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Machine Learning based Integrated Hospital Appointment Booking and Queue Management System

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Abstract

Hospitals have a growing challenge of long queues and consequently more waiting time for patients. Hospitals can better manage resources and anticipate more inflow of patients through estimations on patient count. In this paper, we propose a web-based Machine Learning based Integrated Hospital Appointment Booking and Queue Management System that aims to reduce the queue time of patients and forecast the number of patients present at a given hour of the day. Queue time reduction is done by generating a unique token number for every patient which is used to lead him directly to the respective department and patient forecasting is done using Demand Forecasting which is a Machine Learning Regression Algorithm to predict future patient count at a particular hour of the day. The results can help patients make a better decision of choosing a less crowded time. This will also help the hospital to manage the patient crowd, logistics and resources more efficiently.

Keywords — Hospital, queue, patient, integration, Integrated, doctor, web-based, demand forecasting, machine learning, token.

Introduction

The medical field has made remarkable progress in end of twentieth and the initial twenty first centuries. With this emerges high specialized hospitals for serving patients. Nowadays most of the hospitals are overcrowded with patients. A growing issue in hospitals today is that patients do not have an idea of how much time they will have to spend in a queue to reach the reception desk and further to the doctor. It may affect patients' symptoms, clinical outcome, and satisfaction. It can also affect physician's effectiveness, causing frustration among medical staff. The queues in hospitals are increasing day by day and patients should have an approximate estimate of the number of patients that might be present at the time they arrive.

Machine Learning based Integrated Hospital Appointment Booking and Queue Management System is a proposed system solution to tackle this problem. It is an integrated system which displays a hospital's working departments for patients to choose from, forecasts approximate count of patients at a particular hour of day and generates a unique Token Number for patients which is used throughout their process. Also, this system is integrating multiple hospitals on one platform to enhance the convenience of the patients. It aims to reduce the queue time of patients with the help of Demand Forecasting using Regression and generation of the token number. The proposed forecasting system simulates the process of predicting the future count of patients at any hour of the day using real time dataset of the hospital and the token number ensures that the patient is able to reach the department directly by bypassing the registration phase completely.

There are many hospitals who are already having their portals but do not revert to the query or appointment details that are being made after registration. It is painstaking for patients if they have to visit the doctor for the appointments physically and then wait until they can meet the doctor. It has been observed that the doctors are on duty at different places during the entire day. In case of an emergency the doctor may reach late and the patients would be waiting in mass numbers. In such cases, this project can resolve the issue by giving the patients a token number along with demand forecasting benefits. The accuracy of the system is positive as the prediction is made using Demand Forecasting, a machine learning algorithm which uses historical patient arrival-time data to make a prediction on the number of patients that might be present for a future hour at the hospital. It is a combination of the prediction made on weekends and weekdays, which gives an approximation of when a patient might be able to visit the doctor.

The directed flow of the system starts with the patient registering himself on the page after which he needs to login and choose the hospital's department and time of the day for booking an appointment. After choosing the time, the patient may have the option to see the forecasted count of patients for the chosen hour on that day. After successful registration, he will receive the token number for the whole process. Using the token number, he/she skips the registration process as they already has the appointment slip and can directly go their respective department for check-up or consultation.

The goal of this project is to digitalize and simplify the queue system and predict the futuristic time duration that a patient would be required to wait.

Literature Survey

Sr. No	Title of the paper	Year of publication	Algorithm/ technique/ tools used	Accuracy/ Result Achieved	Remarks
1.	Patient waiting time prediction in hospital queuing system using improved random forest in big data	2019	This research paper is based on incremental patient treatment time prediction (IPTTP) algorithm which is an improved random forest method	The application states that the proposed IPTTP and HQR system could reduce patient waiting times by 25% compared to the current system. The paper also shows that the proposed system can process big data efficiently and without delay.	This paper presents a new method that uses big data and machine learning to solve patient waiting time estimation and treatment planning confirmation problems in hospital queuing systems.
2.	Machine learning based forecast for the prediction of inpatient bed demand	2022	A machine learning (ML)-based strategy to predict weekly hospital admissions to help plan resources in emergency departments and	The paper shows that the proposed model can reduce patient waiting time by 25% compared to the existing model.	A new and effective method for predicting hospitalization rates using ML techniques, specifically K-SVR.

