

論文題目 Quantitative analysis and dynamic scheduling of inpatient nursing care

(病院内看護手順の定量的解析と動的スケジューリング)

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(本文) (Abstract)

In most hospitals in Japan, nurses acquire skills to perform nursing care by learning from their senior nurses. When a nurse receives reports from nurses in the previous shift, she makes a schedule on how she will carry out nursing care using worksheets for all patients who she has to take care in the assigned shift. Because of current complex medical treatment modalities and high acuity levels of patients, the nursing care often does not go as scheduled. This phenomenon creates prolonging nurses' working hours and particularly impacted on novice nurses. An evaluation system for this phenomenon and a corresponding instruction system, however, have been received little attention from nurses. In this thesis, we quantitative analyze the nurses' action rules on the provision of nursing cares, and propose a dynamic scheduling method to instruct inpatient nursing in real time.

As we know, keeping track of times of relative effectiveness in meeting and connecting with another can reveal and extend one's skills of engagement in practical nursing cares. Therefore, modelling inpatient nursing from the viewpoint of scheduling, we propose a new method to quantitatively elucidate the implicit knowledge of nurses on their provision of nursing cares (here, we termed it as action rule) engaged in practical nursing cares, according to a set of candidate existing dispatching rules. In simulations to match the nursing care schedules planned by dispatching rules with the observed ones, we conclude that (1) nurses make schedules based on the rules similar to the dispatching rule of earliest due date (*EDD*), which means they refer the evaluated preparation times of activities and their expected finishing times assigned in worksheets, and (2) nursing staffing level might have an inverse relation (-0.68 for preparation coefficients - the ratio of preparation time evaluated to that in manuals - to work tenures based on the linear regression analysis) with the evaluated preparation times, which affect the possibilities that nurses provide nursing cares as scheduled in worksheets.

Despite this recognition, it is difficult for nurses to provide nursing cares in a timely and accurate fashion according to their own action rules. In this respect, we propose a dynamic scheduling method to instruct nurse (especially novice nurses) in providing high-quality nursing cares. Here, we propose an new scheduling algorithm with 2-layer local search processes based on simulated annealing: (i) permutating tasks from one nurse to another, and (ii) permutating sub-tasks of a nurse. In this way, initialized from a solution generated by the proposed scheduling algorithm, the proposed method iteratively generates new feasible nursing care schedules based on the proposed scheduling algorithm to handle the occurrence of interruptions and prevent prolonging nurses' work hours. Through a set of actually observed nursing cares, the proposed method is certificated to be effective: (1) 20% improvement from the *EDD* on the earliness and tardiness - a performance measuring the cares provided as scheduled in worksheets - in case of no interruptions, (2) 3% improvement on the earliness and tardiness in case of interruptions). In addition, the proposed method is verified to be more effective for the nursing care scheduling problems with higher frequency of interruptions.

Furthermore, to evaluate the practical applicability of the proposed method, we test it in the simulated experimental conditions with which clinical nurses were asked to perform assigned nursing tasks in worksheets and unpredictable ones in interruptions. In addition, simulated patients were also introduced to make it realistic. In the experiments, we instruct clinical nurses in real time to perform the nursing tasks according to the schedules generated by the proposed dynamic scheduling method. By comparing with the care performed by the nurses' own action rules, the proposed method is confirmed to be highly applicable to practical nurses' work environments with better nursing care schedules (71% improvement on average from the nurses own action rules) on the earliness and tardiness.