Improving hospital scheduling for outpatient chemotherapy

On a chemotherapy day, cancer patients have several appointments at the hospital. Despite the large number of patients with cancer (the leading cause of death in the Netherlands), chemotherapy days tend to be poorly planned: patients spend a lot of time waiting between appointments and nurses have stressful and chaotic schedules. Operations management could help make schedules better for nurses and for patients, but very few people have tried to apply it to chemotherapy appointment scheduling. In my thesis, I modeled this scheduling problem with a focus on the nursing step of the service: the actual drug administration.

![Patient's journey on a chemotherapy day](this dissertation)

My work shows that working around the scheduling of drug preparation and oncologist visits is a good first step for optimizing chemotherapy schedules. Then the other steps can be scheduled accordingly. This model could also be used for services similar to chemotherapy, such as kidney dialysis.

I studied both online and offline scheduling. In online scheduling, the clinic informs the patient about the day and time of the next appointment quickly, either as soon as the appointment request comes in or within 24 hours. To look out for the interests of all stakeholders, I designed scheduling rules with the following attributes:

- Starting the appointments according to the strict time limitations of pharmacy and oncologists
- Completing the last appointments of the day as early as possible for the sake of the nurses
- Coordinating the tasks of other stakeholders so patients spend less time waiting
- Giving new patients their first appointment quickly
- Treating returning patients neither too early nor too late, to best prevent side effects and diminishing results
- Little overtime and idle time for the clinic

In offline scheduling, the clinic collects all the appointment requests that it receives for an intended day in the future. Since there is more information available than with online scheduling, the resulting schedule tends to be better in many respects. For example, the clinic can match nurses’ schedules with demand: assigning extra nurses to other parts of the hospital or asking for support nurses on busy days. However, the clinic tells patients the time of their appointment only a few days before the appointment.
In either approach, we attempt to balance nurses’ workload and avoid changing nurses during appointments as much as possible.

I did a case study at a Dutch hospital, with the eventual goal that they will work with my model in their scheduling system. I found that, for patients who need in-house blood tests before infusion, less waiting time is most easily achieved by doing the blood draw, testing and oncologist steps on the day before infusion. The study also indicates that the clinic may need to expand its nursing capacity if demand continues to increase.

For hospitals who want to improve the operational aspects of their chemotherapy service, the following four steps are needed to implement our models:

- Think about scheduling strategy:
  - Online versus offline scheduling.
  - Lab test and oncologist visit on the same day as infusion, the day before, or a combination of both.
- Adjust the Enterprise Resource Planning (ERP) system to provide historical data for modeling.
- Connect mathematical software with the ERP system for scheduling.
- Motivate care providers, especially nurses, that the new scheduling approach gives better results than improvised decision-making.

*Title of PhD-thesis: Tactical & Operational Models for Scheduling Chemotherapy Appointments.*
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