			PACUs, leading to better utilization.		
3.	Mobile-Augmented Smart Queue Management System for Hospitals	2020	The project utilizes smart algorithms for token generation and allocation, including dynamic queue generation.	The Mobile-Augmented Smart Queue Management System offers a comprehensive solution for streamlined queue management.	The system is designed to be easily integrated with an operational Hospital Management Information System.
4.	Automated Queue Management System	2016	The project utilizes two queuing algorithms - First Come First Serve (FCFS) and Shortest Processed First (SPF)	Queuing system, which switches between FCFS and SPF based on testing results, demonstrated a significant reduction in the average waiting time.	The research showed that the proposed automated queue management system, which dynamically selects the queuing algorithm based on testing results.
5.	Smart Queue Management System with Real Time Tracking Using DNN	2020	Image processing with real-time person detection using the OpenCV platform and CNN (Convolutional Neural Network) algorithm. Predictive analysis using machine learning algorithm, (Deep Neural Network)	The specific accuracy or result achieved is not mentioned in the provided extract.	The proposed system aims to minimize dissatisfaction with services due to medium to long waiting times in queues. It enables the administration to receive inputs about mishandling or long queue inefficiencies through a Wi-Fi module.

After conducting primary research of various hospitals in Nagpur we analysed:

- Currently, the online booking portals of hospitals are either not very efficient or do not have a working page.
- Confirming appointments from the hospitals is a time-consuming process as they connect you with a hospital representative who might not necessarily confirm and book the appointment. Sometimes it also happens that the portal doesn't allow the patient to book the appointment and he/she ultimately has to visit the hospital to book an appointment.
- The booking portals of these hospitals display a dropdown list of doctors from various departments but in maximum situations patients are unaware of the doctors unless referenced hence choosing the name of doctor from the dropdown list is futile.

Contrary to the web-systems of the above hospitals, the system of AIIMS Nagpur is very well-organized and handles patient queues efficiently. By referencing a news article on AIIMS Nagpur's new system and visiting and meeting with the queue management in-charge of the hospital, we understood their token management and queue system. With the insights gained, we are developing a Machine Learning based Integrated Hospital Appointment Booking and Queue Management System.

Problems

By conducting primary research, some of the problems identified are:

1. Patients have to wait in long queues without having the knowledge of when their number will be called and when they will be able to consult the doctor.
2. Hospital's efficiency of handling the patients and resources gets hampered in the whole process.
3. Patients do not have a fixed booking confirmation and the time they choose is subject to changes most of the times depending on the situation at that particular moment.
4. Online Appointment Scheduling is a challenge sometimes as many hospitals do not have working portals to schedule bookings or they are unable to connect the person trying to book the appointment with the booking scheduler.

Proposed Methodology

The Machine Learning based Integrated Hospital Appointment Booking and Queue Management System aims to reduce the queue time of patients and the proposed system has the following modules:

1. **Registration/Login** – Register and Login: At very first, a person need to register from the registration page by entering the required fields which include - name, age, contact number, email and password. Name includes first and last name. Contact number must be without ISD code and of 10 digits only. Password must be strong which must include at-least six letters including uppercase alphabet, lowercase alphabet, one number and at-least one special character. Further, to access the website they need to login using email and password. Once they login successfully they can access the website further.

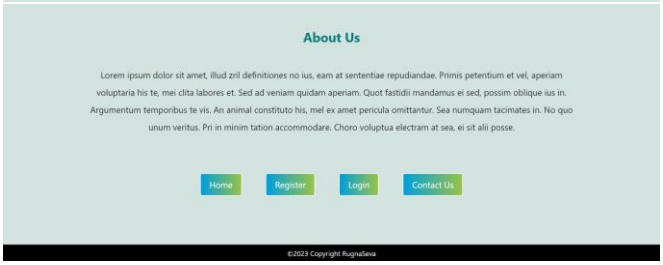
2. **Department & Hospital Selection** – Department & Hospital Selection – After logging in, the patient can choose the department from where he wants to consult the doctor. Once the patient select the department, he will be asked to choose the Hospital based on department selected. Further, patient need to enter their details which include full name, symptoms, date and time of appointment, age. Here, they can see the selected department and hospital so that there not any confusion while submitting the appointment form.

3. **Acknowledgment and Download Slip** – After submitting the details appointment get booked and a page with submitted details get displayed which include the system generated unique token number. Token number includes name of the department selected and queue count number. Example: Cardiology-25. Patient can easily download the slip by simply just clicking on print slip button.

