doctors.

If you're recovering from typhoid fever, these measures can help keep others safe:

- **Take your antibiotics.** Follow your doctor's instructions for taking your antibiotics, and be sure to finish the entire prescription.
- **Wash your hands often.** This is the single most important thing you can do to keep from spreading the infection to others. Use hot, soapy water and scrub thoroughly for at least 30 seconds, especially before eating and after using the toilet.
- **Avoid handling food.** Avoid preparing food for others until your doctor says you're no longer contagious. If you work in the food service industry or a health care facility, you won't be allowed to return to work until tests show that you're no longer shedding typhoid bacteria.

Read more at: https://www.mayoclinic.org/diseases-conditions/typhoid-fever/symptoms-causes/syc-20378661

Content 3: The Power of Artificial Intelligence (AI)

Artificial intelligence (AI) and machine learning (ML) have evolved dramatically since their inception in the 1950s, but broadly speaking, AI is the theory and development of computer systems that can store and synthesize vast amounts of data to perform tasks normally requiring human intelligence (for example, facial recognition, speech recognition, decision-making, etc.). ML is a subset of AI where computers can be programmed to learn from experience and modify processing based on new information or data.

With the increasing avalanche of data available, industries such as financial services and manufacturing are realizing the advantages of AI and ML to automate tasks as well as deliver insights and models. Healthcare, and the rare disease space in particular, is in a unique position to take advantage of the advancements in AI and ML to drive improvements in complex patient diagnostics and care.

"If we can use AI to predict a problem before we waste resources and time on both sides of the patient-provider relationship, we're going to create better experiences for everyone." Katherine Andriole, Ph.D., Director of Research Strategy and Operations at the MGH & BWH Center for Clinical Data Science (CCDS).

There are over 7,000 identified rare diseases worldwide. It is unrealistic to expect a primary care physician to have a depth of knowledge or experience in the complex symptoms, diagnostic criteria, and therapies of this plethora of rare diseases. Even specialists will not have in-depth knowledge of every rare

disease. This is where the benefits of AI and ML can address the challenges in diagnosing and treating rare diseases.

Today's computing power allows for huge amounts of data from multiple sources to be easily stored and rapidly analysed. This unstructured data can then be synthesized and structured in meaningful ways such as classifying patients based on their level of risk of certain diseases and/or predicting progression based on data trends. The combination of these multiple benefits yields a high potential for improving the speed and accuracy of the differential diagnosis and treatment of complex rare disease patients.

5 Ways How can AI be applied in HealthCare?

The major AI trend in medicine is using deep learning in medical diagnosis to detect cancer. A recent study published in the Journal of the National Cancer Institute shows that the AI system has achieved a breast cancer detection accuracy comparable to an average breast radiologist.

Both radiologists and the AI system have shown 95 per cent confidence intervals. With the ability of AI networks to train themselves continually, there are big chances that their performance will be significantly improved in the nearest future.

Another promising implementation is the use of AI and the Internet of Medical Things in consumer health applications. These solutions use medical IoT devices to gather healthcare data and AI-based apps to process the information and offer adjustments to the current lifestyle of a patient.

The patient-centered approach of medical software developers leads to a trend for at-home health solutions. One of its possible implementations that are under development is a voice-based virtual nurse program. Its major purpose is to improve the hospital room experience and simplify the process of preparing patients to continue their healing at home. Also, virtual nurses reduce patient anxiety, improve safety, keep people entertained, and increase patient satisfaction with medical services.

1. Detecting diseases

Applying AI to medical diagnosis provides numerous benefits to the evolving of the healthcare industry. AI-based software can tell whether a patient has a certain disease even before evident symptoms appear. In their latest research,

Google proves that a neural network can be trained to detect signs of lung cancer earlier and faster than trained radiologists.

2. Classifying diseases

The opportunity of deep learning technologies to analyze images and recognize patterns opens up the potential for creating algorithms to help doctors diagnose specific diseases faster and more accurately. Existing similar solutions already use AI for cancer diagnosis by processing photos of skin lesions. Using such tools, doctors can diagnose patients more accurately and prescribe the most suitable treatment.

3. Improving the decision-making process

Diagnostics and treatment have always been tricky processes. The reason for this is that doctors need to simultaneously consider symptoms the patient has, possible research mistakes, all the existing treatment methods, potential side effects, diseases with very similar signs, and many more aspects. Modern solutions based on AI technology already help doctors to overcome research obstacles, process vast amounts of health data fast, and ensure a holistic understanding of a patient's health.

4. AI-based treatment solutions

Even when the disease is detected and classified, the treatment process can cause additional issues. Not only, a treatment plan includes prescribing medicines and exercises, but also coordinate care plans, help patients manage their treatment programs, and consider the risk of an adverse event.

Modern AI algorithms already help doctors arrange a comprehensive approach to disease management. Moreover, they are often used to improve surgical robots that execute highly complex operations.

5. Making people live longer

AI is often predicted to be a key technology to help people live longer and reduce the need for hospitalization.

For detail: https://khurehealth.ca/the-power-of-ai-in-diagnosing-rare-disease/

https://roboticsandautomationnews.com/2020/03/09/how-ai-technologies-accelerate-progress-in-medical-diagnosis/31184/

Content 4: Collaboration & Augmented Intelligence: The Way out

Combining Artificial Intelligence systems with an irreplaceable human clinician can advance better diagnosis. This is called Augmented Intelligence and seems to be the best way to improve typhoid fever early diagnosis and help efficiently fight against the disease.

For perfect collaboration, we need a community of people having a strong heart to help fight against typhoid fever. People who are ready to work together

(a) To collect association of symptoms on the diseases and it level of severity;
(b) To provide data on perspectives and retro perspectives clinical data as well as images of infected patients from different ethnic groups, gender and age in order to have a heterogeneous dataset to allow us to avoid the biases that may arise and undermine the use of our solution;
(c) To Design the Convolutional Neural Networks to train images and Decision tree to train structured data.

Using such collaborative and participatory open source approach will greatly help design an integrated solution for diagnosing typhoid fever efficiently and at a very low cost; and to save more lives.

It is time for work; Please Join our Community; Click Here