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ORIGINAL

Investigation of the dynamic system of providing medical services in the hospital for Covid-19 disease patients

Investigación del sistema dinámico de prestación de servicios médicos en el hospital para pacientes con la enfermedad de Covid-19

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Abstract

Introduction and objective: Hospitals are among the social organizations that play a major role in improving the health status of the country and providing health services. The speed of providing health services and the fact that patients do not wait too long to receive these services are among the factors that are considered as the quality of medical services in each hospital. Especially in the current situation, which is very important in hospitals due to coronary heart disease. Therefore, the purpose of this study is to design a dynamic model to study the system of hospital services.
Methods: In this study, first, important and influential factors in the system of providing health services in the hospital were identified through literature review, and after drawing the causal relationships between these factors, the flow accumulation diagram of the system was designed and used using a simulator and a simulator. Was made.
Results and conclusion: results of this study show that hospital management by increasing the number of physicians and increasing the number of hospital beds, can create conditions to improve the quality of health services.

Key words: Dynamic model, health services, hospital, systems dynamics.

Resumen

Introducción y objetivo: Los hospitales se encuentran entre las organizaciones sociales que desempeñan un papel importante en la mejora del estado de salud del país y en la prestación de servicios sanitarios. La rapidez en la prestación de servicios sanitarios y el hecho de que los pacientes no esperen demasiado tiempo para recibir estos servicios son algunos de los factores que se consideran como la calidad de los servicios médicos en cada hospital. Especialmente en la situación actual, que es muy importante en los hospitales debido a las enfermedades coronarias. Por lo tanto, el propósito de este estudio es diseñar un modelo dinámico para estudiar el sistema de servicios hospitalarios.
Metodología: En este estudio, en primer lugar, se identificaron los factores importantes e influyentes en el sistema de prestación de servicios sanitarios en el hospital a través de la revisión de la literatura, y después de dibujar las relaciones causales entre estos factores, se diseñó el diagrama de acumulación de flujo del sistema y se utilizó utilizando un simulador y un simulador. se realizó.
Resultados y conclusión: Los resultados de este estudio muestran que la gestión del hospital, al aumentar el número de médicos y el número de camas del hospital, puede crear condiciones para mejorar la calidad de los servicios sanitarios.

Palabras clave: Modelo dinámico, servicios sanitarios, hospital, dinámica de sistemas.

Introduction

The new coronavirus (Covid-19) is caused by acute respiratory syndrome. The disease was first diagnosed in December 2019 in Hubei Province, Wuhan City, China. On March 11, 2020, the World Health Organization declared the virus a pandemic. According to the latest global statistics of the World Database, as of November 8, 2020, 27 million 327 thousand 404 people in the world have been infected with this virus, of which one million 211 thousand 428 people have died. The economic shock of the Corona outbreak has also led to negative economic effects, including declining sales of many related businesses[1-2]. One of the important concerns of countries is to prevent this disease and predict ways to control and reduce it3-4. The results show that the correct use of the mask and the observance of social distance as well as air flow in spaces and avoidance of closed spaces have a significant effect on reducing the spread of the disease and reducing mortality[5-8].

In this project, corona prediction is investigated with a systems dynamics approach. First, the relationships of important effective variables on the development of the disease are obtained in SPSS software and then the data is analyzed using Vensim software. In the following, by analyzing the sensitivity and providing recommendations, the effect of vaccines to control the conditions of this new crisis will be examined.

Literature review

High quality of services provided in the hospital is related to issues such as patient satisfaction, efficiency and superiority of the organization, but low quality leads to poor service, which in turn leads to higher prevalence of the disease, higher costs and less trust in the health system[4-5].

Zarei et al in a study aimed at comparing the quality of services from the patient's perspective in the emergency department of public and private hospitals under the auspices of Shahid Beheshti University of Medical Sciences in 2015. In this study, 373 discharged patients from 8 public and private hospitals were selected by convenience sampling method. Data were analyzed using descriptive statistics, Mann-Whitney and multivariate regression tests in SPSS software. The results of this study show that the quality of emergency services in private hospitals is better than public hospitals. They stated that the management of the hospitals should pay more attention to the aspects of education before discharge and follow-up treatment, as well as prompt treatment, and by giving educational booklets to the patient during discharge, along with telephone follow-up and reduction. Waiting times increase patient satisfaction by re-engineering care processes.