4. **Machine Learning** – In Hospital module, the hospital admin need to login by valid credentials. By entering correct credentials, staff may login and operate the system with functionalities it consist. The account details are only at the backend. As the appointment get booked by the patient, hospital's page get automatically updated with the new entry. New entry is added to respective table of the department. It also includes Machine Learning based demand forecasting - Future Hour Prediction of Patient Count which is predicted based on earlier appointment of the patient.

Implementation

Fig: Home Page



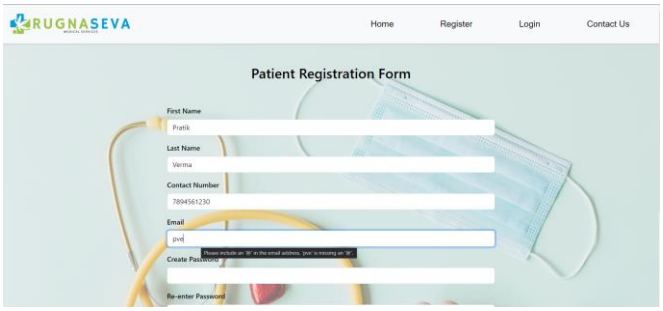


Fig:Registration Page

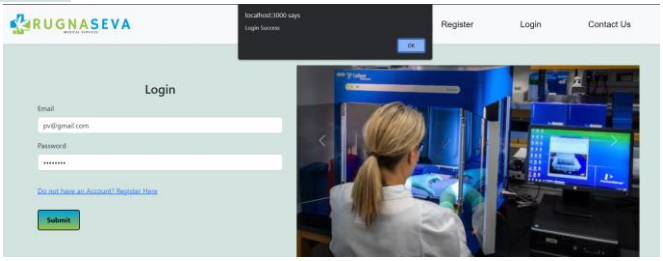


Fig:Login Page

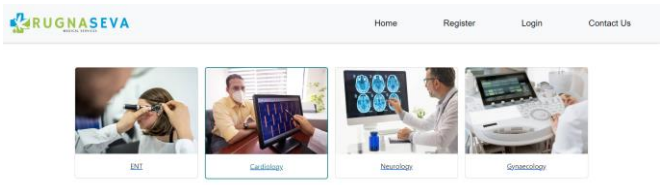


Fig:Select Department

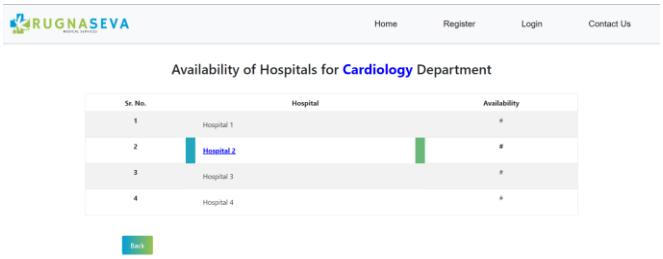
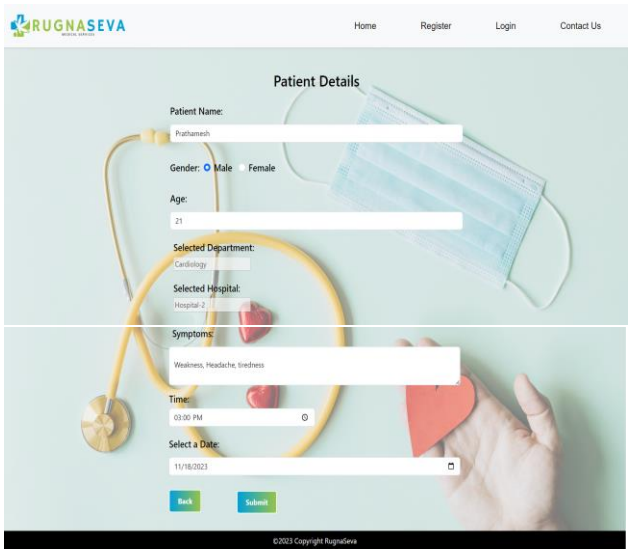
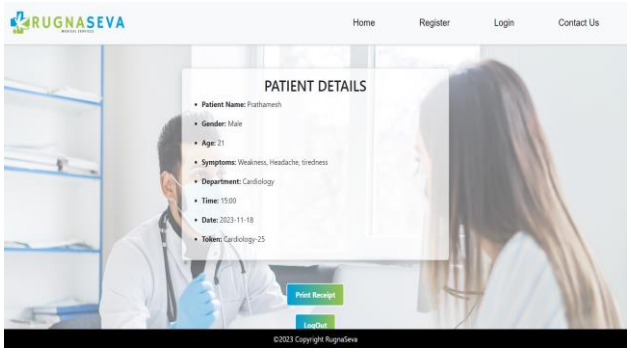


