Original Article

Decreased Emergency Department Overcrowding by Discharge Lounge: A Computer Simulation Study

Abstract

Background: In the past decade, factors such as population growth, increased environmental incidents, and substance abuse have caused patient-overcrowding in emergency departments (EDs). Our main objective was to assess the effects of a discharge lounge on decreasing the patient waiting time and ED overcrowding by computer simulation. **Methods:** In this cross-sectional retrospective study, the statistical population consisted of 39264 persons referred to the ED of Al-Zahra Hospital. The sample size was calculated as 1275 through systematic random sampling at 99% confidence. To increase research accuracy, the number of patients was increased to 2515. Data were collected by standardized checklists and hospital information systems. **Results:** Mean waiting time for level 2 patients who left the ED against medical advice after completing the treatment was declined from 56 min to 44 min and before completing the treatment process from 80 min to 50 min. Average waiting time for level 3 patients for personal satisfaction after completing the treatment process decreased from 15 min to 13 min and before the completion of the treatment process from 67 min to 41 min; the number of discharged patients awaiting discharge was decreased at level 2 from 3 to 2 and at level 3 from 2 to 1. The number of patients waiting for admission at triage stations reduced from 44 to 39%, and the average number of patients discharged from emergency room was increased from 7 to 12. **Conclusions:** ED overcrowding is the hallmark of a mismatch between the availability of health care resources and patient demand for emergency care. Among major factors contributing to these situations are hindrances in patient flow and occupation of ED beds by nonurgent patients. The establishment of a discharge unit in the ED could be a practical solution to ED overcrowding.

Keywords: *Computer simulation, discharge unit, emergency department, hospital*

Mehdi Nasr Isfahani, Fereshte Davari[1], Reza Azizkhani, Majid Rezvani[2]

Department of Emergency Medicine, Isfahan University of Medical Sciences, Isfahan, Iran, [1]Health Management and Economics Research Center, Isfahan University of Medical Sciences, Isfahan, Iran, [2]Department of Neurosurgery, Isfahan University of Medical Sciences, Isfahan, Iran

Address for correspondence:
Dr. Fereshte Davari, Health Management and Economics Research Center, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: davari_angel@yahoo.com

Introduction

A hospital, with regard to its functional jurisdiction, could be considered the most important health care institution and even a medico-social organization. Comprehensive health care services are in fact provided mainly by hospitals in many countries. Emergency departments (EDs), due to their nature, are considered one of the most vital parts of a hospital, with its main role in providing emergency medical services.[1] Throughout the country,[2] with respect to the number of patients in need of diagnostic or treatment measures, ED is considered as the most complicated operational and clinical setting in modern hospitals. Al-Zahra hospital has more than 100,000 patients admitted annually with near 1000 beds, of which over 100 beds are assigned for the ED.[3] The necessity for complex, multiple, prompt, high quality and efficient processes makes the ED of paramount importance.

An inverse correlation exists between waiting time (WT) for medical care and patient outcome.[4] The long WT and length of stay of patients in EDs are the result of inefficient workflow process in three stages: entering the ED, providing emergency care, and leaving the patient.[2,3,5-7]

Studies show that WT for medical services and ED throughput time has a key role in patient outcome and satisfaction.[3] Despite a lack of increase in the number of emergency rooms during recent years, factors such as population growth, increased intentional or unintentional injuries along with drug abuse in previous decades have contributed to ED overcrowding.[8] ED overcrowding is a sign of mismatch between health system supply and patients' demands for prompt and convenient services.[9]

In the ED, time is important for patients but also are determining factors in death, serious disabilities, or the quality of life.[1,4,5]

How to cite this article: Nasr Isfahani M, Davari F, Azizkhani R, Rezvani M. Decreased emergency department overcrowding by discharge lounge: A computer simulation study. Int J Prev Med 2020;11:13.