Bozorgi et al conducted a study to determine the speed of emergency services and related factors in the 5-level triage system in Imam Khomeini Medical Center in Sari. This cross-sectional study was performed in December 2012 at Imam Khomeini Medical Center in Sari. They reviewed medical records and patient triage sheets by completing data collection forms and calculating the speed of action taken for each patient. The number of samples was 365, statistical analysis was performed using SPSS16 statistical software and data were analyzed by chi-square and Anova tests. The results of this study showed that there is a significant relationship between work shift and the time of access to the doctor and services and patient assignment. There was a significant relationship between the patient's level with the time of access to the doctor and services and assignment. In the end, it was found that the time of providing services in the emergency department of Imam Sari Hospital, which uses a 5-level triage system, is short and the speed of providing services is at the desired level.

Identify factors and determine causal relationships

Many variables and factors affect the system that can affect the behavior of the model. Like all economic, social, etc. systems, the health care delivery system is influenced by several factors that are related to each other.

The first step to build a model in the science of system dynamics is to identify important factors and variables affecting the system under study so that based on these variables can determine the model boundary and determine the causal relationships.

Factors affecting the model of this research and interactions and causal relationships between these factors were identified with the help of experts.

Figure 1 shows the causal relationships between the model variables in our study.

After identifying the variables and drawing a causal diagram, the type and nature of the variables should be determined and then the accumulation-flow diagram of the model should be drawn. The list of variables used in the model and their type and nature are given in **table I**.

After determining the type of variables, the accumulation-flow diagram of the model was plotted as shown in **figure 2**.

Figure 1: Causal diagram of medical services delivery system. Accumulation-flow diagram.

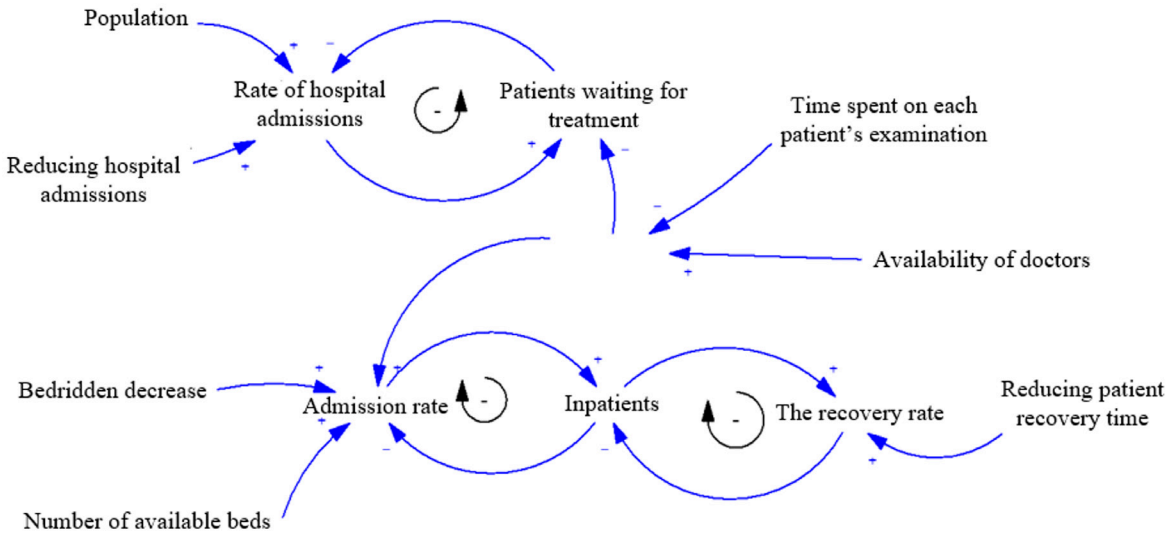

Figure 2: Accumulation-flow diagram of the health care delivery system.