Fig:Select Hospital



Enter Patient Details



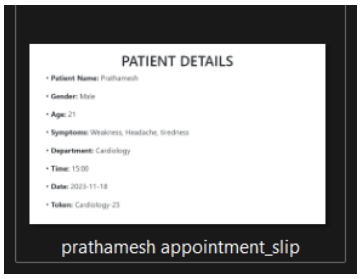


Fig:Slip Generation and Download

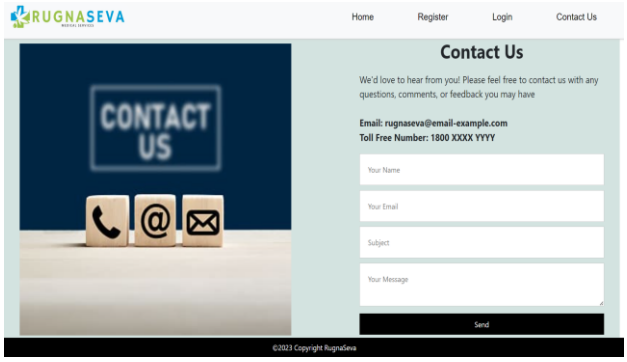


Fig: Contact us

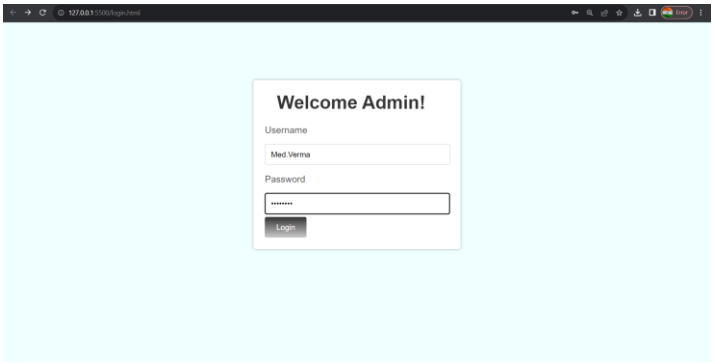
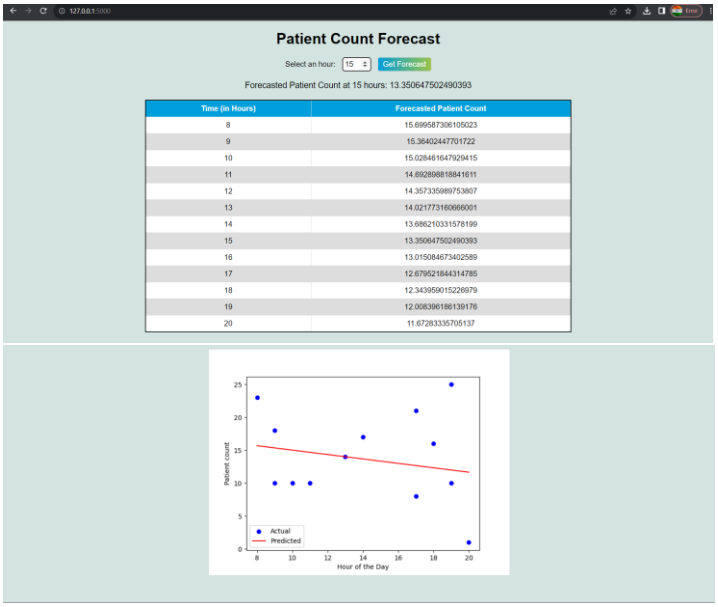


Fig: Hospital side Login

Fig: Home: Select Department for Patient details or Open Future Predicted Patient Count



