Emergency Severity Index (ESI), A More Suitable System for Emergencies in Burkina Faso

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Abstract. The triage system an emergency department must prioritize the patients' needs above all else. Additionally, it enables improved care organization based on client type, institutional mission, and available resources. In order to conduct effective triage, the Orientation and Reception Nurse (ORN) should employ a reliable, valid, and reproducible tool that considers the specificities of both pediatric and adult patients in prehospital medicine, as well as the national healthcare. The aim is to assess the validity and reliability of existing triage systems in emergency care, with the ultimate objective of developing an emergency triage system tailored to Burkina. To achieve this, our focus will be on identifying reliable and valid triage systems, which will serve as a basis for proposing or adapting a suitable triage system for Burkina Faso.

Keywords: Emergency Severity Index (ESI) · Electrocardiogram (ECG) · Pulse Oxymetry · Healthcare · patient · triage

1 Introduction

Triage is a critical process in emergency departments (EDs) that involves assessing and prioritizing patients based on the severity of their condition and the available resources. Its primary objective is to ensure that critical patients receive timely and suitable care, while efficiently managing limited. Triage systems have been developed and implemented in various countries, including several African nations. Burkina Faso does not have an official triage system for patients, it will be discussed after the review to propose a triage system in Burkina Faso. By implementing an effective triage system in Burkina Faso, healthcare providers can deliver prompt and appropriate care to patients, ultimately saving lives and enhancing overall operations within the emergency department.

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2 Research Methodology

In our comprehensive literature review, we considered the most recent updated versions of various triage systems and prioritized studies that provided analytical data. The implementation of these triage systems has been reinforced in China and numerous other countries, largely due to the impact of COVID-19 [1–3]. We performed a systematic review using a broad search strategy to identify all studies evaluating the performance of triage systems in emergency care against any reference standard that approximates the actual patient emergency, specifically in the African zone where resources (material and personnel) are particularly limited. Given the absence of an official triage system in Burkina Faso, our approach relied on observational methods. After a thorough review of valid and reliable triage systems around the world, such as the Emergency Severity Index (ESI) [4] and the Canadian Triage and Acuity Scale (CTAS) [5], there's also the Manchester Triage System [6], not forgetting the Australasian Triage Scale (ATS) [7] and the Pediatric Emergency Care Applied Research Network (PECARN) [8]. Closer to home, South Africa offers the South African Triage Score (SATS) [9], while Malawi opts for the Emergency Triage, Assessment and Treatment (ETAT) [10]. Better still are systems based on Artificial Intelligence [1]. We found that the triage methods used in Burkina Faso's health centers were closer to the ESI model. However, it is important to note that the health environment in Burkina Faso lacks material and human resources. With the aim of adapting an established practice, we have customized the ESI model to incorporate the collection of patients' vital signs and medical history, thus providing a triage framework suited to our specific context.

3 Related Work

Several triage systems have been created worldwide to help emergency services optimize care, such as ESI [4, 13], CTAS [5], MTS [6], ATS [7], PECARN [8]. Each attempt to tropicalize triage procedures according to resources and local context, such as intelligent systems [1, 11] or MEWS [12], SATS [1, 11, 14]. In Africa, there have been significant advancements in triage systems in emergency departments in recent years like SATS [9], ETAT [10], MEWS [12] or ESI [13]. These advancements aim to enhance the efficiency and efficacy of patient care; particularly in resource-limited environments. Here are some examples of triage systems that have been developed within African emergency departments:

3.1 South African Triage Scale (SATS)

South African Triage Scale (SATS) [9] is widely utilized as a triage system not only in South Africa but also in several other African countries. Its primary objective is to ensure that patients receive appropriate and timely medical care based on the severity of their condition. SATS employs a combination of physiological parameters, presenting complaints, and clinical judgment to assign patients into one of four triage categories: emergency, very urgent, urgent, and non-urgent. One of key strengths of the South African Triage Scale (SATS) is the simplicity and ease of use [14]: SATS is intentionally designed to be a simple and user-friendly triage system [14]. It allows for a rapid assessment of patients and appropriate allocation of resources based on their needs. Note also that SATS is culturally appropriate [15, 16].

