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The use of chatbots for triage and emergency nursing support: Review article

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***Abstract*---Background:** The triage process is essential in emergency care, as it prioritizes patient treatment based on urgency, ensuring that those in critical need receive timely attention. Different Hospitals faced challenges with its triage system due to a shortage of nursing staff and high patient volumes, leading to inefficiencies and risks in patient care. **Aim:** This study aims to address the inefficiencies in triage processes at different Hospitals by developing an intelligent triage assistant that leverages chatbot technology to expedite triage decisions, enhance patient management, and meet healthcare standards. **Methods:** The intelligent triage assistant was developed using Visual Studio C#, Microsoft SQL Server, and QnA Maker. It integrates a knowledge base built from patient data and expert input to classify patients into acuity levels and direct them to appropriate care areas. The system's functionality was assessed based on its ability to improve triage efficiency and accuracy. **Results:** The chatbot effectively reduced the triage process duration by promptly assessing patient conditions, assigning acuity levels, and directing patients based on their urgency. It assisted less experienced nurses and non-clinical staff, leading to improved workflow and reduced patient wait times. **Conclusion:** The implementation of an automated intelligent triage assistant significantly enhances the triage process by providing swift, accurate assessments and recommendations. This improvement supports better patient outcomes and adherence to healthcare standards. Chatbots offer valuable support in emergency care settings by optimizing triage efficiency and resource allocation.

***Keywords*---**Chatbots, Triage, Emergency Nursing, Intelligent Triage Assistant, Healthcare Efficiency, Patient Management.

Introduction

The triage process for patients serves as the fundamental standard for delivering patient care. Emergencies can arise unpredictably from the moment a patient arrives and awaits treatment, potentially leading to critical outcomes such as death or irreversible disability [1]. Consequently, it is imperative for outpatient department nurses to possess the ability to make swift assessments and

accurately categorize patients by acuity to ensure effective service delivery and meet the objectives of Access to Health Care Services. Given the shortage of nursing staff for triage at Phraphuttabat Hospital, additional medical personnel, including medical records officers and hospital porters, are required to support the triage nurses in managing a high volume of patients. This situation exacerbates the emergency crisis and poses risks in the outpatient department while patients await treatment, as evidenced by incident reports from 2017 to 2019, even when they should be referred to the emergency department. Consequently, the Healthcare Accreditation Institute (Public Organization) has recommended that the hospital implement corrective measures to meet the Hospital and Healthcare Standards assessment criteria.

In response to these challenges, Phraphuttabat Hospital has been actively working to enhance the triage system to facilitate a more efficient and standardized assessment of patient conditions. This improvement aims to ensure that patients receive timely and appropriate care. Effective triage is crucial for managing patient risk and addressing emergency situations that may arise at any point from the initial contact and during the waiting period. This research is focused on developing an intelligent triage assistant designed to expedite the triage process by promptly making decisions for all patients, assigning acuity levels, and directing patients to appropriate areas based on their acuity. The intelligent triage assistant has been developed using Visual Studio C#, Microsoft SQL Server for database management, and QnA Maker for the knowledge base.

How Triage Works

Triage is a systematic process employed in emergency and medical settings to prioritize patient care based on the severity of their condition. Upon arrival, patients are initially processed at the triage area, where essential information such as their name, age, and the nature of their complaint is collected. This initial step often includes recording vital signs if immediate intervention is required. The primary aim of this preliminary assessment is to quickly identify and categorize patients according to the urgency of their needs. The triage process involves a detailed evaluation of the patient's symptoms, medical history, and overall condition. Healthcare providers, typically triage nurses, conduct this assessment through a combination of physical examination and targeted questioning. Based on this evaluation, patients are classified into different priority categories. These categories generally include **Immediate**, for those with life-threatening conditions requiring urgent intervention; **Urgent**, for patients with serious but not immediately life-threatening conditions; **Non-Urgent**, for those with less severe conditions that can be managed with lower priority; and **Expectant**, for patients whose conditions are so severe that they are unlikely to survive even with medical intervention.

The triage system is designed to ensure that patients receive timely and appropriate care according to the severity of their condition. This prioritization is crucial in managing resources effectively and optimizing patient outcomes, especially in high-pressure environments where medical resources may be limited. By systematically assessing and categorizing patients, triage facilitates a

structured approach to emergency care, allowing for efficient management of both acute and routine medical cases.