PATIENT INFORMATION

Cardiology Gynaecology ENT Neurology

Cardiology Department

Name	Symptoms	Gender	Department
pratik	ureaysvhs	male	Cardiology
PRATIK	jh	male	Cardiology
pratik v	852svaervv	male	Cardiology
PRATIK VERMA	vr we	male	Cardiology
pratik v	reer aerer	male	Cardiology
PRATIK VERMA	iuegrivb	male	Cardiology
PRATIK	wefwe	male	Cardiology
Pratik Arvind Verma	jh	Male	Cardiology
Pratik Arvind Verma	aryfva	Male	Cardiology
Pratik Arvind Verma	rygycv	Male	Cardiology
PRATIK VERMA	Head ache	Male	Cardiology
Pratik Arvind Verma	rger erfeerv weffwelf	Male	Cardiology
Prathamesh	Weakness, Headache, tiredness	Male	Cardiology

Gynaecology Department

Name	Symptoms	Gender	Department
PRATIK	wewe awervwe	male	Gynaecology
PRATHAMESH	wefwe	Female	Gynaecology
PRATIK	wefwef	Male	Gynaecology
PRATIK	vr we	Male	Gynaecology
PRATHAMESH	wewfwe wew	Male	Gynaecology
TEST TEST	wef	Male	Gynaecology
DDDDD	WEF	Male	Gynaecology

ENT Department

Name	Symptoms	Gender	Department
PRATIK	852svaervv	Male	ENT
PRATIK	reer aerer	Male	ENT
PRATIK	wewe awervwe	Male	ENT
PRATIK	wefwfe	Male	ENT
PRATHAMESH	rrwg qqr	Male	ENT
PRATHAMESH	qqfqf	Male	ENT
qwerr	wefew wef	Male	ENT
Pratik Arvind Verma	WKEfwb ew;ueffbwuf ;wulfqwj3 fiuw	Male	ENT

Neurology Department

Name	Symptoms	Gender	Department
Pratik Arvind Verma	rtbbrb rtb 4uub	Male	Neurology
Pratik Arvind Verma	weewg		Neurology
PRATIK VERMA	gjmhj	Male	Neurology
PRATIK VERMA	ddfv	Male	Neurology
PRATIK VERMA	gddhty	Male	Neurology
AAAA	rgwrgwr eerb	Male	Neurology
BBBB	wew	Male	Neurology

Technologies used:

- HTML
- CSS
- JS
- React
- Bootstrap
- Java + Spring Boot
- MySQL
- Python
- Flask
- NodeJS

Tools used:

- Visual Studio (VS) Code
- Intellij IDEA Ultimate
- MySQL Shell and Workbench

- **Future Scope**

The future expansion of this system includes, but not only limited to the following services:

- **Blood & Organ Donation:** Find blood bank & donor near you
- **Test Lab booking:** Lab test booking, also tests at patient's doorstep
- **Ambulance Service:** Book ambulance using GPS for precise location & faster service
- **On-call / Video-call consultation:** Book virtual consultation with doctors
- **AI-ChatBot:** For enquiry about booking process, booked slots, change in slot and other

- **Conclusion**

The Machine Learning based Integrated Hospital Appointment Booking and Queue Management System is a system that will help to reduce the queue time from hours to minutes using Hourly Demand Forecasting and Future Hour Prediction of Patients. This will not only help to manage queue but also improve the efficiency of Hospital Management.

There is a lot of research available on queuing analysis related to a variety of hospital services such as cardiac care units, operating rooms, and emergency services. However, due to a lack of real-world validation, many proposed queuing models have yet to be adopted by hospital authorities. Therefore, there is a need to explore the utility and implications of queuing theory by validating a simple queuing model in a busy hospital of India.

The system can be initially implemented in few hospitals where the process is to some extent streamlined. Further, after testing and based on efficiency it can be used as fully functional with nation-wide implementation.

- **References**

[1] "Patient waiting time prediction in hospital queuing system using improved random forest in big data," ieeexplore.ieee.org. https://ieeexplore.ieee.org/document/8977717 (accessed Oct. 23, 2023).