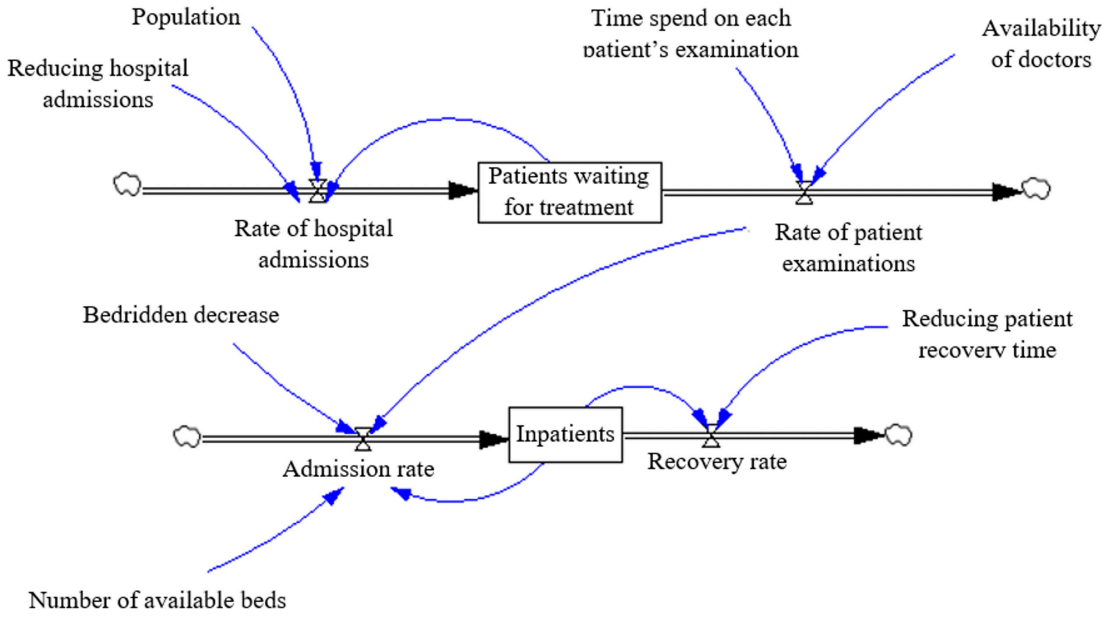

Table I: Variables used in the model.

Name of a variable	Type of variable	The variable's nature	Name of a variable	Type of variable	The variable's nature
Population	Subsidiary	External	Admission rate	Rate	Internal
Rate of hospital admissions	Rate	Internal	Patients waiting for treatment	Accumulation	Internal
Time spend on each patient's examination	Subsidiary	External	Reducing hospital admissions	Subsidiary	External
Availability of doctors	Subsidiary	External	Number of available beds	Subsidiary	external
Reducing patient recovery time	Subsidiary	External	Bedridden decrease	Subsidiary	external
Recovery rate	Rate	Internal	Rate of patient examinations	Rate	Internal
Inpatients	Accumulation	Internal			

Simulation

After drawing the flow accumulation diagram, in order to simulate the model, it is necessary to write a formula that the formulas used in the research model are:
(01) FINAL TIME = 168
Units: Hour
The final time for the simulation.
(02) INITIAL TIME = 0
Units: Hour
The initial time for the simulation.
(03) SAVEPER =
TIME STEP
Units: Hour [0 ,?]
The frequency with which output is stored.
(04) TIME STEP = 1
Units: Hour [0 ,?]
The time step for the simulation.
(05) Inpatients = INTEG (hospitalization rate-recovery rate, 20)
Units: ** undefined **
(06) Patients waiting in the treatment queue = INTEG (Patient examination rate-Patient admission rate, 150)
Units: ** undefined **
(07) Number of beds available = 200
Units: ** undefined **
(08) Number of available physicians = 15
Units: ** undefined **
(09) population = 900000
Units: ** undefined **
(10) Mean examination time per patient = 0.1
Units: ** undefined **
(11) Hospitalization rate = IF THEN ELSE (hospitalized patients> = number of available beds, 0, hospitalization deduction * patient examination rate)
Units: ** undefined **
(12) Recovery rate = Patient recovery fraction * Inpatients
Units: ** undefined **
(13) Patient examination rate = number of available physicians * Average examination time per patient
Units: ** undefined **
(14) Patient admission rate = patients waiting in the treatment queue / (population * patient admission deduction)
Units: ** undefined **
(15) Hospitalization fraction = 0.9
Units: ** undefined **
(16) Patient recovery fraction = 0.001
Units: ** undefined **
(17) Patient admission deduction = 0.001
Units: ** undefined **

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After formulating the model, the structure of the model equations should be examined by vensim software. **Figure 3** shows the accuracy of the structure of the equations used in the model.

