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ASSESSMENT OF PATIENT-PHYSICIAN ASSIGNMENT CRITERIA IN EMERGENCY DEPARTMENT BY USING DISCRET-EVENT-SIMULATION

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ABSTRACT

Physician's workload inequality in Emergency Departments (ED) is a relevant problem that affects their stress level, which influences the service quality and working conditions. The patient-physician assignment rule (PPAR) has a bearing on the physicians' workload, which has been studied in the Medical literature by performing interventions. These show that, contrary to basic models of queuing theory, automatic assignment of patients to physicians at triage (multiple queues model) reduces patient length of stay compared to self-assignment of patients by physicians (single queue allocation). Rotational PPAR facilitates the triage nurses' decision making and ensures an equal distribution of the number of patients, but it may not offset the differences in patients' severity and care needs, which lead to physicians' workload imbalance. Thus, such a problem has been addressed in a Spanish ED by developing a discrete-event-simulation model to assess different PPARs optimizing both criteria, patient's waiting time and physician's workload variability.

1 INTRODUCTION

Medical literature has proved, by the implementation of different management policies to Emergency Department (ED), that assigning patients to physicians at triage is more efficient than single queue allocation. This, indeed, contradicts the basic models of queuing theory and might be accounted by specific behavioral aspects such as a lack of clarity of physician's responsibility, non-immediate and ambiguous physician's ownership, etc. (Hirshon et al. 1996; Traub et al. 2016). Following these practical findings, we have developed a Discrete Event Simulation model to investigate patient-physician assignment policies with a multiple queues structure. The objectives of these strategies are two: optimizing arrival to provider time (patient's point of view) and optimizing physician's workload balancing (physician's point of view). This is the first time that the latter objective is considered in ED "front-end" operations. The study takes place in the ED of the Hospital Compound of Navarre, which is staffed 24 hours per day with more than 350 workers, 120,000 annual users and almost half a million potential patients.

2 DEFINITION AND EVALUATION OF PATIENT-PHYSICIAN ASSIGNMENT RULES

Single Rotational Rule (SRR): Currently, the ED has a rotational patient assignment system that depends on their arrival time, which facilitates the triage nurses' decision making and ensures an equal distribution of the number of patients to different physicians. However, the differences in the complexity of clinic cases lead to an unbalanced physicians' workload since the average severity of patients assigned to one physician might be higher than that of patients assigned to another. Thus, to overcome this handicap, we have defined different patient-physician assignment rules.

Multiple Rotational Rule (MRR): First, we have investigated an improved extension of the SRR that takes into account patient's Emergency Severity Index (1-5) attributed by the triage nurse. High and low severity patients are considered and the rotational assignment rule is applied to each of these patients' categories. The results of the MRR model have improved considerably the SRR's although the remaining work burden of physician at the time of a new patient allocation is not taken into account, which could increase inequality.

Remaining and Completed Workload Rule (RCWR): The physician's workload at each time is considered by defining two different measures:

1. Remaining work for each physician at time t, denoted by $\mathrm{M}_1(t)$.
2. Completed work by each physician from the beginning of his/her work-shift until time t, denoted by $\mathrm{M}_2(t)$.

A parametric assignment rule is obtained from the linear combination of these two standards, and an incoming patient is assigned to the physician with the minimum value of $R_\lambda(t)$ associated:

$$R_\lambda(t) = \lambda M_1(t) + (1-\lambda) M_2(t) \qquad t \in (0,\, t_{END}]\ ;\ \ \lambda \in [0,\, 1]$$

Evaluation of SRR, MRR, RCWR

The processes complexity, patient arrival seasonality, variability in service delivery, care needs, etc. make the development of a very detailed ED simulation model essential (Gunal 2012; Lee et al. 2015). In order to evaluate the assignment rules proposed above, we defined the following Key Performance Indicators:

- ***Arrival to provider time (ATPT)***: interval between when the patient is triaged and the time at which physician claims the patient on the electronic tracking board to be assisted.
- ***Workload Variability (WV)***: instantaneous remaining work variability (IWV) among physicians and variability of work done by physicians for a work-shift (CWV, historical assistances).

ATPT measures the quality of service from the patient's point of view while WV measures the work quality and balancing from the physician's point of view.

3 RESULTS

The implementation of MRR has cut down considerably physicians' workload variability compared to SRR. Furthermore, ATPT of high severity patients has been reduced while ATPT of low severity patients has slightly increased.

The patient-physician assignment rule at ED triage that minimizes the WV and patient's ATPT is a bi-objective mathematical problem. No assignment rule has been able to optimize both objective functions simultaneously. Therefore, in case of the parametric family of RCWR the Pareto's frontier was estimated by simulation.

In addition, it has been identified a set of rules RCWR which dominate the one currently used in the studied ED system (SRR). Thus, the implementation of any of these solutions would improve both objectives simultaneously. Consequently, recommendations to hospital managers on patient-physician assignment rule have been made, which are supported by the animation of the simulation model.

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