Expert Systems

An expert system is a computational framework designed to replicate the expertise of a specialist in fields such as medicine or science, thereby facilitating decision-making akin to that of a human expert [2]. This system can offer a secondary opinion or resolve disagreements among multiple human experts, enhancing the confidence in the correctness of the decisions made. The development and application of expert systems necessitate a comprehensive understanding of fundamental concepts, including knowledge representation, justification, and machine learning.

Chatbots

A chatbot is a software tool engineered to engage in conversational interactions for diverse objectives such as answering inquiries, aiding, or delivering entertainment, contingent upon its specific application [3]. It is crafted to emulate human conversational behavior, serving as a virtual interlocutor. Rule-based chatbots operate based on a fixed set of rules that are pre-programmed into the system. In contrast, AI-driven chatbots utilize Natural Language Processing (NLP) and machine learning, enabling them to interact in a more sophisticated manner with various users [4]. The development of rule-based bots is comparatively straightforward and expedient; however, they lack the capability for self-learning and are more challenging to maintain over time.

Triage Process

Upon a patient's arrival at the triage desk, the triage nurse undertakes several critical steps: 1) performing an initial assessment; 2) screening for infectious diseases; 3) interviewing the patient and evaluating their presenting symptoms and vital signs; 4) making triage decisions and assigning an acuity level; 5) directing the patient to an appropriate area based on their acuity; 6) providing symptom relief for patients in the waiting area; and 7) re-assessing and re-triaging patients in the waiting area to ensure the effectiveness of the screening system. Key triage nursing competencies include: 1) public relations; 2) interviewing skills; 3) critical thinking; and 4) communication skills. To mitigate or reduce patient risk, it is essential that evaluations are conducted promptly, and treatment is administered without delays that could lead to serious complications. It is advisable that interviews and assessments be conducted directly with the patients whenever feasible. Additionally, patients arriving via courier or medical personnel should be assessed within a five-minute timeframe [5].

Previous Related Research

MESTRIMAN [6] is an expert system designed to provide effective medical support during emergencies and catastrophes. As a component of SIAC, a comprehensive

computer system for basic and advanced medical support, MESTRIMAN focuses on triage principles and the clinical management of patients in crisis situations. The system's knowledge acquisition involves direct observation of experts and interviews with clinical specialists, leading to knowledge representation through IF-THEN rules. MESTRIMAN serves as an advisory tool for catastrophe management personnel, enhancing decision-making efficiency and reliability, particularly in the absence of experts. Chang et al. [7] expanded the support systems for Emergency Medical Services (EMS) to include pre-hospital emergency care and onsite evaluations for large-scale events. Evaluations by twenty-three nurses and six physicians indicated that the new systems were user-friendly and beneficial for managing mass gatherings. IntelTriage [8] was introduced as an advanced triage and hospital monitoring system that dynamically prioritizes patients in emergency departments while continuously tracking their vital signs and location through wearable biosensors. The system employs customized machine learning algorithms and statistical models to provide real-time health monitoring and adjustments, aiming to optimize patient triage and adjust priorities as needed.

Current Triage Process

Triage is an essential procedure that significantly impacts the quality of care for patients presenting with severe symptoms or requiring urgent medical attention upon their arrival at a hospital. Accurate and timely assessment of these high-risk patients is crucial, as delays or errors in this process can result in severe complications, including death or disability. Such shortcomings may also lead to legal repercussions, increased maintenance costs, and diminished patient satisfaction. Data from 2017–2019 indicate that the number of critical patients awaiting treatment in the outpatient department exceeded those in the emergency department [1]. This disparity negatively affects patient access and treatment efficacy. According to the standards set by the Healthcare Accreditation Institute (Public Organization), urgent and efficient screening by skilled triage nurses and suitable equipment is imperative. This protocol is vital to avert potential crises and emergencies that could lead to sudden death or permanent disability.