Access this article online

Website: www.ijpvmjournal.net/www.ijpm.ir

DOI: 10.4103/ijpvm.IJPVM_582_18

Quick Response Code:

The main reason for overcrowding in the ED is a hindrance in patient flow when demands for emergency services outweigh the available resources in a given time.[10] Although ED overcrowding is a multifactorial issue involving internal and external factors, the use of ED spaces and resources for patients with nonurgent conditions may aggravate the situation. Decreased length of stay and WT for nonurgent patients could improve patient flow in the ED.[9,11]

In spite of its huge impact, there is limited present evidence to improve patient flow in the ED. In recent years, health system stakeholders in many countries have established standards aimed at decreasing ED length of stay, such as the 4-h target, developed by the English National Health Service.[12]

In 2009, Jabbari *et al*. conducted research aimed at determining WT in order to develop a policy and procedure in Al-Zahra ED. They showed that these WT exceeded standards defined by Iran's ministry of health and many other hospital systems around the world.[2]

In 2014, Hernandez *et al*. showed that 4 months after a "Discharge Hospitality Center" project was launched, ED stays over 6 h decreased from 24.6 to 15.8%, discharges before noon increased from 33.4 to 41.5%, and the time from a discharge order being written to the time the patient actually left their inpatient bed reduced from 126 to 84 min.[13]

The "discharge room" or discharge unit is a place for patients who have been discharged to wait for a transfer, a drug, or other treatment before leaving the hospital.[14] The main purpose of establishing a discharge unit is to create more treatment spaces for patients in urgent need (i.e., to free up beds). ED beds are therefore always at hand, resulting in improved patient flow. According to their condition, patients will be transferred to appropriate wards, the process of patient transfer from hospital to home will be facilitated, and they will experience a convenient, satisfying discharge.[15] Discharge units may be provided with beds as needed, and even the possibility of taking a shower as well.[16]

The discharge hall is a safe and comfortable waiting room for patients, relatives, and caregivers. The use of the discharge hall allows for the preparation of sections for future patients. Before transferring the patient to the discharge room, the following should be noted: Staff at the discharge room must be informed of the patient's arrival prior to transfer to receive them warmly. Employee checklists should also ensure that staff is able to care for patients with a specific condition, such as diabetics or those with visual or hearing impairments. The patient's required documentation and medication should be accompanied by the patient, and the patient's rehabilitation should be completed using physiotherapy and drug therapy.[17]

Al-Zahra Emergency Hospital is one of the most visited EDs in the country due to the variety of specialized and specialty facilities. In this study, different solutions were used to reduce patients' WT and reduce emergency congestion at Al-Zahra Hospital. This article illustrates the impact of establishing a "discharge hall" in reducing patient WT and crowding.

The emergency ward of Al-Zahra teaching hospital is one of the most visited emergency wards in the country.[1] Simulating a shrinking model of a real thing, social situation, or a process is, in fact, the science and art of building a model of a process or system to evaluate and test strategies and a way to know the results of the proposed ideas before they are implemented. Simulation is used in many categories, including modeling to gain insight into how natural and human systems work. Simulation can be used to show the impacts and consequences of different situations that are not, for example, real or the impact of existing factors.[18,19] In this study, our main objectives were to evaluate the various solutions to reduce the WT of patients and to reduce the emergency overcrowding of Al-Zahra hospital using a simulation technique. This article shows the effect of creating a discharge unit to reduce the WT for the patients.

Methods

This retrospective cross-sectional study was conducted. The population included 39,264 patients attending the Al-Zahra Hospital between November 2013 and October 2014. The sample size was estimated from the equation as 1275 using systematic random sampling with a $n=\left(\frac{zs}{d}\right)^2$ confidence level of 99%. To increase the accuracy of the research, the number of patients included was increased to 2515. Data collection tools were a validated questionnaire and hospital information system (HIS). The questionnaire [t able 1] contained 24 questions about: case number, age, and sex of the patient, how patient recourse (personal visit or referrals from other centers), visit date, triage time, triage level, admission time, the patient's first visit by a specialist, execution time order by nurses, the time of radiology request and time of doing it, the time of tests request for patients, the time of admission, the patient sample in the laboratory, response time by laboratory, the time of first advice request and the time of counseling for the patient, the time of electrocardiogram request and the time of doing it, the time of patient transfer to hospital wards or discharge from the ED by a physician or personal satisfaction, the time of discharge and to empty his bed. Table 1 shows the questionnaire that is used for patient tracking in ED of Al-Zahra University Hospital.

The interviewers were stationed in the medical records unit of Al-Zahra Hospital and they were not selected from hospital staff to avoid potential bias.

The questionnaire was developed by experts (emergency medicine specialists and other medical experts in Al-Zahra Hospital of Isfahan) and was validated after several revisions by assessing patients' records in Al-Zahra Hospital's medical records unit. Internal consistency or reliability was determined by Cronbach's alpha. SPSS software was used for data analysis. All information on the variables from the medical record unit, except those related to laboratory and radiological results were available via HIS. Statistical analysis was performed using SPSS version 21 statistical software (SPSS Inc., Chicago, IL, USA).

