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Simulation-based Decision Making on Intra-hospital Patient Referral in a Collaborative Medical Alliance

Authors : Yuguang Gao, Mingtao Deng

Abstract : The integration of independently operating hospitals into a unified healthcare service system has become a strategic imperative in the pursuit of hospitals' high-quality development. Central to the concept of group governance over such transformation, exemplified by a collaborative medical alliance, is the delineation of shared value, vision, and goals. Given the inherent disparity in capabilities among hospitals within the alliance, particularly in the treatment of different diseases characterized by Disease Related Groups (DRG) in terms of effectiveness, efficiency and resource utilization, this study aims to address the centralized decision-making of intra-hospital patient referral within the medical alliance to enhance the overall production and quality of service provided. We first introduce the notion of production utility, where a higher production utility for a hospital implies better performance in treating patients diagnosed with that specific DRG group of diseases. Then, a Discrete-Event Simulation (DES) framework is established for patient referral among hospitals, where patient flow modeling incorporates a queueing system with fixed capacities for each hospital. The simulation study begins with a two-member alliance. The pivotal strategy examined is a "whether-to-refer" decision triggered when the bed usage rate surpasses a predefined threshold for either hospital. Then, the decision encompasses referring patients to the other hospital based on DRG groups' production utility differentials as well as bed availability. The objective is to maximize the total production utility of the alliance while minimizing patients' average length of stay and turnover rate. Thus the parameter under scrutiny is the bed usage rate threshold, influencing the efficacy of the referral strategy. Extending the study to a three-member alliance, which could readily be generalized to multi-member alliances, we maintain the core setup while introducing an additional "which-to-refer" decision that involves referring patients with specific DRG groups to the member hospital according to their respective production utility rankings. The overarching goal remains consistent, for which the bed usage rate threshold is once again a focal point for analysis. For the two-member alliance scenario, our simulation results indicate that the optimal bed usage rate threshold hinges on the discrepancy in the number of beds between member hospitals, the distribution of DRG groups among incoming patients, and variations in production utilities across hospitals. Transitioning to the three-member alliance, we observe similar dependencies on these parameters. Additionally, it becomes evident that an imbalanced distribution of DRG diagnoses and further disparity in production utilities among member hospitals may lead to an increase in the turnover rate. In general, it was found that the intra-hospital referral mechanism enhances the overall production utility of the medical alliance compared to individual hospitals without partnership. Patients' average length of stay is also reduced, showcasing the positive impact of the collaborative approach. However, the turnover rate exhibits variability based on parameter setups, particularly when patients are redirected within the alliance. In conclusion, the re-structuring of diagnostic disease groups within the medical alliance proves instrumental in improving overall healthcare service outcomes, providing a compelling rationale for the government's promotion of patient referrals within collaborative medical alliances.

Keywords : collaborative medical alliance, disease related group, patient referral, simulation
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