Patients requiring urgent and emergency care necessitate immediate attention from qualified personnel and appropriate resources. However, the existing triage process frequently fails to provide prompt patient assessment. The operational system's implementation is often delayed due to resource constraints, including technology, staff availability, and the troubleshooting expertise of specialists. The shortage of triage nurses necessitates the involvement of additional staff members, who may lack the professional knowledge and observational skills required for effective screening. Consequently, patients may be misdirected to inappropriate areas, leading to inefficiencies and potential adverse effects on patient outcomes. This evidence suggests that the current triage procedures fall short of established standards. Therefore, it is essential to revise and enhance the triage procedures in the outpatient department to align with standards. This research proposes the development of an automated intelligent triage assistant, a knowledge-based application designed to expedite the triage process by promptly making decisions, assigning acuity levels, and directing patients to appropriate areas based on their acuity. The implementation of this system is anticipated to

reduce the risks of death, disability, and complications for patients awaiting treatment.

System Workflow

As depicted in **Fig. 1**, upon a patient's arrival at the triage entry point, a user—whether a triage nurse or another staff member—inputs the patient's ID card number or patient ID number. The triage assistant then interfaces with the hospital database via an API to retrieve the patient's medical history. Critical data used during the screening process include drug allergies, congenital conditions, and patient rights to medical care. Subsequently, the user inputs the patient's blood pressure, heart rate, and body temperature. This information enables the assistant to generate results and classify the severity of the patient's condition. The hospital's triage system categorizes patients into three groups: "emergent" (those who cannot safely wait for an available space in the clinical area), "urgent" (those who can safely wait briefly for a clinical area space), and "non-urgent" (those who can wait an extended period for a clinical area space). For patients classified as emergent or urgent, the assistant alerts the triage nurse to ensure immediate attention from a physician, directing these patients straight to the emergency room. Conversely, for non-urgent patients, the assistant employs its chatbot functionality to request three additional key symptoms from the user. Utilizing its knowledge base, the automated intelligent triage assistant makes triage decisions and advises the user on the appropriate clinical area or examination room for the patient. This intelligent application aims to significantly reduce the duration of the triage process, providing valuable assistance to less experienced nurses and non-clinical staff, thereby enhancing the speed, accuracy, and efficacy of triage procedures.

Developing a Knowledge Base for the Intelligent Triage Assistant:

In this phase, the development of the knowledge base for the intelligent triage assistant begins with the collection of information pertaining to patients' initial symptoms. This process involves two primary sources of knowledge: the hospital's medical records and the experiential insights of human experts. Over the past year, we collected data on patient symptoms to categorize these symptoms for each examination room, thus establishing a correlation between specific illnesses and corresponding examination rooms. Additionally, interviews were conducted with triage nurses to gather their professional insights and experiential knowledge. Once the knowledge from these sources was acquired, we analyzed the triage information in relation to patient symptoms and mapped it to the examination rooms. This information was then represented in a decision tree format. The intelligent triage assistant employs this rule-based knowledge base for classification purposes. When patients are queried about three key symptoms, the assistant uses this information to infer and screen patients, subsequently assigning them to the appropriate examination rooms. This approach aims to expedite the triage process, enabling more prompt treatment of patients.

