Predicting mortality by comorbidity for patients with hip arthroplasty

Prospective observational register studies of a nationwide Swedish cohort

Akademisk avhandling

Som för avläggande av medecine doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet kommer att offentligen försvaras i R-aulan, Sahlgrenska universitetssjukhuset, Mölndal, fredagen den 18 september 2020, klockan 9.00

av Erik Bülow, MSc. matematisk statistik

Fakultetsopponent: Docent Aldana Rosso, Lunds universitet, Sverige

Avhandlingen baseras på följande delarbeten

I. E Bülow. coder: An R package for code-based item classification.
    In manuscript

II. E Bülow, O Rolfson, P Cnudde, C Rogmark, G Garellick, S Nemes.
    Comorbidity does not predict long-term mortality after total hip arthroplasty.
    Acta Orthopaedica, **88** (July) 2017

III. E Bülow, P Cnudde, C Rogmark, O Rolfson, S Nemes. Low predictive power of comorbidity indices identified for mortality after acute arthroplasty surgery undertaken for femoral neck fracture. *The Bone & Joint Journal.* 2019;**101**-B(1):104-112. doi:10.1302/0301-620X.101B1.BJJ-2018-0894.R1

IV. A Garland, E Bülow, E Lenguerrand, A Blom, MJ Wilkinson, A Sayers, O Rolfson, NP Hailer. Prediction of 90-day mortality after total hip arthroplasty: A simplified and externally validated model based on observational registry data from Sweden, England and Wales
    In manuscript

V. E Bülow, O Rolfson, S Nemes. Comorbidity decreased the restricted mean survival time for patients with total hip arthroplasty: An observational register study of 150,367 patients from the Swedish Hip Arthroplasty Register 1999–2015.
    In manuscript

SAHLGRENSKA AKADEMIN
INSTITUTIONEN FÖR KLINISKA VETENSKAPER

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Predicting mortality by comorbidity for patients with hip arthroplasty

Prospective observational register studies of a nationwide Swedish cohort

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Abstract

Introduction: Patients with total hip arthroplasty (THA) due to osteoarthritis (OA) are usually healthy, some with a remaining lifetime of several decades after surgery. Patients with hip arthroplasty due to a femoral neck fracture (FNF) are often old and frail with 13 % mortality within 90 days of surgery. To predict all-cause mortality for those groups has been considered but no prediction model has so far been widely accepted.

Patients and methods: We developed an R package to estimate comorbidity from large datasets. We used data from the Swedish Hip Arthroplasty Register (SHAR), the National patient register (NPR), the national prescription register, the Longitudinal integrated database for health insurance and labour market studies (LISA), the Swedish population register and the National Joint Registry for England, Wales, Northern Ireland, the Isle of Man and the States of Guernsey (NJR). We evaluated the discriminatory abilities of the Charlson and Elixhauser comorbidity indices to predict mortality for patients with hip arthroplasty due to OA and FNF. We also developed a new statistical prediction model for 90-day mortality after cemented THA due to OA using a bootstrap ranking procedure with logistic least absolute shrinkage and selection operator (LASSO) regression. The model was validated internally, as well as externally with patients from England and Wales. We built a web calculator for clinical usage. Finally, association between the Elixhauser comorbidity index and the restricted mean survival time (RMST) after surgery was assessed for patients with THA due to OA.

Results: The *coder* R-package provides a dynamic solution for patient classification. Neither the Elixhauser, nor the Charlson comorbidity indices accurately predicted mortality after hip arthroplasty due to OA or FNF (area under the curve (AUC) < 0.6 and AUC < 0.7; where 0.7 is a common lower threshold for an acceptable model). The new model, based on age, sex, the American Society of Anesthesiologists (ASA) physical status class, and the presence of cancer, disease of the central nervous system (CNS), kidney disease and obesity, did predict 90-day mortality with good discriminatory ability (AUC > 0.7) and was well calibrated for predicted probabilities up to 5 %. Shortening of the RMST for 10 years after surgery ranged from 315 days for patients with no comorbidity, to 1,193 days for patients with at least 3 comorbidities.

Conclusion: We found that the Charlson and Elixhauser comorbidity indices, although associated with RMST, did not predict mortality after hip arthroplasty. Our parsimonious model did predict 90-day mortality after THA due to OA.