UPDATED DESCRIPTION

Description

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

Context

Typhoid or enteric fever is an acute life-threatening febrile illness caused by *Salmonella typhi*, a gram-negative bacterium with a long history and impact on human lives. It remains the most frequently reported faecal- oral disease outbreaks worldwide, but mainly common in developing countries such as India, Asia and Africa where it poses public health threats due to its high endemicity, difficulty in adopting control measures, and because of its significant morbidity and mortality rates (Duncan *et al*, 2016). Recent data estimates 16.6 million new infections and about 600,000 deaths each year (Ousenu *et al*, 2021). Typhoid fever becomes fatal when untreated or poorly treated and about 3% - 5% of people suffer from an acute illness of typhoid fever and become carriers of the bacteria after the acute illness. These people may become long-term carriers of the bacteria even though they have no symptoms and become the source of new outbreaks of typhoid fever for many years.

There are a number of tests available presently, from molecular to immunological and biochemical to microbiological. Some well-known and conventional Method of Diagnosis of Typhoid Fever are :

- **Microbiological cultures**: The isolation of the causative organism, *Salmonella enterica serovar typhi (Salmonella typhi*), is the gold standard for the diagnosis (WHO, 2018). Body fluids like blood, bone marrow, stool, urine, rose spots, gastric and intestinal secretions may be cultured. Blood culture gives a definitive diagnosis. 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:** These 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.

So, misdiagnosis is usually experienced since most health care facilities use only Widal test without confirmation of results with a second test method. In addition, the diagnosis of Typhoid involves several levels of uncertainties. Patients cannot tell exactly how they feel, doctors and nurses cannot tell exactly what they observe.

Also, challenges in standardized surveillance and imperfect diagnostic tools have resulted in patchy local disease data, which are not well acknowledged or integrated into local country evidence and health awareness for decision making therefore, the need to strengthen diagnostics for the generation of burden data in country (Duncan *et al*, 2016). Furthermore, the guidelines and training for treatment of enteric fever cases in Africa are sorely needed to help mitigate the inappropriate use of antimicrobial treatment.

Furthermore, the evolution in diagnostic assays have occurred due to an increase in the antibiotic resistance of *Salmonella tyhpi* into a multidrug resistant bacterium that therefore requires timely diagnosis to start the appropriate and correct treatment of typhoid to prevent further complications (Arti *et al*, 2017). There is therefore a need for rapid and correct diagnostic methods for proper data collection and treatment of typhoid fever.

Opportunities and 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 microcultures 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. Everything will depend on the volume of images we have, if we have few we will use transfer learning to automate the test of microbiological cultures .As we saw above this test is reliable at 61% and to reinforce the reliability of this test we will use the second algorithm which is a fast decision tree learner. This algorithm based on 18 symptoma variables will allow us not only to confirm the diagnosis but above all to determine the level of severity of the disease. **The main challenge our project is facing is availability of local and high quality open data.**

References

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