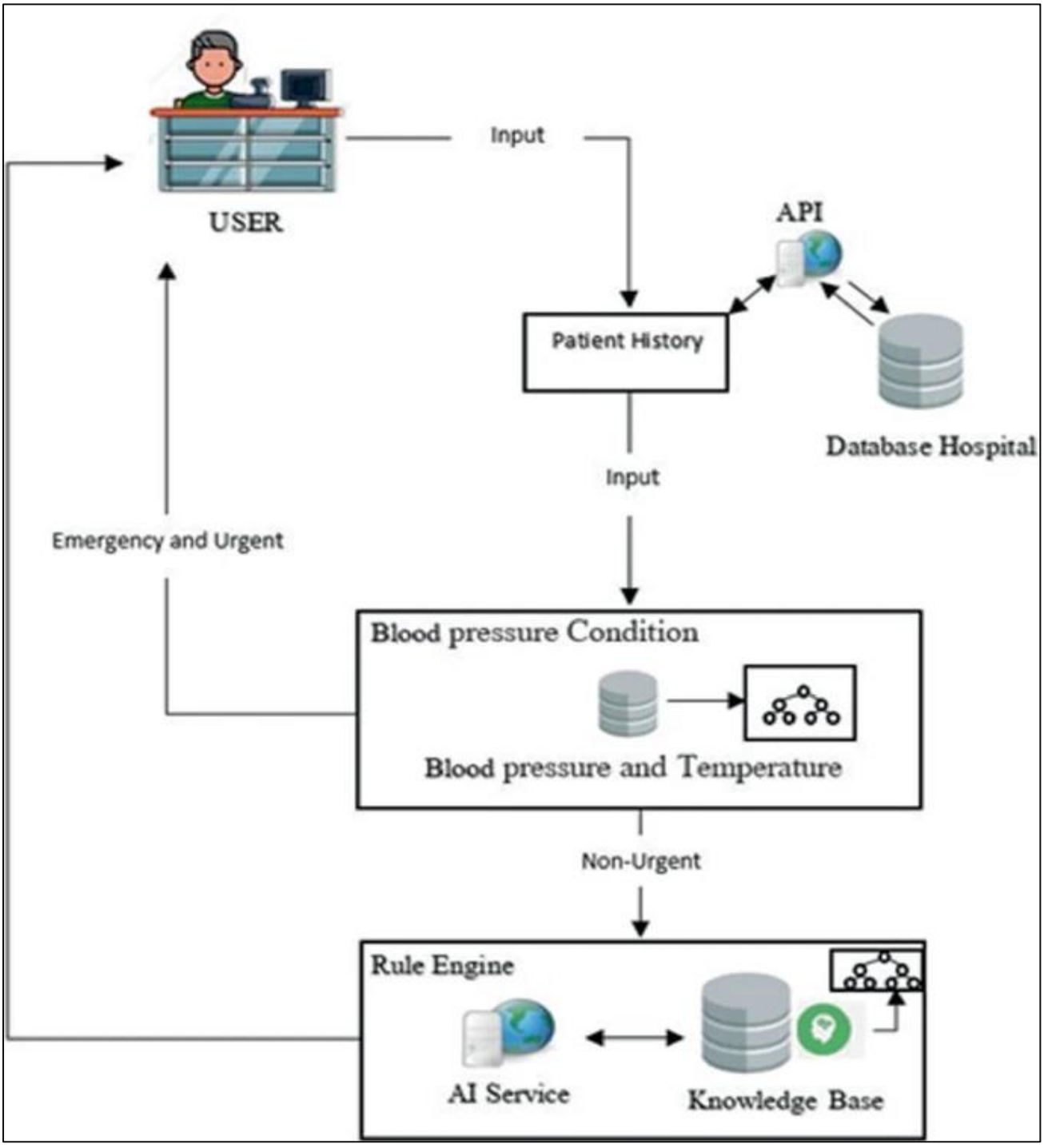

Fig. 1: Chatbot workflow

Implementation of Automated Intelligent Triage Assistant:

For the implementation of the automated intelligent triage assistant, we utilized MS Visual Studio 2017 in conjunction with MS SQL Server. A patient database was established to facilitate data management. Additionally, Microsoft Azure was employed for cloud computing services. Azure, an integrated cloud computing and artificial intelligence platform, supports various AI services such as machine learning, bot services, cognitive services, and web services. We specifically used QnA Maker [9] to develop a chatbot that functions as a triage expert system. QnA Maker, a cloud-based Natural Language Processing (NLP) service, is designed to create conversational client applications, including chatbots and speech-enabled applications. It leverages a custom knowledge base to provide the most accurate responses to user inputs, assisting in making informed triage decisions and directing patients to the appropriate examination rooms.

Different Applications of Chatbots in Health sector:
Chatbots have emerged as valuable tools in various clinical applications, enhancing healthcare delivery and patient engagement. Here are some key applications:

1. Patient Screening and Triage
Chatbots can assist in the initial screening of patients by asking relevant questions about their symptoms, medical history, and other pertinent information. They can help prioritize patients based on the urgency of their conditions, guiding them to appropriate care. For instance, chatbots are used to triage patients in emergency departments, ensuring that those with more severe symptoms receive timely attention.
2. Symptom Checking and Diagnosis
Chatbots can provide preliminary assessments by analyzing patient-reported symptoms and offering possible diagnoses or recommendations. These systems use algorithms and medical databases to suggest potential conditions and advise on whether professional medical evaluation is necessary. They can also offer guidance on home remedies or preventive measures for minor ailments.
3. Medication Management
Chatbots can help patients manage their medication regimens by sending reminders for taking medications, tracking adherence, and providing information about drug interactions and side effects. They can also assist in managing chronic conditions by monitoring medication schedules and offering support for medication-related queries.
4. Appointment Scheduling and Management
Chatbots can streamline the appointment scheduling process by allowing patients to book, reschedule, or cancel appointments through a conversational interface. They can also provide reminders and updates about upcoming appointments, helping to reduce no-show rates and improve clinic efficiency.
5. Patient Education and Information
Chatbots can deliver personalized educational content to patients about their conditions, treatment options, and general health topics. They can provide information on disease management, preventive measures, and lifestyle changes, helping patients better understand their health and treatment plans.