Simulation is a shortened model of the real thing, social status, or a process. In fact, it is a science and art for model building of a process or system to evaluate strategies, and it is a way to find out the results of the proposed ideas before implementing them. Simulation is used in many categories including modeling to gain insight and knowledge about natural and human systems. The simulation can be used to show the effects and consequences of different circumstances, that it's not true, and it also is used to evaluate the effect of existing factors.[10]

Arena simulation software package (ANSYS, Pennsylvania, U.S.A) is used for discrete event systems. This software is designed to analyze the impact of major and complex changes in relation to the supply chain, manufacturing, logistics, warehousing and distribution, and service systems. Arena software helps managers to optimize three important factors in the ED. These three factors are costs, patient WT, and number of personnel.

This study was conducted using simulation techniques by attention to the high level of patient WT in the ED and the importance of reducing these times by minimum cost and maximum efficiency of hospital resources. A physical model of the real system was designed by Arena software and then the flow of patients at Al-Zahra hospital were observed by on-screen graphical animation.

Model distribution function was 0.001 + EXPO (13.2). Input Analyzer software was used to detect the model input distribution function. Three-point distribution was used for all process functions and model execution was performed 1000 times in Arena software. Then, according to the presumed bottlenecks in the ED, solutions to reduce WT were proposed and compared with Arena software. This article illustrates the impact of implementing a discharge hall solution to reduce patients' WT and reduce emergency overcrowding in a university hospital.

Results

The utility output of Input Analyzer software showed exponential function with a mean time of 13.2 min. This means that on average every 13.2 min, a patient is admitted to the ED of Al-Zahra Hospital. Patients are classified into three levels of 1, 2, and 3, based on the severity of the disease after referral and triage. The results showed that the lowest number of patients attending is 59 per 24 h, of these, the number of first level patients is equal to zero, the number of second-level patients is equal to 14, and the number of third-level patients is equal to 45. The maximum number of patients is 163, with 12 first-level patients, 56-second level patients, and 95 third level patients. The average patient input is 109 with 4 of the level 1 patient, 35 level 2 patients, and 70 level 3 patients. However, 9% of patients in level 2 and 11% of level 3 patients are discharged from the hospital before completing their personal consent treatment. Chart 1 shows the path of patients at all three levels.

Figure 1 shows the patient tracking in all three levels and Table 2 shows the current status of Al-Zahra hospital ED based on the personnel number.

Table 2 also shows the WT of patients at the discharge station in the baseline situation and the implementation of the "Discharge Lounge" scenario.

By implementation of the "Discharge Lounge" scenario, the following changes are made:

1. The average WT for level 2 patients with personal satisfaction was reduced from 56 min to 44 min, and the average patient WT for level 3 decreased from 15 min to 13 min
2. The average WT for level 2 patients to be discharged with personal consent at a time when the treatment process is not yet completed has been reduced from 80 min to 50 min and for level 3 patients from 67 min to 41 min
3. The number of patients in level 2 waiting to be discharged by the physician has been reduced from 3 to 2, and the number of patients in level 3 waiting to leave has decreased from 2 to 1
4. The number of patients waiting for level 3 patients at the reception station has also been reduced from 44 to 39
5. The average number of outputs has increased from 7 to 12.

As shown in Chart 1, the WT for patients in the discharge scenario at both second and third emergency levels have decreased in comparison with WT for patients in the baseline situation.

Discussion

There is not a single answer to the problems that the health care industry faces today. Although technology and medical advances are being made at incredible rates, the process of delivering care is still inefficient where wait delays and cancelations occur regularly. Hospitals have responded by adding resources such as more beds, larger facilities, and increased staff to mitigate the delays but have found this alone is not the answer.[20,21] According to Haraden and Resar, the answer is believed to lie within understanding the patient flow as a system challenge, and improving ways so as to patients are

Table 1: Patient checklist in the emergency department (ED) of Al-Zahra University Hospital

Row No	Age	Sex	How patient recourse	Visit date	Triage time	Triage level	Admission time	Patient's first visit by a specialist	Execution time order by nurses	request time	Radiology		laboratory		Consult		Electrocardiogram (ECG)		Time of patient transfer to a hospital wards by a physician	Discharge		
											time of doing	request time	admission time	response time	request time	time of doing	request time	time of doing		personal Satisfaction	Time of discharge	Date of discharge
1																						
2																						
Validate																						