However, like any triage system, SATS has both strengths and weaknesses. In some instances, due to the system's simplicity, patients with potentially serious conditions may be assigned a lower priority [17, 18], resulting in delayed care. Additionally, the subjectivity of individual assessors can influence the triage outcomes [17, 19].

3.2 Emergency Triage, Assessment, and Treatment (ETAT)

ETAT [20] is a systematic approach widely employed in emergency medical settings to prioritize patient care and optimize resource allocation [10]. It follows a standardized set of guidelines and protocols, reducing variability in care and improving quality and safety. ETAT can be effectively implemented across diverse emergency settings, encompassing hospitals, clinics, and mobile healthcare services, with adaptations specifically tailored to pediatric emergencies [21].

An invaluable asset of the ETAT is that ETAT facilitates effective communication among healthcare professionals involved in the emergency response. However, we noted that different healthcare professionals may interpret a patient's condition differently, leading to inconsistencies and errors in patient management [22]. Furthermore, challenges arise from limited availability of healthcare providers, as well as shortages in essential equipment and medications, which can impact the ability to deliver timely and comprehensive care. Therefore, a comprehensive evaluation of patients becomes crucial in addressing their complete healthcare needs [22].

3.3 Emergency Severity Index (ESI)

The Emergency Severity Index (ESI) [4] is an algorithm used for classifying patients into distinct acuity levels, enabling effective triage decisions and resource allocation. It considers both adult and pediatric triage and employs four decision points (A, B, C, and D) to assign patients to one of five triage levels.

We give below the four-decision points witch can be reduced to four key questions represented in Fig. 1: **A**: Does this patient require immediate intervention to be saved? **B**: Is this a patient who should not wait? **C**: How many resources will this patient need? D: What are the patient's vital signs?

4 Emergency Severity Index Like Triage System in Burkina Faso (ESI)

The utilization of a level 5 scale is not widely implemented across all emergency departments in Burkina Faso. Consequently, the assessment of severity levels is subjectively determined by the personnel receiving the patients. Upon arrival, the patient has direct access to the examination room [23]. If this room is already occupied, the patient is placed on the waiting bench in the corridor. There is no reception service as such that's but also, the triage system currently used in our health centers looks more like ESI [4]. Taking into consideration the practices of emergency physicians and aiming to enhance

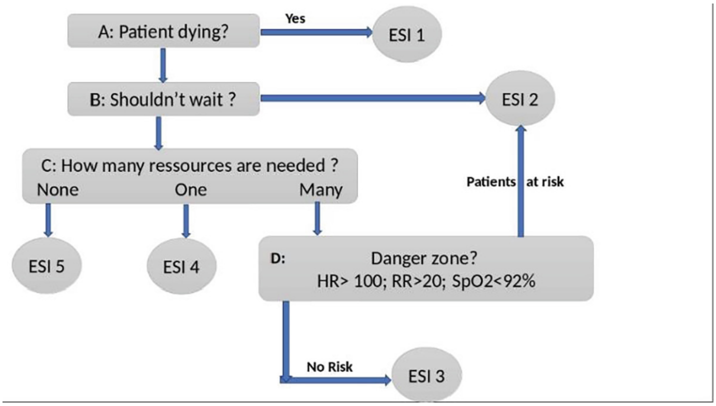

Fig. 1. ESI algorithm

the system, we have adopted the ESI as our triage system. We have implemented the ESI algorithm, with the exception that we propose the automatic collection of vital signs (within milliseconds). Another advantage lies in the simplicity of its algorithm, alongside our efforts to provide access to vital signs and patient medical histories. These contributions mark the current stage of our thesis.

4.1 Vital Signs Acquisition Scheme Design

The solution is to design a tool that automatically detects vital constants (D of the ESI algorithm) shown in Fig. 2. This sensor of physiological data such as oxygen level, pulse, ECG, pressure (Fig. 3), are automatically detected and displayed on the screen with the possibility to print. This module is suitable for ambulances and fire departments and makes the printed data available at the same time as the patient is admitted to the hospital.