After confirming the model structure, we simulated the model for a period of 168 hours. The results of model simulation are shown in **figures 4** and **5**.

Figure 3: Shows the accuracy of the structure of the equations used in the model.

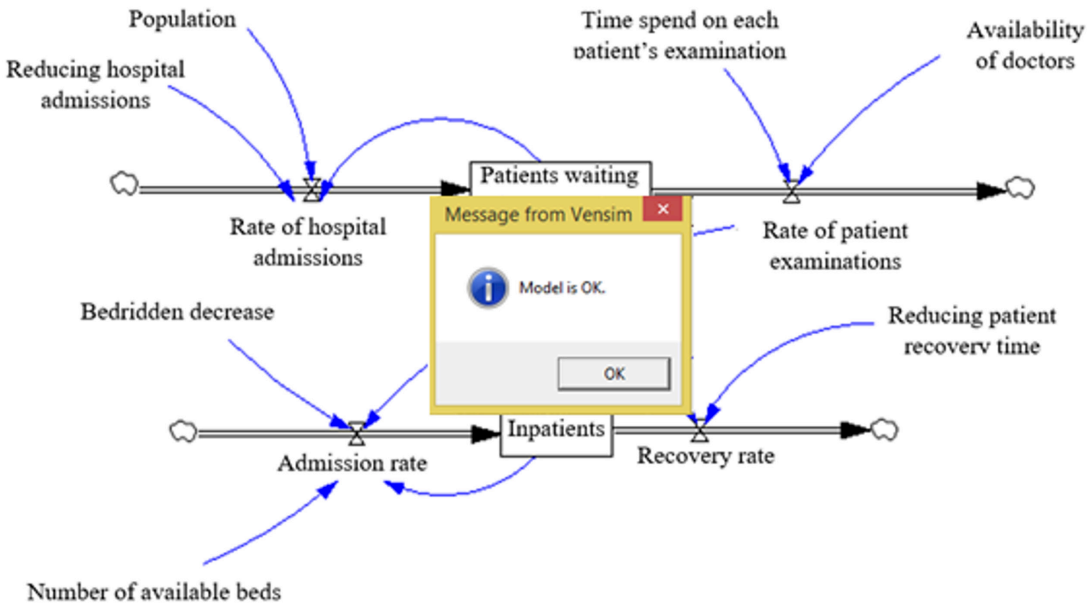


Figure 4: Patients waiting in the treatment queue during the simulation time.

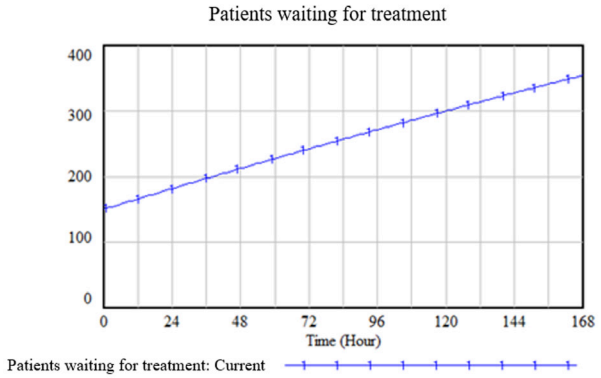
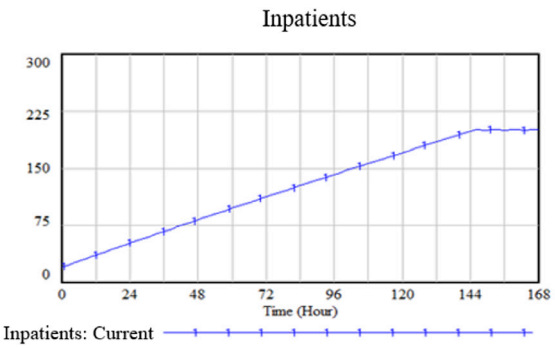


