Operations Research for Health Care 11 (2016) 20–34

Contents lists available at ScienceDirect

Operations Research for Health Care

journal homepage: www.elsevier.com/locate/orhc

On the performance of small-scale living facilities in nursing homes: A simulation approach

Dennis Moeke [a,c,*], Ruben van de Geer [b], Ger Koole [b], Rene Bekker [b]

[a] Faculty of Economics and Business Administration, VU University Amsterdam, The Netherlands
[b] Department of Mathematics, VU University Amsterdam, The Netherlands
[c] Research Group Logistics and Alliances, HAN University of Applied Sciences, The Netherlands

ARTICLE INFO

Article history:
Received 3 December 2015
Accepted 12 October 2016
Available online 25 October 2016

Keywords:
Nursing home care
Simulation
Small-scale living facilities
Staffing
Client-centered care

ABSTRACT

Scientific evidence on the impact of small-scale living facilities (SSLFs) on quality of life of nursing home clients remains scarce. In this study a simulation model is developed to examine the performance of SSLFs, in terms of meeting the time preferences of their residents. We model scheduled care using historical data and unscheduled care using a Poisson–Gamma mixture model. The model is used to explore the impact of a change in demand characteristics, duration of care delivery, travel time, allocation flexibility, shifts, number of clients and allocation policy. The results show that to further improve the performance, the focus should lie on: (1) increasing the allocation flexibility of care workers and the number of clients per SSLF, and (2) time dependent staffing. Furthermore, this study shows that simulation is a useful tool for assessing and improving daily nursing home operations. The presented simulation model provides a basis for building a decision support tool for nursing home managers.

1. Introduction

In the last decades, many Dutch nursing homes have transformed their care environments into more client-centered, small-scale care settings. These small-scale settings, often referred to as small-scale living facilities (SSLFs) or small-scale care facilities, provide care and/or support to a small group of residents in a homelike environment. This approach aims to enable residents to live their lives according to their own needs and preferences [1] or as stated by [2, p. 804] "daily life and care provision are adjusted to residents lifestyle and preferences as much as possible". Despite the fact that most nursing homes have embraced the concept of SSLFs as a way to give substance to client-centered care, scientific evidence on the impact of SSLFs on quality of life (QoL) is still scarce [3,4].

In order to make it possible for nursing home residents to live their lives according to their needs and preferences, the necessary care and support should be delivered as close as possible to the time preferences of the residents. Hence, with regard to the delivery of care and support, earliness and waiting should be avoided, without overstretching the available budget. From this perspective, QoL largely depends on the co-ordination and timing of service delivery.

In this study a simulation model is developed to examine the performance of SSLFs, in terms of meeting the time preferences of their residents, under different assumptions. Furthermore, improvements in the allocation of care workers are suggested. Simulation is a commonly used method to study the effectiveness or efficiency of larger and/or complex systems which do not lend themselves for analytic approaches. Regarding the purpose of this study, the main advantage of a simulation approach is its flexibility, as parameters and assumptions of the underlying model can be adjusted relatively easy. As such, simulation (1) is well suited to answer "what-if" questions and (2) allows for a detailed analysis of how components interact and of the trade-offs involved.

Several studies [5–8] show that, during the past two decades, simulation has been extensively used for modeling healthcare systems. The vast majority of existing studies focus on supporting better operational decision-making and planning in a hospital setting, with an emphasis on specific subsystems. Examples of those subsystems are: operating theaters [9,10], emergency departments [11,12] and intensive care units [13,14]. As mentioned by Van Eeden et al. [15], to date the area of nursing home care received hardly any attention in the Operations Research (OR) literature. To the best of our knowledge this is the first study examining the daily operations of SSLFs.

* Correspondence to: Amsterdam Center for Business Analytics (ACBA), VU University Amsterdam, De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands.
E-mail address: d.moeke@vu.nl (D. Moeke).

http://dx.doi.org/10.1016/j.orhc.2016.10.001
2211-6923/

The remainder of this paper is structured as follows. In the next section, the study is outlined and justified by providing an overview of the existing literature. Then, in Section 3 we present the analysis of the input data and in Section 4 the model is described. The scenarios together with their performance are presented in Section 5. In Section 6, for each half-hour interval, we determine the number of care workers required to meet a predetermined service level. Finally, in the last section, conclusions are drawn and the results are discussed.