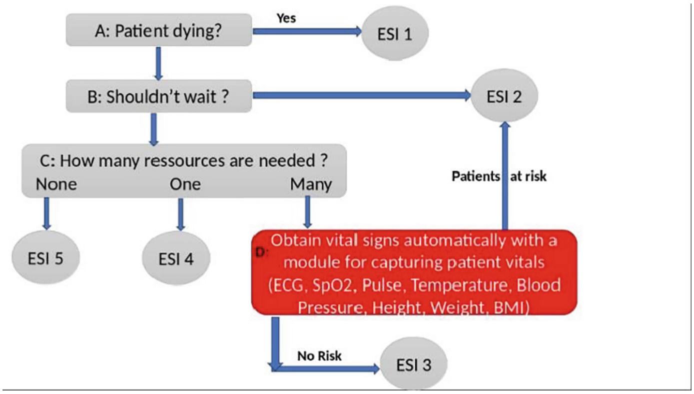

Fig. 2. ESI algorithm adapted in Burkina Faso

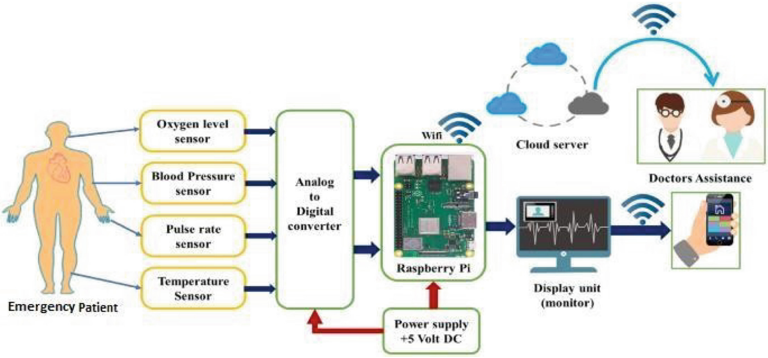

Fig. 3. Automatic vital signs capture process

4.2 Medical History Obtaining Process

Equipped with a Wi-Fi module, data collected by the patient is automatically synchronized with the monitor and the electronic medical record based on the International Classification of Diseases version 11 (ICD11) [28] and taking into account interoperability standards used in the healthcare field [29]. If there is no connection, patient data can be printed out and updated at a later date. To validate our tests, we developed an electronic patient health record. It should be noted that this idea is supported and defended by the Burkina Faso Ministry of Health, which wishes to set up a patient health record valid in Burkina Faso's health centers. This helps also to enhanced communication: ours works facilitate effective communication among healthcare professionals involved in the emergency response by using a common language terminology and unique patient identifier (Patient ID), it ensures clear and concise communication, leading to better coordination and teamwork.

5 Results and Discussion

In order to validate our findings, we conducted a comparative study on measurement speed within emergency department. The objective was to compare our newly developed automated vitals capture tool with the current manual method used by the hospital. To assess the time required for vital signs measurement using the manual method, we visited 10 healthcare facilities and recorded the duration of each measurement for 55 patients. During our visits, we identified that 5 measuring devices were faulty, representing 10% of the study population, and thus we excluded these patients from our analysis. The number of patients considered in this study is 50. The measurement time of the manual method (for the most part several minutes (Mn)) compares with our so-called automatic method, which takes a few milliseconds (mis) to take vital signs of 50 patients.

5.1 Results

We proceeded by analyzing the time required for measuring the constants. The data was obtained nearly instantaneously, in milliseconds. The doctor or nurse in charge took the saturometer or blood pressure monitor to measure the patient's vital signs, and we timed the process. It should be noted that in some cases, the device is faulty, and we either have to shake it, charge the batteries or go to another department to take a printout. In such cases, we don't take the time into account, as it becomes abnormally long, and we therefore consider them as outliers. The table below compares the measurement time for each constant. The data includes the average measurement time for each vital sign, both for all 50 patients and for each method (automatic and manual). The total number of patients is 50, and the average measurement time is computed by summing the duration for each patient and dividing it by the total number of patients, i.e., 50. For instance, the average weight measurements are calculated using the following formula:

$$\text{Average Weigth} = \sum_{n=1}^{50}\left(\frac{Duration\,for\,each\,patient}{50}\right)$$

$Average_{weight} = 13800$ ms *for Manual method*
$\text{Average}_{weight} = 5{,}18$ ms *for Automatic method*