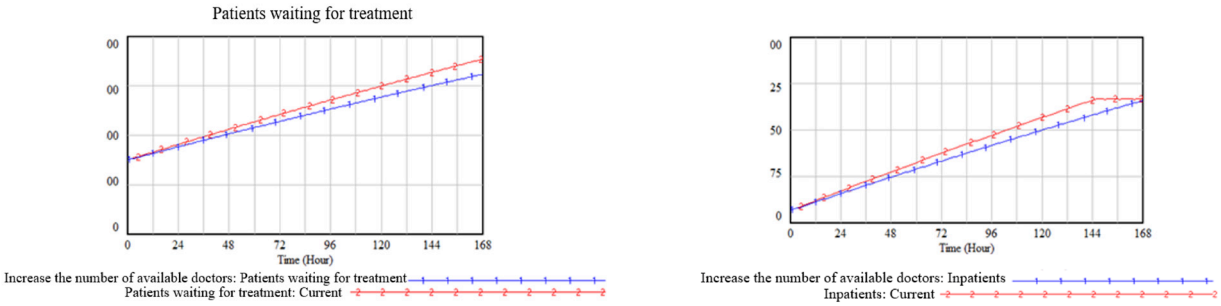
Figure 5: Patients admitted during the simulation time.



Excessively waiting for patients to receive medical services has always been an annoying issue for patients, which will have a negative impact on the quality of service. Therefore, it is necessary to review different policies to reduce patients waiting in the treatment queue.

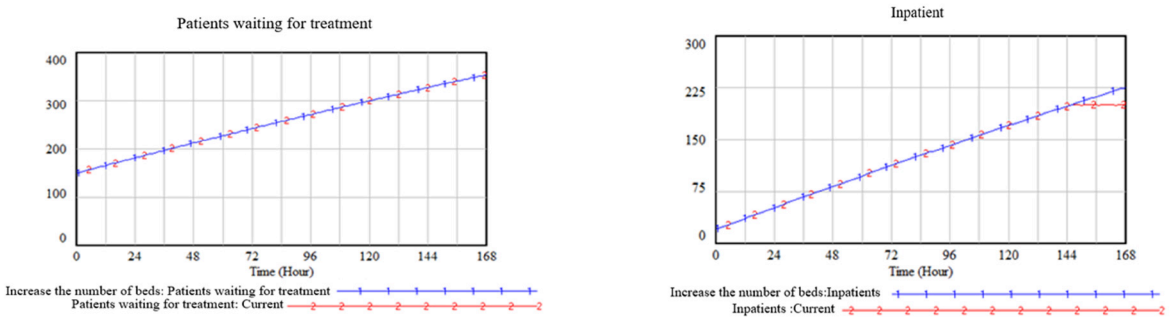
Policy to increase the number of hospital physicians and treatment staff: As the number of hospital physicians increases, the speed of service to patients increases and as a result, the number of people waiting in the treatment queue decreases. The changes to this policy are shown in **figure 6**.

Figure 6: Changes resulting from the implementation of the policy of increasing the number of hospital physicians.



Policies to increase the number of beds: Patients who go to the hospital and are examined by a doctor, are either treated on an outpatient basis and are discharged from the hospital, or need to be admitted if the hospital does not have enough beds. Can accept a new patient for hospitalization and therefore the patient has to go to another medical center or hospital, which can be unpleasant for the patient. Since another factor that affects the quality of medical services is the timely and rapid provision of services to patients and the lack of sufficient beds is a negative factor to determine the quality of the hospital, so increase the number of beds. Hospitals can be an effective measure to improve the speed of providing medical services to patients. **figure 7** shows the changes resulting from this policy.

Figure 7: Changes resulting from the implementation of the policy of increasing the number of hospital beds.



Conclusion

Hospitals are among the social organizations that play a major role in improving the health status of the country and providing health services. The speed of providing health services in Mani and not waiting too long for patients to receive these services are among the factors that are considered as the quality of the level of medical services in each hospital. The results of model simulation and application of different policies show that hospital management by increasing the number of physicians can reduce the waiting time of patients in the treatment queue and lead to patient satisfaction with the quality of medical services. Also, increasing the number of hospital beds increases the capacity of the hospital to accept patients who need to be admitted, and as a result, the probability that the patient needs to be admitted but due to the lack of beds, the hospital will not be able to accept it will be less. This issue also increases patients' satisfaction with the level of quality of medical services.

Conflict of Interest

The authors declare that they have no conflict of interest.

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