[2] S. Burungale, K. Kurane, S. Mhatre, and P. Deepali Vora, "Patient Queue Management System," 2018. Accessed: Oct. 23, 2023. [Online]. Available: https://ijesi.org/papers/Vol%287%29i2/Version-2/G0702023941.pdf

[3] D. Yaduvanshi, A. Sharma, and P. V. More, "Application of Queuing Theory to Optimize Waiting-Time in Hospital Operations," Operations and Supply Chain Management: An International Journal, p. 165, 2019, Available: https://www.academia.edu/56104107/Application_of_Queuing_Theory_to_Optimize_Waiting_Time_in_Hospital_Operations

[4] N. Titarmare and A. Yerlekar, "A Survey on Patient Queue Management System," International Journal of Advanced Engineering, Management and Science, vol. 4, no. 4, p. 229, 2018, Accessed: Oct. 23, 2023. [Online]. Available: https://www.academia.edu/36597498/A_Survey_on_Patient_Queue_Management_S

[5] E. Benevento, D. Aloini, and N. Squicciarini, "Towards a real-time prediction of waiting times in emergency departments: A comparative analysis of machine learning techniques," International Journal of Forecasting, Dec. 2021, doi: https://doi.org/10.1016/j.ijforecast.2021.10.006.

[6] K. Anil and R. Jain, "A Review on Datamining Techniques in Healthcare Sector," SSRN Electronic Journal, 2022, doi: https://doi.org/10.2139/ssrn.4019442.

[7] S. Lee, K. Xie, D. Ngoduy, and M. Keyvan-Ekbatani, "An advanced deep learning approach to real-time estimation of lane-based queue lengths at a signalized junction," Transportation Research Part C: Emerging Technologies, vol. 109, pp. 117–136, Dec. 2019, doi: https://doi.org/10.1016/j.trc.2019.10.011.

[8] Q. Xu, K.-L. Tsui, W. Jiang, and H. Guo, "A Hybrid Approach for Forecasting Patient Visits in Emergency Department," Quality and Reliability Engineering International, vol. 32, no. 8, pp. 2751–2759, Oct. 2016, doi: https://doi.org/10.1002/qre.2095.

[9] M. K. Pandey and D. K. Gangeshwer, "Application of Queuing Theory to Analysis of Waiting Time in the Hospital," International Journal Bioautomation, vol. 27, no. 3, pp. 139–146, Sep. 2023, doi: https://doi.org/10.7546/ijba.2023.27.3.000904.

[10] M. Ngorsed and P. Suesaowaluk, "Hospital Service Queue Management System with Wireless Approach," Lecture Notes in Electrical Engineering, pp. 627–637, 2016, doi: https://doi.org/10.1007/978-981-10-0539-8_61.

[11] Y.-H. Kuo et al., "An Integrated Approach of Machine Learning and Systems Thinking for Waiting Time Prediction in an Emergency Department," International Journal of Medical Informatics, vol. 139, p. 104143, Jul. 2020, doi: https://doi.org/10.1016/j.ijmedinf.2020.104143.

[12] M. Tello et al., "Machine learning based forecast for the prediction of inpatient bed demand," BMC Medical Informatics and Decision Making, vol. 22, no. 1, Mar. 2022, doi: https://doi.org/10.1186/s12911-022-01787-9.

[13] B. C. Paul, N. Kumar, A. Kumar, and S. K. Neogy, "'Queuing-Model' to optimize Patient waiting time in Out Patient Department (OPD) of a Super-speciality...," ResearchGate, Dec. 2021, [Online]. Available: https://www.researchgate.net/publication/356749884_%27Queuing-Model%27_to_optimize_Patient_waiting_time_in_Out_Patient_Department_OPD_of_a_Super-speciality_public_hospital_of_India

[14] U. Naiker, G. FitzGerald, J. M. Dulhunty, and M. Rosemann, "Time to wait: a systematic review of strategies that affect out-patient waiting times," Australian Health Review, vol. 42, no. 3, p. 286, Jan. 2018, doi: 10.1071/ah16275.

[15] M. A. Baballe, "Hospital queue management systems' effects," ResearchGate, Sep. 2022, [Online]. Available: https://www.researchgate.net/publication/363800747_Hospital_Queue_Management_Systems'_Effects

[16] Q. Zhai et al., "Using machine learning tools to predict outcomes for emergency department intensive care unit patients," Scientific Reports, vol. 10, no. 1, Dec. 2020, doi: 10.1038/s41598-020-77548-3.

[17] F. Gorunescu, S. McClean, and P. Millard, "A queueing model for bed-occupancy management and planning of hospitals," Journal of the Operational Research Society, vol. 53, no. 1, pp. 19–24, Jan. 2002, doi: 10.1057/palgrave/jors/2601244.