2. Background

Today, the concept of SSLFs is applied in both somatic and psychogeriatric care settings. Most research on the effects of SSLFs has been conducted in psychogeriatric settings. This is not surprising considering the fact that SSLFs were originally developed for residents suffering from dementia. The term 'dementia' is a catch-all term for a group of symptoms caused by gradual death of brain cells [16]. Common symptoms are problems with concentration, memory, thinking, behavior and the ability to perform everyday activities. The often progressive nature of the disease makes that carrying out activities of daily living (ADL) becomes more and more of a challenge and causes an increase in dependency. Therefore, as the disease progresses, institutional nursing is often inevitable. Until the eighties of the last century the behavior of dementia clients was mainly interpreted from a disease perspective, whereby little attention was paid to the experiences and perceptions of the dementing person [17]. From the nineteen nineties onwards, more and more emphasis was put on how people with dementia cope with the consequences of their illness and on how they experience and value their personal situation [18]. The aim to make dementia care fit the feelings and emotional needs of each individual client has led to development of so-called 'integrated emotion-oriented care', in which "the offered care and activities are person-centered and well attuned to the abilities, experiences and preferences of the person with dementia" [19, p. 153]. This shift towards more holistic dementia care was accompanied by the emergence of small-scale and homelike nursing home settings. In the Netherlands, the first SSLF was introduced in the early nineteen eighties. In the decades that followed, encouraged by government policies and programs, the number of SSLFs increased. In 2010, roughly 25% of the residents with dementia who received nursing home care lived in SSLFs [20]. Despite the lack of a uniform definition of a SSLF, the following common characteristics regarding SSLFs can be identified [1]:

1. Providing care and/or support to 6–8 residents.
2. Home-like environment.
3. Small fixed team of care workers.
4. Care workers perform a broad range of tasks.
5. More individual decision making by care workers.
6. Residents should have influence on their daily routine.

Today it is generally assumed that living in a SSLF will add to the QoL, however scientific evidence to support this assumption is sparse and mixed in its results.

In a comparative study, Te Boekhorst et al. [21] examined the effects of small-scale living for people with dementia compared with living in a traditional nursing home setting. The results of this study show that the residents living in a SSLF (1) needed less assistance with ADLs, (2) had more social engagement, (3) had greater sense of aesthetics, (4) had more to do during the day and (5) were prescribed less physical restraints. However, the authors did not find differences in cognitive status, behavioral problems and the prescription of psychotropic drugs. Verbeek et al. [22] also investigated the effects of small-scale living compared with traditional nursing home care. The purpose of that study was to evaluate the effects of small-scale living facilities in dementia care on residents (QoL and behavior), family caregivers (experienced burden, involvement with care and satisfaction), and staff (job satisfaction and motivation). This study found no effect on residents' total QoL. However, family caregivers in SSLFs experienced less burden and were more satisfied with the nursing staff compared to family caregivers in traditional nursing homes. With regard to the involvement of family caregivers, no significant differences were found. Also, no significant differences were found for staffs' job satisfaction and motivation. Given these mixed results, the authors concluded that providing small-scale care "may not be a final solution to accomplish high-quality dementia care and that other options should be considered" [22, p. 662].

Using a quasi-experiment, De Rooij et al. [3] examined the benefits of small-scale living for residents with dementia, compared to traditional long-term care in the Netherlands and Belgium. Their findings indicate that both small-scale and traditional settings appear to have beneficial effects on different domains. The Dutch sample showed higher scores on 'social relations', 'positive affect' and 'having something to do' for small-scale settings compared to residents in traditional settings. Moreover, mean scores on 'caregiver relation' and 'negative affect' remained more stable over time among residents in small-scale settings compared to traditional settings. In the Belgian sample, the differences found between traditional and small-scale settings were less evident. The authors also found that residents 'felt more at home' in traditional settings. Moreover, the mean QoL scores on 'restless behavior', 'having something to do' and 'social relations' remained stable in the traditional setting but decreased in the small-scale settings.

The recent studies of Moeke et al. [23] and Lieder et al. [24] show that, when it comes to efficiently meeting the time preferences of nursing home clients, scale of scheduling plays a prominent role. Applying small-scale scheduling can lead to less efficiency in terms of number of care workers needed to meet the demand. We believe the disadvantages of organizing care on a small scale can be compensated for by applying job enlargement, but only up to a certain extent. Hence, our preliminary hypothesis is that *when the scale of scheduling becomes too small, it will become impossible to meet the preferences of the nursing home residents (in terms of moment and time) without increasing the number of care workers*. As care and support activities in SSLFs are organized on a relatively small scale, we expect the quality of care in terms of meeting the time preferences of the residents to be low (i.e., we expect waiting times to be relatively long).

The main contributions of this study can be summarized as follows. Using simulation and real-life data we:

1. Examine the performance of SSLFs, in terms of meeting the time preferences of their residents, under different assumptions.
2. Suggest improvements (i.e., alternative approaches) regarding the allocation of care workers, using the simulation results.
3. Show that simulation can be a useful tool for assessing and improving daily nursing home operations.

3. Preliminary data analysis

For the delivery of care and support in a nursing home, two types of care activities can be distinguished. For some of the care activities it is possible, based on the needs and preferences of the clients, to make a fairly detailed schedule in advance. Examples of this type of activities are 'giving medicine' and 'help with getting out of bed in the morning'. These activities are also referred to as 'care by appointment' or 'scheduled care' [23,24]. On the other hand, there are healthcare activities which are carried out in