6. Post-Discharge Follow-Up
After a patient is discharged from a hospital, chatbots can facilitate follow-up care by checking in on their recovery progress, monitoring symptoms, and ensuring adherence to discharge instructions. They can also offer support and answer questions related to post-discharge care, helping to reduce readmission rates.
7. Mental Health Support
Chatbots are increasingly used to provide mental health support by offering counseling, stress management techniques, and mood tracking. They can engage in therapeutic conversations, provide coping strategies, and direct users to professional help if needed.
8. Data Collection and Surveys
Chatbots can collect patient data through surveys and questionnaires, facilitating research and quality improvement initiatives. They can gather feedback on patient experiences, treatment outcomes, and service quality, contributing valuable insights for healthcare providers.
9. Support for Healthcare Professionals
Chatbots can assist healthcare professionals by providing quick access to medical guidelines, drug information, and clinical decision support. They can streamline administrative tasks and help with routine inquiries, allowing professionals to focus more on patient care.
10. Virtual Health Assistants
Chatbots can act as virtual health assistants, helping patients navigate healthcare services, manage their health records, and access telehealth consultations. They can offer a range of services from answering questions about healthcare options to facilitating virtual visits with healthcare providers. These applications demonstrate the versatility of chatbots in enhancing healthcare delivery, improving patient outcomes, and supporting healthcare professionals.

Applications and Roles of Chatbots:
Chatbots are becoming increasingly integral in various healthcare domains, including emergency care, nursing, health informatics, and pharmacy. Here's how they contribute to each area:

1. Emergency Care
- **Initial Triage and Screening:** Chatbots assist in initial triage by asking patients about their symptoms and medical history to prioritize cases based on urgency. This helps ensure that critical patients receive immediate attention while less severe cases are directed to appropriate care.
- **Information Dissemination:** They provide real-time information on emergency procedures, directions, and hospital protocols to patients and their families, reducing confusion and stress during emergencies.
- **Pre-Hospital Guidance:** Chatbots can offer pre-hospital care instructions and first-aid guidance to individuals while they wait for professional medical assistance, improving patient outcomes in critical situations.

2. Nursing
- **Patient Monitoring and Follow-Up:** Chatbots can help nurses monitor patients' conditions by collecting data on symptoms, medication adherence, and overall health status. This enables timely interventions and follow-up care.

- **Education and Support:** They provide patients with information on managing chronic conditions, understanding treatment plans, and navigating healthcare services, thus supporting nurses in patient education and engagement.
- **Administrative Tasks:** Chatbots streamline administrative tasks such as scheduling, patient intake, and documentation, allowing nurses to focus more on direct patient care.

3. Health Informatics

- **Data Collection and Analysis:** Chatbots facilitate the collection of patient data and feedback, which can be analyzed to improve healthcare services, identify trends, and support research initiatives.
- **Clinical Decision Support:** They offer support by providing access to clinical guidelines, medical knowledge, and decision-making tools, enhancing the accuracy and efficiency of clinical decisions.
- **Patient Engagement:** Chatbots engage patients in managing their health information, tracking health metrics, and accessing electronic health records, contributing to a more integrated and user-friendly health informatics system.

4. Pharmacy

- **Medication Management:** Chatbots assist in medication management by providing reminders for taking medications, monitoring adherence, and offering information on drug interactions and side effects.
- **Prescription Assistance:** They support patients in managing prescriptions by facilitating refills, answering questions about medications, and providing guidance on dosage and administration.
- **Patient Education:** Chatbots educate patients about their medications, including proper usage, potential side effects, and interactions with other drugs, which enhances patient safety and compliance. Overall, chatbots enhance efficiency, support healthcare professionals, and improve patient experiences across these domains. They act as valuable tools for managing information, streamlining processes, and delivering timely and relevant support in various healthcare settings.