Table 2: Comparison of existing status with the implementation of the "Discharge Unit" scenario

Third level				Second level				Service station
Implementation of the scenario		The present situation		Implementation of the "Discharge Lounge" scenario		The present situation		
Queue	Average waiting time for patients (min)	Queue	Average waiting time for patients (min)	Queue	Average waiting time for patients (min)	Queue	Average waiting time for patients (min)	
0	40.5865	1	67.4585	0	49.5909	1	2757/80	Discharge station with personal satisfaction before completing the treatment process
0	13.2242	0	14.5931	0	43.7918	0	4063/56	Discharge station with personal satisfaction after completing the treatment process

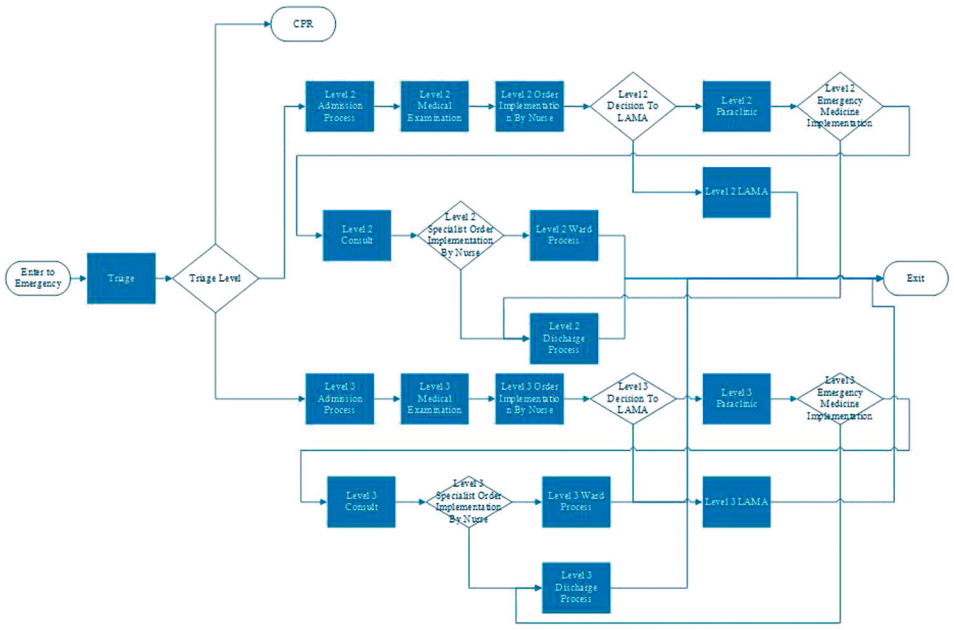

Figure 1: The patient tracking in the emergency department (ED) of Al-Zahra Hospital

able to receive timely care which is in line with our results.[22] Overcrowding in the ED creates delays, and as Han *et al*. have found, and causes patients to leave without seeing a physician, decrease patient satisfaction, increase patient pain and suffering, and negatively affect the quality of care provided. Olshaker and Rathlev in a study similar to ours considered the inability to transfer emergency patients to inpatient beds or free up the ED

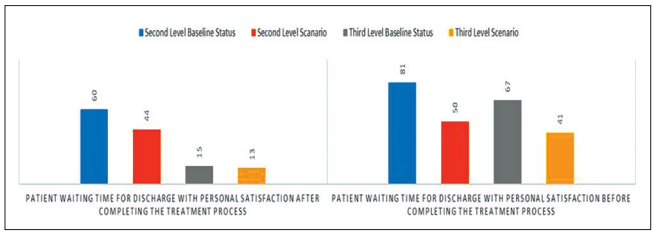

Chart 1: Patients' baseline waiting times with discharge lounge scenario

beds as the most important factor causing overcrowding in the ED.[23]

Discharge lounges/units can help bridge the gap between acute admission and return to the community and also expedite the intake of new admissions as beds are freed up.[24] We have now evidence that discharge lounges/units may have the following positive effects: Allow beds to be freed sooner, therefore, increasing capacity; help ease the collection of patients for transport; help in the delivery of medication to patients to take home.[25]

The discharge unit requires space in the hospital as any other unit or ward would. Specialized discharge coordinators can also be a part of the unit and begin planning for the patient's discharge on admission. Patients can stay in the unit until their transportation arrives.[26,27]

According to Khare *et al*., computer simulations are considered to be a promising tool that provides a method to study and improve processes without affecting patient care or needing significant monetary investments.[28,29]

The use of simulation is growing and is seen as a powerful tool within the health care industry being able to model a wide range of topic areas and answer a variety of research questions. However, it is still yet to be seen the effects and true value of modeling such processes due to the lack of model implementation on the real system. A similar problem that we had faced during our study.[30]

Using simulation will not guarantee real-life results but provide an approach to tackle the inefficiencies that plague our health systems today.

