

A staffing decision support methodology using a quality loss function: A cross-disciplinary quantitative study

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Abstract

Background: Understanding the quality loss implications of short staffing is essential in maintaining service quality on a limited budget.

Objectives: For elaborate financial control on staffing decisions, it is necessary to quantify the cost of the incidental quality loss that a given workload and staffing level entail.

Design: We develop a quantitative methodology that uses a quality loss function to support staffing decisions. Loss function candidates are compared based on their mean squared error of retest.

Data source: Our methodology is presented on previously collected data on the nursing service of an adolescent mental health unit. This data was used to test commonly used hypotheses on the quality loss function.

Results: A quality-centred methodology was developed to support daily staffing decisions, creating a synthesis of the literature on quality and workload measurement based on operations research techniques. For quality loss function development, the quadratic form hypothesis resulted in a mean squared error of 10.93, the patient-to-nurse ratio hypothesis was 8.27, and the ridge estimator was 7.04.

Conclusions: Using proper data collection, quality data can help in making rational staffing decisions via the development of a quality loss function. Our tests indicate that the quadratic form hypothesis on the quality loss function is weak, whereas the patient-to-nurse hypothesis has potential for practical use.

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What is already known about the topic?

- The higher the staffing level, the better the patient outcomes and quality of care.
- The staffing level and the workload are the two major factors that explain the quality of (nursing) care.
- Measurement of quality loss is a useful supplement for decision making on staffing.

What this paper adds

- We provide a methodology that synthesizes the literature on quality and workload measurement and operations research techniques for staffing decisions.
- We recognize the importance of using quality data when making staffing decisions, and provide collection guidelines.
- We test commonly used hypotheses on the structure of quality loss.

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1. Introduction

In order to make good staffing decisions, it is necessary to possess knowledge of the consequences these decisions will have on service quality. Staffing levels are restricted by budgetary limitations and, therefore, should be carefully selected to reach a high, stable level of quality. Decisions on future staffing levels must be based on a workload forecast that anticipates both the resulting quality and the new budgetary situation.

Maximizing long-term quality requires a consistent series of staffing budget allocation decisions. To achieve this consistency, stable preferences between quality scenarios are necessary. If preferences are not specified between quality scenarios, consistency in staffing decisions cannot be achieved. Assuming a quality scale ranging from ‘poor’ to ‘excellent’, the decision could be, for example, between (a) two poor days combined with eight excellent days or (b) ten average days. The person with a constant preference has a good basis for providing a consistently high quality of care.

We present a methodology to support staffing decisions in service environments that have quality considerations. To clearly illustrate this methodology, we use nursing services as an example in the study. Nursing services were chosen because this field was found to have the strongest literature base and we felt that our approach could contribute the most to this field. However, the methodology we present here can be applied to other types of quality-driven services where budgeted staffing decisions are made.

A vital part of our methodology is the development of a quality loss function (QLF). Since our focus is only on staffing decisions, the meaning of quality we adopt in this context discounts many other dimensions that typically fall under “quality” (see Badger, 1999; Morris and Bell, 1996). By “quality loss”, we mean the cost of quality deterioration due to short staffing. Consequently, quality loss is a function of the staffing level and workload, similar to that in traditional operations research literature on quantitative staff planning by Warner and Prawda (1972). This definition of quality is justified in the health-care literature. Safford and Schlotfeldt (1960), Newman et al. (2001), and Rafferty et al. (2007) independently show that (for a given workload) staff shortage is the primary reason for loss of service quality. We can conclude that developing QLFs, with the arguments of workload and staffing level, strengthens the applicability of the operations research models by founding an empirical basis. Using this basis, we can synthesize the quality and workload measurement and the quantitative staff planning literature.

In our approach, the first QLF argument is the workload. Workload already has many different conceptualizations in the nursing literature (see Morris et al., 2007), and many types of measurement systems (see Brady et al., 2007). However, these studies have no connection with the operations research staff planning literature. The only study in the staff planning literature that we are aware of is by Warner and Prawda (1972), which addresses the conceptualization of workload by equating workload to the required number of nurses. This concept is used in our paper and provides a link to the operations research literature.

The other argument of our loss function is the staffing level. The staffing level may seem to be easy to measure. However, recording the available nursing capacity each working shift, including temporary workers, overtime, and cross-shifts (i.e., shifts that do not start at a regular time, thus overlapping two regular shifts) is a cumbersome task. For example, the staffing level data collected in Ridley (2007) is more reliable on a daily basis than on a shift basis, because of the cross-shifts that are involved. In cases where staff-mix fluctuations over time are large, one may also need to record staff-mix (the number of RNs, LPNs, and NAs) to learn more about actual capacity (Blegen et al., 1998). In conclusion, neither of the QLF arguments are easy to measure precisely, but previous research gives guidelines for achieving good estimates.

In the following text, we suggest a quality-centric methodology for staffing decision support, and illustrate its application on an inpatient nursing service case. Some commonly used hypotheses are also tested. Finally, conclusions are drawn and suggestions for future research are presented.

2. Methodology for staffing decision support

Our methodology consists of three consecutive phases. In the first phase, we collect data, which is used in the second phase to develop a quality loss function. The third phase involves the actual staffing decisions. The sequence of these three phases is repeated in overlapping cycles such that the last phases follow each other without interruption (see Fig. 1). Each phase is discussed in detail in the following sections.

2.1. Data collection

Our goal is to express nursing service quality, q , as a function of the workload, w , and the nursing capacity, c , in

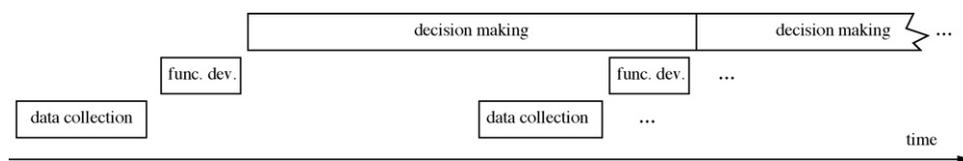


Fig. 1. The repeating overlapping cycles of the three phases.

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