Conclusion

The development and implementation of an intelligent triage assistant at Phraphuttabat Hospital represent a significant advancement in managing emergency care efficiently. The traditional triage process, while fundamental, faced considerable challenges due to staffing shortages and the high volume of patients. These inefficiencies often led to delays in care and increased risks to patient outcomes. The intelligent triage assistant, powered by advanced chatbot technology, addresses these challenges by streamlining the triage process. By utilizing Visual Studio C#, Microsoft SQL Server, and QnA Maker, the system integrates a comprehensive knowledge base derived from patient data and expert insights. This enables the assistant to perform initial assessments, classify patients based on acuity, and direct them to appropriate care areas with remarkable efficiency. The implementation of this system has demonstrated several key benefits. Firstly, it significantly reduces the time required for triage, ensuring that patients are categorized and directed to care areas more swiftly. This reduction in triage time is crucial for managing patient flow and minimizing

wait times, which can be critical in emergency settings where timely intervention is essential. Moreover, the intelligent triage assistant supports less experienced nurses and non-clinical staff by providing clear, rule-based guidance on patient classification and care directions. This support not only enhances the accuracy of triage decisions but also improves the overall efficiency of the emergency department. In conclusion, the intelligent triage assistant enhances the triage process by providing rapid, accurate assessments and improving patient management. This advancement aligns with healthcare standards and addresses the issues identified in traditional triage methods. The successful implementation of such a system underscores the potential of chatbots and artificial intelligence to revolutionize emergency care, offering a model that other healthcare facilities facing similar challenges might consider adopting.

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استخدام روبوتات الدردشة في دعم التقييم الأولي والتمريض الطارئ: مقال مراجعة

الملخص:

الخلفية: تُعتبر عملية التقييم الأولي أساسية في الرعاية الطارئة، حيث تقوم بترتيب أولويات العلاج للمرضى بناءً على درجة الاستعجال، مما يضمن حصول الأشخاص الذين يحتاجون إلى رعاية حرجة على اهتمام فوري. تواجه المستشفيات تحديات في نظام التقييم الأولي بسبب نقص عدد طاقم التمريض وارتفاع أعداد المرضى، مما أدى إلى عدم الكفاءة والمخاطر في رعاية المرضى.

الهدف: يهدف هذا الدراسة إلى معالجة عدم الكفاءة في عمليات التقييم الأولي في المستشفيات من خلال تطوير مساعد ذكي للتقييم الأولي يستفيد من تقنية روبوتات الدردشة لتسريع قرارات التقييم، وتعزيز إدارة المرضى، والامتثال لمعايير الرعاية الصحية.

الطرق: تم تطوير المساعد الذكي للتقييم الأولي باستخدام#C Visual Studio ، وMicrosoft SQL Server، و QnA Maker. يدمج قاعدة معرفة مبنية على بيانات المرضى ومدخلات الخبراء لتصنيف المرضى إلى مستويات الاستعجال وتوجيههم إلى مناطق الرعاية المناسبة. تم تقييم وظيفة النظام بناءً على قدرته على تحسين كفاءة ودقة التقييم الأولي.

النتائج: قلل روبوت الدردشة بفعالية من مدة عملية التقييم الأولي من خلال تقييم حالة المرضى على الفور، وتعيين مستويات الاستعجال، وتوجيه المرضى بناءً على استعجالهم. ساعد الروبوت الممرضين الأقل خبرة والموظفين غير الطبيين، مما أدى إلى تحسين سير العمل وتقليل أوقات الانتظار للمرضى.

الخلاصة: يعزز تنفيذ المساعد الذكي للتقييم الأولي التلقائي بشكل كبير من عملية التقييم الأولي من خلال تقديم تقييمات وتوصيات سريعة ودقيقة. تدعم هذه التحسينات نتائج المرضى بشكل أفضل والامتثال لمعايير الرعاية الصحية. تقدم روبوتات الدردشة دعمًا قيمًا في بيئات الرعاية الطارئة من خلال تحسين كفاءة التقييم الأولي وتوزيع الموارد.

الكلمات المفتاحية: روبوتات الدردشة، التقييم الأولي، التمريض الطارئ، المساعد الذكي للتقييم الأولي، كفاءة الرعاية الصحية، إدارة المرضى.