

# Calculating Emergency Room Metrics through Process Mining

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**Abstract**—Process Performance Metrics in healthcare, and particularly in Emergency rooms (ER), are of great importance, since they can give insight of how to improve the process and the quality of the services provided. This paper explores the capabilities of Process Mining (PM) to calculate ER metrics.

## I. INTRODUCTION

Performance metrics in healthcare allow the quantification of the quality of the provided services in ER, understanding how to measure process performance has been vital to generate improvements both on the patient treatment and the medical centers. These ER metrics have been used to develop standards to improve the operations and processes, impacting directly the provided care [3]. PM is an emerging discipline [2] that allows the analysis of the real process execution based on the records saved in Hospital Information Systems (HIS). Identifying process activities enables the discovery of models and the characterization of activities and resources, and execution times. Using this discipline to measure ER metrics can be of high relevance in this field since it has not been performed in the past. This article presents an exploratory analysis of how to calculate ER metrics with PM.

## II. EMERGENCY ROOM METRICS

Literature indicates that ER metrics have been widely studied in the past [1]. Measurements have been centered in different aspects of ER, such as, patient satisfaction, consumed resources, different times through the patient's treatment and the overall operation. For each of these metrics, very specific aspects are calculated [1], such as: errors of incorrect medication and unidentified diagnosis, patient abandonment without receiving attention, satisfaction of the provided services, and resources performance. Finally, for the general ER operation, metrics are mainly related to box occupation, prescribed medications, number of referrals, length of stay, and bed assignment intervals.

## III. EXPERIMENTS AND RESULTS

As an experiment, two metrics were calculated using PM techniques. The first metric consisted in measuring the episode duration, from the patient arrival to the ER until the end of the attention, including all involved activities. The second metric consisted in measuring the boarding time for patients being hospitalized after the diagnosis is given. These metrics were computed based on an event log that

was built using real data from the HIS, corresponding to all 5,591 episodes in the ER in a hospital in Santiago, Chile, during July 2014. The HIS includes all data related to the executed activities, for example, patient information, triage classification, final diagnostics, referral data, resource information, and the exact time when these activities were executed. This event log was analyzed with the PM tool Disco<sup>1</sup>, which includes several techniques to discover the process model and the order of the activities executed. Time measurements between two or more activities are required to calculate duration times.

The first metric calculates the time spent since the moment the patient arrives to the ER until is sent home, is discharged to the hospital, leaves the facility, or dies. Through the discovered model, the metric can give insight of the complete set of activities executed, their order, and their duration. 3.7 hours is the mean length of stay of all episodes. This metric can also be calculated for episodes with specific features, such as diagnostics, age, or gender. For example, the mean length of stay for patients diagnosed with Pneumonia and Hepatitis is 5.3 and 7.5 hours, respectively.

For the second metric, an analysis was done to identify the inpatient episodes and determine what the boarding time was (i.e., the time from the decision to the movement of a patient from the emergency room to a hospital bed). The time when this decision is made was detected as an activity called 'final discharge' (i.e., receiving the discharge report) in which the physician identifies the final diagnosis and decides whether a patient is hospitalized or sent home. In the calculated metric, only episodes where patients were hospitalized were kept, resulting in a mean time of 54.6 minutes.

## IV. CONCLUSION

PM tools allow medical experts to identify activities executed and measure several ER metrics. By identifying the adequate activities and the required times, any additional metrics could be calculated.

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