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ScienceDirect

Procedia Computer Science 108C (2017) 149–158

Procedia Computer Science

International Conference on Computational Science, ICCS 2017, 12-14 June 2017, Zurich, Switzerland

Support managing population aging stress of emergency departments in a computational way

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Abstract

Old people usually have more complex health problems and use healthcare services more frequently than young people. It is obvious that the increasing old people both in number and proportion will challenge the emergency departments (ED). This paper firstly presents a way to quantitatively predict and explain this challenge by using simulation techniques. Then, we outline the capability of simulation for decision support to overcome this challenge. Specifically, we use simulation to predict and explain the impact of population aging over an ED. In which, a precise ED simulator which has been validated for a public hospital ED will be used to predict the behavior of an ED under population aging in the next 15 years. Our prediction shows that the stress of population aging to EDs can no longer be ignored and ED upgrade must be carefully planned. Based on this prediction, the cost and benefits of several upgrade proposals are evaluated.

Peer-review under responsibility of the scientific committee of the International Conference on Computational Science

Keywords: Population aging, Agent-Based Model, Emergency Department

1 Introduction

Hospital emergency departments provide a crucial public service. It is critically important to the health of the population. Older patients often present to EDs with more complex clinical conditions and normally require more diagnosing and consultation service than younger patients. With one in nine persons in the world aged 60 years or over, projected to increase to one in five by 2050, population aging is a phenomenon that can no longer be ignored [15]. All countries in Europe are experiencing an aging of their populations, a trend that is projected to continue until at least the middle of the 21 century. This is mostly because of a combination of low fertility and longer life expectancy [12]. For example, the Catalonia in Spain is facing new challenges with an in-depth population aging process compared with other European countries. Currently, 17% and 4.4% of the population are over 65 and 80 years old, respectively. In 2050, over 30% and 12% of the population will be over 65 and 80 years old, respectively. As a consequence, an increasing number of people with chronic conditions will increase very

1877-0509
Peer-review under responsibility of the scientific committee of the International Conference on Computational Science
10.1016/j.procs.2017.05.147

intensively [6]. This process is often regarded as a major cause of upward stress on health care costs [11]. Several studies have investigated the increased presence of elderly patients in ED [12, 16, 5]. To the best of our knowledge, there is no work on quantitively predicting the influence of aging on EDs and overcoming the stress by using simulation. The objective of this paper is to evaluate overcrowding problem in ED arising from the population change. Our method enables ED managers to quantify the effects of system redesign prior to the implementation and to examine how the redesign can be best applied to their particular hospital.

The rest of the paper is structured as follows: §2 gives a literature review on related work. The care service requirement of elderly patients will be analyzed in §3 based on real data from a public hospital. Then, by using an ED simulator, the §4 will predict the behavior of an ED in the future based on population pyramid prediction. In terms of the impact of population aging on ED, the §5 will demonstrate the use of simulation techniques on decision support for policy makers. At last, §6 draws the conclusions.

2 Related work

Worldwide, impacts of population aging are steadily attracting researchers' attention. For example, by using current trends and estimates in conjunction with future population growth and climate change scenarios, G. Toloo et al. [14] studied the effects of increasingly warmer temperatures on the burden of already overcrowded hospital EDs. S. Vilpert et al. [16] investigated the trend in ED visits by patients aged 85 years and over between 2005 and 2010, and to compare their service use to that of patients aged 65–84 years during this period and to investigate the evolution of these comparisons over time. Their results highlight the growing importance of elderly patients in EDs, and indicated that the ED managers should be aware of these oncoming challenges so that they can adapt their training curricula and working procedures accordingly.

By comparing data collected in 1990 and 2004, George et al. [4] found that the stress on emergency care is associated with a disproportionate increase in the number of elderly patients and with an increased tendency to investigate them. They concluded that, increasing life expectancy and a declining birthrate have caused the population to age, the needs of older people are crucial in planning emergency healthcare in developed countries. Ref. [10] studied how the aging of the U.S. population would affect the demand for ED services and hospitalizations in the coming decades. They found that demographic change will not cause the number of ED visits to increase, but visits will get longer and there will be more hospitalizations. Authors indicated that, ED capacity will have to increase by 10 %, even without an increase in the number of visits and, hospital admissions from the ED will increase 23 percent faster than population growth, which will require hospitals to expand capacity faster than required by raw population growth alone. In order to assess micro-simulation for testing policy options under demographic aging, Davis et al. [2] applied a novel micro-simulation approach both to create a synthesized data set from a number of sources and to present quantifiable scenarios. The authors concluded that there is potential for micro-simulation to assist in the synthesis of data and to help quantify scenario options for policy development.

In summary, most of the work on analyzing the impact of population aging in literature are qualitative analysis or prediction with linear extrapolation or intuition. Since ED is a complex system, extrapolation based on data-driven models may meet the singularity point in nonlinear response and result in unacceptable error in prediction. We believe that a precise ED simulator can more accurately predict the ED's behavior in the coming decades with population aging. Moreover, as a typical complex system, tackling the problem of efficiently managing ED has became a great challenges to both managers in ED and policy makers in the governments.