Shim *et al*. conducted a study regarding computer simulation that models the patient discharge process and evaluates the effects, which the changes would have on the time taken in the process and the utilization of resources involved in the process. The simulation results on the time taken in the process demonstrate that the RFID system can shorten patient wait times, staff busy times, and bed occupation times, while the discharge lounge can significantly shorten bed occupation times which is congruent with our study.[31]

As the admission/discharge process is a multifactorial problem involving many different input variables and processes such as ED and non-ED admission rates, discharge hours, waiting for bed queue, and length of stay (LOS) distributions, a discrete event simulation (DES) software was used. June *et al*. showed that the use of DES provides a flexible means to model, analyze, and understand dynamic systems. DES software is also considered as a research technique that is able to ask what-if questions and test different process scenarios while assessing the efficiency of the health care process.[32] Of course, in our study we used Arena software as a simulation tool, the results achieved from preplanned scenarios were, to some extent, in accordance with the previous studies.

Conclusions

Based on our experience, an appropriately designed discharge unit can help improve the efficiency of the discharge process. By approaching the issue in a proper way, we believe that the ED and admissions will be able to maximize hospital bed count, staff will endorse the process, and patient satisfaction will be high during this final patient interface in the cycle. We conclude that discharge lounge can be utilized to streamline patient flow, increase availability of bed space for new patients, mitigate health complications in the ED, create higher revenue, and increase client. In fact, the simulation results on the utilization of resources in the present study suggest that the discharge lounge can significantly mitigate the nurses' tasks in the process. So, the authors support the implementation of the discharge lounge to improve the patient discharge process in the hospital. A well-designed, multicenter study such as ED process-mining, however, will help make the matter more transparent.

Acknowledgments

We wish to thank the Emergency Medicine Research Center and Al-Zahra Research Institute of Isfahan University of Medical Sciences for providing financial support for this study with the research project number 295266.

Ethical approval

The research project has received the confirmation of the Ethics Committee at Isfahan University of Medical Sciences.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Received: 02 Jan 19 **Accepted:** 21 Nov 19
Published: 17 Feb 20

References

1. Ajami S, Ketabi S, Bagherian H. Reducing waiting time in emergency department at Ayatollah-Kashani hospital using simulation; Isfahan University of Medical Sciences. Health Manage J 2012;51:84-94.
2. Jabbari A, Jafarian M, Khorasani E, Ghaffari M, Majlesi M.

