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USING SIMULATION TO FORECAST THE DEMAND FOR HOSPITAL EMERGENCY SERVICES AT THE REGIONAL LEVEL

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ABSTRACT

We present a general simulation framework designed to model the Polish regional emergency hospital services system. Based partly on the last year's demand and structure, the National Health Fund grants contracts for admission units and emergency wards (AU/EW) to cover the next year's costs of treatment of acute patients. The hybrid simulation model examines the impact of forecasted regional demographic fluctuations on the expected type, volume, and cost of medical procedures for patients in emergency departments. Two simulation models are developed. A Monte Carlo model examines the influence of the observed demographic trends on the volume of emergency demand directed toward AU/EW in the region. The discrete-event model simulates patients' pathways and received services. The model's output may help healthcare decision makers to estimate future needs for emergency hospital care that must be satisfied at the regional level.

1 INTRODUCTION

Demand for service reflects the relationship between price and the quantity demanded. In Poland, most health care is provided through the National Health Fund (NFZ), which is financed by obligatory health insurance contributions from every working citizen. This legal system excludes the possibility of a regulatory role of a price mechanism because health care is provided to patients free of charge at the point of delivery. In the case of elective hospital care, the supply and demand relationship is rationed by waiting lists. Emergency services are provided without limits for every patient who requires medical assistance. The NFZ grants contracts for emergency services for the following year based partly on the last year's demand volume and structure. According to Chalkley and McVicar (2008), this payment mechanism is a variation of a *sophisticated block* contract because all patients are treated, and the monitored cost influences the value of the next year's contract. The credible assessment of future demand in relation not only to the number of treated patients but also to the number and type of activities performed in admission units and emergency wards (AU/EW) defines the overall cost of forecasted acute services.

2 MODELING APPROACH

Historical data were collected on the treatment of acute patients registered in 2010 in Wrocław Region (WR), the sub-region of Lower Silesia province. In particular, two data sets were analyzed. The first set describes 183,517 patients living in Wrocław Region who were registered at emergency units located in the Lower Silesia area during 2010. The second data set encompasses 201,636 patients (without considering residence address) who were registered in 2010 at emergency rooms operating in Wrocław Region. In 2010, 12 admission units (AU) and 5 emergency hospital wards (EW) operated in the area. Based on the collected data, a statistical analysis was performed and input distributions were fitted.

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We consider two simulation models, a Monte Carlo (MC) model and a discrete-event (DES) model (Figure 1). The MC model examines demographic trends across the Wrocław Region population and explores the influence of changes in the population of inhabitants of WR on the volume of the emergency need for service, part of which is served by 17 AU/EW departments in WR. A regression model is developed to link the volume of WR emergency patients with the WR population. Changes in the population size are sampled from the input probability distributions characterizing the forecasted demographic trends, and assessments describing changes in the volume of emergency services related to each AU/EW are simulated. The output from the MC model affects input flow 1 (Figure 1) in the DES model. The DES model captures three geographically related sources of emergency patients for direct admission to one of 17 AU/EW located in Wrocław Region: arrivals from WR, arrivals from other sub-regions of Lower Silesia, and arrivals from other Polish provinces. The model simulates the patients' pathways. Upon arrival, a patient is registered, assessed and treated. Various services are performed for every admitted patient. After at least one day in an AU/EW, the patient is discharged or admitted to a hospital as an inpatient. In contrast to most DES health care model applications (Mielczarek and Uziałko-Mydlikowska 2012), our DES model does not focus on a specific AU/EW department. Instead, we are interested in the level of emergency services that should be contracted by the NFZ for Wrocław Region for the following year to cover the forecasted demand. The goal of the DES model is to assess the number and type of services performed on patients from three separate input flows and the level of a hospital's financial resources that are needed to meet demand at the sub-regional level.

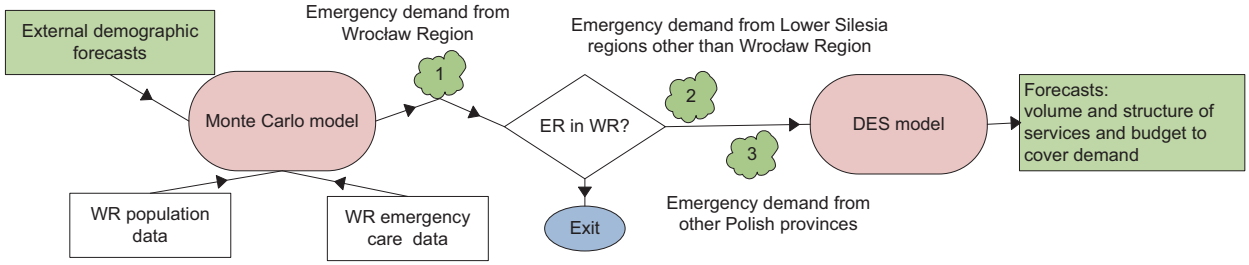

Figure 1: The modeling approach: layout of two simulation models

The model can be used at a regional policy level to investigate cause and effect relations, such as the effects of demographic changes on the number of services provided in AU/EW departments. For example, how does the demand for hospital emergency services change when the population size in WR regions increases or decreases? How does the demand change due to recognized regional trends in ageing and gender? We plan to enhance this study by examining the long-term influence of population morbidity from specific causes (e.g., cardiovascular diseases) on the level of demand for hospital emergency services.

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