The other data in the table are obtained using the same formula and are listed in the table below:

Methods	weight measurement time in milliseconds	Size measurement time in milliseconds	Temperature Measurement tine in milliseconds	Pouls Measurement tine in milliseconds
Manual method (MM)	138000	257520	435780	299460
Automatic method (AM)	5, 18	5,20	5,9578	4,8958
Time saved (TS) = MM-AM	137994,8436 = 2,28 mn	257514,793 = 4,29 mn	435774,042 = 7,26 mn	299455,076 = 4,99 mn
Methods	Oxygene saturation (SpO2) measurement time in milliseconds	Electrocardiogram (ECG) measurement time in milliseconds	Blood Pressure Measurement tine in milliseconds	Body Mass Index (BMI) Measurement tine in milliseconds
Manual method (MM)	1187880	519660	355920	137520
Automatic method (AM)	5,9578	4,7734	7,550446809	3,7316
Time saved (TS) = MM-AM	1187874,044 = 1,97 mn	519655,225 = 8,66 mn	355912,45 = 5,93 mn	137516,25 = 2,29 mn

We present the differences between the two measurement methods through the following graphs.

Figures 4 and 5 summarize the difference in measurement between the two methods: one is fast, stable and predictable (brown), while the other (blue) is slow (average measurement time is 6 minutes for Oxygen saturation (SpO2) and temperature (see table)) and unpredictable because it is manual. This time is invaluable for attending to other patients. Beyond the speed of measurement, these two graphs tell us that automatic measurement is reliable and valid no matter who measures it, whereas manual measurement

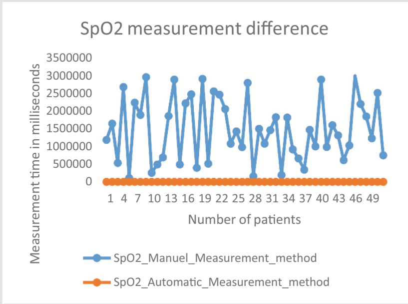

Fig. 4. SpO2 Measurement difference

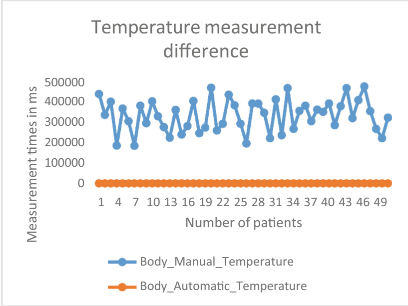

Fig. 5. Temperature measurement difference

requires a minimum of experience (the more experience you have, the more accurate your measurement). This is why the curve for manual measurement varies.

5.2 Strengths and Weaknesses

This literature review is based on a comprehensive and systematic search and has attempted to include as many relevant studies as possible. This study is a synthesis that aims to find a more pragmatic approach to sorting systems in Burkina Faso in order to propose a system that can be easily used. After observation, we noted that some centers resemble the ESI sorting model in practice. In view of the fact that study data on the validity [24] and reliability of the ESI [25] sorting system [26] was available, we opted for a model that could be adopted in Burkina Faso. As a major contribution, ESI does not tell you how to obtain vital signs, so we have proposed a tool to automatically capture vital signs and make them available for emergencies. We're also aware that a patient's medical history is essential for proper care, which is why we've integrated the patient's electronic health record. This record retrieves data on the patient's vital signs during the consultation. However, this remains a proposal that needs to be accepted and adapted by Burkina Faso's healthcare stakeholders. This study does not take into account the optimization of resources, which is why we have to take this into account in the rest of this article.

6 Conclusions

Triage is essential, as it is the only option for managing patient flow in the emergency room. It's important to note that there are many triage tools available worldwide. Each tool is well adapted to the area of action, medical policies and available resources. This is why we chose to adapt the ESI triage system to Burkina Faso, given its ease of use and good inter- and extra-judge correlation [27, 28]. We proposed a rapid solution for obtaining vital signs and patient consultation histories.

6.1 Strengths and Weaknesses

After proposing methods for measuring vital signs and medical histories based on the Internet of Medical Objects, the next stage of our work will focus on optimizing healthcare resources in a world where there is a real shortage of them.

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