Emergency department waiting time at Alzahra hospital, Isfahan University of Medical Sciences. Health Inf Manage Iran 2011:4.
3. Masoumi Gh, Jalili M, Siah Tir M. Indicators of Hospital Emergency Ward; 2011.
4. Tabibi SJ, Najafi B, Shoaee Sh. Waiting time in the emergency department in selected hospitals of Iran University of Medical Sciences in 2007. Pejouhesh 2009;33:117-22.
5. Ross J, Emergency Care Nova Scotia Interim Report, Canadian Association of Emergency; 2010; Physicians, file:///C:/Users/Angel%20Falls/Downloads/Documents/b10608163.pdf.
6. Yousefzadeh Chabok Sh, Mohtasham Amiri Z, Haghdust Z, Mohseni M, Asadi P, Kazemnezhad Leili E. Patients discharged before and after presence of medical emergency specialists. Jameenegar Nurs Midwifery 2012:71. Available from: www.jameenegar.com. [Last accessed on 2019 Oct 08].
7. Cheng I, Lee J, Mittmann N, Tyberg J, Ramagnano Sh, Kiss A, *et al*. Implementing wait-time reductions under Ontario government benchmarks (Pay-for-Results): A cluster randomized trial of the effect of a physician-nurse supplementary triage assistance team (MDRNSTAT) on emergency department patient wait times. BMC Emerg Med 2013;13:17.
8. Asadi P, Monsef Kasmaie V, Zohrevandi B, Zia Ziabari SM, Beikzadeh Marzbani B. Disposition of patients before and after establishment of emergency medicine specialists. Emerg Med Iran J 2014:1.
9. Sayah A, Rogers L, Devarajan K, Kingsley-Rocker L, Luis F. Lobon, minimizing ED waiting times and improving patient flow and experience of care. Emerg Med Int, 2014;2014:98147.
10. Zare Mehrjardi Y, Hoboubati M, Safaee Nik F. Improvement of waiting time for patients referring to emergency room using discrete event simulation. Shahid Sadoughi Univ Med Sci 2010;19:302-12.
11. Devkaran S, Parsons H, Van Dyke M, Drennan J, Rajah J. The impact of a fast track area on quality and effectiveness outcomes: A Middle Eastern emergency department perspective. BMC Emerg Med 2009;9:11.
12. Golaghaie F, Sarmadian H, Rafiie R, Nejat N. A study on waiting time and length of stay of attendants to emergency department of Vali-e-Asr Hospital, Arak-Iran. J Arak Univ Med Sci Arak 2008;11:74-83.
13. Hernandez N, John D, Mitchell J. A reimagined discharge lounge as a way to an efficient discharge process. BMJ Qual Improv Rep 2014;3. doi: 10.1136/BMJ quality.u204930.w2080.
14. Neff T. Discharge Lounge 2.0 a Growing Success. University of Colorado Health Insider 2012;6.
15. Hanson K, Davis S, Howells R, Gregory S. Discharge Lounge Standard Operating Procedure; 2015; V1.0, Version 2.
16. Holds worth L, Hospital discharge unit/lounge.
17. Golden Jubilee National Hospital. NHS National Waiting Times Centre, Discharge Lounge Information guide for staff 2015; Version 1.
18. Singer AJ, Thor HC, Vicellio P, Pines JM. The association between length of emergency department boarding and mortality. Acad Emerg Med 2011:1324-9.
19. Hagerty T, Clemente C, Sachdeva A. Discharge lounge that works: A pathway for implementation. Capital Marketing Services [Online]. 2010. Available from: Capitalmarketingservices.com/links/Discharge_Lounge_Pl-2.pdf.
20. Anbari E, Yarmohammadian M, Isfahani M. From investigation of hospital protocols and guidelines to designing a generic protocol for responding to chemical, biological, radiological, and nuclear incidents. Int J Health Syst Disaster Manage 2015;3:195.
21. Davari F, Isfahani MN, Rezvani M, Omidallah M, Pakravan F. Process management model in the emergency department of a university hospital: Reduction of patient waiting times by changes in human resources. J Res Med Dental Sci 2018;6:578-85.
22. Haraden C, Resar R. Patient flow in hospitals: Understanding and controlling it better. Front Health Serv Manage 2004;24:3-15.
23. Olshaker JS, Rathlev NK. Emergency department over-crowding and ambulance diversion: The impact and potential solutions of extended boarding of admitted patients in the emergency department. J Emerg Med 2006;30:351-6.
24. West Suffolk Hospital. Your guide to the discharge unit. 2004.
25. Health & Social Care Joint Unit and Change Agents Team. Discharge from Hospital: Pathway, Process and Practice. London: DH; 2003. (Good practice guidance).
26. Bird J. 'Dischargemadesimple'. Nusingtimes.net [Online]. 2008. Available from: http://www.nursingtimes.net/discharge-made-simple/1477936.article.
27. Department of Health - Discharge from hospital pathway, process and practice.
28. National Audit Office. Inpatient admissions and bed management in NHS acute hospitals. London: TSO; 2000.
29. Khare R, Powell E, Reinhardt G, Lucenti M. Adding more beds to the emergency department or reducing admitted patient boarding times: Which has a more significant influence on emergency department congestion? Ann Emerg Med 2009;53:575-85.
30. Fone D, Hollinghurst S, Temple M, Round A, Lester N, Weightman A, *et al*. Systematic review of the use and value of computer simulation modelling in population health and health care delivery. J Public Health Med 2003;25:325-35.
31. Shim SJ, Kumar A, Jiao R. Using a radiofrequency identification system for improving the patient discharge process: A simulation study. J Med Pract Manage 2016;31:383-7.
32. Jun JB, Jacobson SH, Swisher JR. Application of discrete event simulation in health care clinics: A survey. J Oper Res Soc 1999;50:167-86.