Göteborg, 2023

Machine learning and big data for personalized epilepsy treatment

Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet kommer att offentligen försvaras i Arvid Carlsson, Medicinaregatan 3, den 16:e juni klockan 09:00.

av Samuel Håkansson

Fakultetsopponent:
Professor Spiros Denaxas
University College London, England

Avhandlingen baseras på följande delarbeten

I. **Samuel Håkansson**, Markus Karlander, David Larsson, Zamzam Mahamud, Sara Garcia-Ptacek, Aleksej Zelezniak, Johan Zelano.
Potential for improved retention rate by personalized antiseizure medication selection: A register-based analysis. *Epilepsia* 2021; 62(9): 2123-2132.

II. **Samuel Håkansson**, Johan Zelano.
Big data analysis of ASM retention rates and expert ASM algorithm: A comparative study. *Epilepsia* 2022; 63(6): 1553-1562.

III. **Samuel Håkansson**, Ronny Wickström, Johan Zelano.
Selection and continuation of antiseizure medication in children with epilepsy in Sweden 2007-2020. *Pediatric Neurology* 2023; 144: 19-25.

IV. **Samuel Håkansson**, Fredrik D. Johansson, Aleksej Zelezniak, Johan Zelano.
Personalized anti-seizure medication selection using counterfactual time-to-event machine learning: a national retrospective study. *Manuscript*.

SAHLGRENSKA AKADEMIN
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Machine learning and big data for personalized epilepsy treatment

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Abstract

Finding an effective anti-seizure medication (ASM) with minimal side effects is a challenge. Patient characteristics are used to guide treatment selection, but about half of the patients with epilepsy do not achieve seizure freedom with their first ASM. While randomized controlled trials are the gold standard for estimating treatment efficacy, they may not always be clinically relevant, especially for rare conditions. Registers are valuable sources of data because they can contain many patients, are accessible, and are updated regularly. The aim of the present research is to evaluate registers and develop machine learning algorithms for personalized medicine in epilepsy.

We used prescriptions, in- and outpatient data, and mortality data from national Swedish registers to model ASM use of patients. As a bundled estimation of efficacy and tolerability, retention rate was used as the measure of outcome.

The results indicate that using register data to estimate retention of ASMs is feasible and personalized ASM selection can potentially improve patient outcomes. Retention rates from registers are similar to that of RCTs and meta-analyses of RCTs. In an analysis of patients with epilepsy and comorbidities, there was a potential improvement of 14-21% of the 5-year retention rate for the initial ASM (Paper I). Ranking of ASMs for patient cases based on retention rates from register data is similar to suggestions based on expert advice (Paper II). We also studied ASM use in children, a group with limited evidence (Paper III). Specialized machine learning algorithms can potentially be a useful source of information for doctors for selecting ASMs (Paper IV).

In conclusion, this research highlights the potential of registers as a data source for personalized medicine. Machine learning trained on register data can be used to predict the efficacy of ASMs, but the methodology needs further development and clinical verification.

Keywords: anti-seizure medication, personalized treatment, machine learning

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