Göteborg, 2021

Towards a balanced radiotherapy workflow using practical solutions identified by field studies and simulations

Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet kommer att offentligen försvaras i hörsal Arvid Carlsson, Medicinaregatan 3, Göteborg, fredagen den 19 november 2021, klockan 9.00.

av **Jesper Lindberg**

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Avhandlingen baseras på följande delarbeten

I. *A national perspective about the current work situation at modern radiotherapy departments.* **Jesper Lindberg**, Paul Holmström, Stefan Hallberg, Thomas Björk-Eriksson, Caroline E. Olsson. Clin Transl Radiat Oncol. 2020;24:127-134.

II. *Linear accelerator utilization: Concept and tool to aid the scheduling of patients for radiotherapy.* **Jesper Lindberg**, Thomas Björk-Eriksson and Caroline E. Olsson. Tech Innov Patient Support Radiat Oncol. 2021;20:10-16.

III. *An analytical approach to aggregate patient inflows to a simulation model over the radiotherapy process.* **Jesper Lindberg**, Paul Holmström, Stefan Hallberg, Thomas Björk-Eriksson, Caroline E. Olsson. BMC Health Serv Res. 2021;21:207.

IV. *Resource planning principles for the radiotherapy process using simulations applied to a longer vacation period use case.* **Jesper Lindberg**, Mrugaja Gurjar, Paul Holmström, Stefan Hallberg, Thomas Björk-Eriksson, Caroline E. Olsson. Accepted for publication in Tech Innov Patient Support Radiat Oncol.

SAHLGRENSKA AKADEMIN
INSTITUTIONEN FÖR KLINISKA VETENSKAPER

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Towards a balanced radiotherapy workflow using practical solutions identified by field studies and simulations

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Abstract

With increasing cancer incidence comes a higher demand for radiotherapy (RT). Resources available for RT, well-educated staff, and linear accelerators (linacs), are limited. To meet the increasing demand without violating the staffs working conditions, improvements in resource use are warranted but in need of careful evaluation before being introduced in the clinic.

In this thesis, we used study-specific questionnaires, directed to staff and managers at Sweden's RT departments, to increase understanding about the modern RT process. Extracted scheduling data from the oncology information system, ARIA, were analyzed for future (planned) and observed (actual) scheduling levels. A tool to aid staff to overview scheduling levels was developed and evaluated. Different approaches to aggregate RT workflow groups for use in a simulation model were also investigated. Performance of the different grouping strategies was tested in a simulation model covering the preparatory part of the RT process. A simulation model covering the whole RT process was developed and used together with managers and staff to investigate different resource scenarios for an example use case over the summer vacation period.

Scheduling of patients was an identified step in the RT process with a particular need of improvement. RT staff expected the managers to be better prepared for reoccurring unplanned events that halted the workflow. We found that linacs were fully booked several weeks in advance. Evaluation of the in-house developed tool to aid with scheduling generated positive feedback regarding the potential to schedule patients more evenly.

Preferred methods for aggregation of RT workflows were either by grouping workflows with similar resource use together or by applying the 80/20 (Pareto) principle (acknowledge RT workflows related to 80% of the patients separately and the remaining 20% in a single group). Simulations investigating scenarios to schedule staff for the summer vacation period showed that the best combination of resource use and shortest waiting list was achieved when the vacation period for the preparatory part of the RT workflow started 1-2 weeks prior to the vacation period of the treatment part.

An identified need of staff and managers at Swedish RT departments was to aid with scheduling of patients and to prepare for unwanted scenarios. A customized tool to aid with scheduling can enable an even workload for the RT workflow and simulations can aid managers in planning how to use resources better with regard to patient waiting times and staff workload.

Keywords: radiotherapy, workflow, organization, planning, simulation

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