**Time-Varying Fluid Networks with Blocking: Models Supporting Patient Flow Analysis in Hospital**

**Abstract:**

This research focuses on elderly patients who have been hospitalized, are ready to be discharged but must remain in the hospital until a bed in a geriatric institution becomes available; these patients “block” hospital beds. Bed-blocking has become a challenge to healthcare operators due to its economic implications and quality-of-life effect on patients.

We are thus motivated to model and analyze the flow of patients between hospitals and geriatric institutions, in order to improve their joint operation. To this end, we develop a mathematical fluid model of this patient flow, which accounts for blocking, mortality and readmission – all significant features of the discussed environment. The time-varying fluid model we developed for this system was found accurate when compared against a two-year data set from a hospital chain and simulation results. Analyzing the fluid model and its offered-load counterpart yields a closed-form expression for bed allocation decisions, which minimizes underage and overage costs. Solving for the optimal number of geriatric beds in our system demonstrates that significant cost reductions are achievable, when compared to current operations.

Finally, to achieve a more comprehensive view of the system, the perspective should include ED boarded patients waiting for admission to hospital wards. The analysis should also include finite waiting rooms and customer loss when the first station is full. Accordingly, we set out to model and analyze time-varying tandem flow lines with blocking and reflection. Our models yield operational insights on network performance, specifically on the effects of line-length, bottleneck location, waiting room size and the interaction among these effects.