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Comparing colon cancer outcomes: The impact of low hospital case volume and case-mix adjustment

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Abstract

Objective: When comparing performance across hospitals it is essential to consider the noise caused by low hospital case volume and to perform adequate case-mix adjustment. We aimed to quantify the role of noise and case-mix adjustment on standardized postoperative mortality and anastomotic leakage (AL) rates.
Methods: We studied 13 120 patients who underwent colon cancer resection in 85 Dutch hospitals. We addressed differences between hospitals in postoperative mortality and AL, using fixed (ignoring noise) and random effects (incorporating noise) logistic regression models with general and additional, disease specific, case-mix adjustment.
Results: Adding disease specific variables improved the performance of the case-mix adjustment models for postoperative mortality (c-statistic increased from 0.77 to 0.81). The overall variation in standardized mortality ratios was similar, but some individual hospitals changed considerably. For the standardized AL rates the performance of the adjustment models was poor (c-statistic 0.59 and 0.60) and overall variation was small. Most of the observed variation between hospitals was actually noise.
Conclusion: Noise had a larger effect on hospital performance than extended case-mix adjustment, although some individual hospital outcome rates were affected by more detailed case-mix adjustment. To compare outcomes between hospitals it is crucial to consider noise due to low hospital case volume with a random effects model.

Keywords: Colon cancer; Mortality; Anastomotic leakage; Low hospital case volume; Case-mix adjustment

Introduction

Accountability to the public has become a major topic in health care in the past decade; consequently outcome measures increasingly receive attention.[1,2] Colorectal cancer is the third most common cancer,[3] in 2012 an incidence of 13 408 new cases is registered in the Netherlands.[4] Surgeries for colorectal cancer cause considerable morbidity

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and mortality.[5] In cancer surgery mainly short-term outcome measures are used to measures quality of care, as they are little influenced by non-modifiable disease-related factors.[6] Short-term outcome measures for colorectal cancer surgery include postoperative mortality and anastomotic leakage (AL). AL is one of the most serious complications in colon cancer surgery, as it is associated with increased morbidity and mortality.[7] Moreover, variations between providers can be observed.[8–10]

However, variation in outcome across centres is not made up exclusively by quality of care differences, which it is intended to display.[11,12] Case-mix factors are thought to explain a large part of the observed outcome variation,[13] but case-mix models are usually fairly generic.[14] Especially when they are based on administrative data, not intended for quality assessment.[15–17] For colon cancer, research has shown that surgical high risk profile patients are not equally distributed across centres.[18,19]

Next, partial variation across centres can be attributed to 'noise' in the comparison (variation by chance). The noise in the comparison is especially influenced when the hospital case volume, so the number of patients with an event per hospital, is low.

For example, an average number of 10 deaths per year in a hospital will fluctuate over the years because of chance, also if no changes in quality occur. With larger numbers of outcomes per hospital (e.g. >50) the effect of chance variation decreases. Random effects regression models are able to take the variation by chance into account, in contrast to the mainly used fixed effects models.[20,21]

In this study we aimed to quantify the role of noise and case-mix adjustment on standardized postoperative mortality and AL rates.

Methods

Study population

For this study data was derived from the Dutch Surgical Colorectal Audit (DSCA), a national, web-based and interactive database.[22] The database, in which all Dutch hospitals participate, includes detailed information on patient- and tumour characteristics, diagnostics, procedures and outcomes of patients undergoing a resection of a primary colorectal carcinoma. In each hospital a surgeon is appointed for the data-entry. For participating hospitals it is possible to review their uploaded data as well as benchmarking information on a protected web page. Further, data quality reports are sent to the hospitals.[18] Approximately 97 percent of all patients with a primary colorectal carcinoma resection in the Netherlands are captured in this database.[23] The dataset is based on evidence-based guidelines and annually verified with the Netherlands Cancer Registry (NCR) data. Further information on the data collection and methodology of the DSCA can be found elsewhere[18,22] [www.dsca.clinicalaudit.nl].

We used data of all patients who underwent a primary colon carcinoma resection in the Netherlands between 1st of January 2011 and 31st of December 2012 (92 hospitals, 13 672 patients). Seven hospitals (with 552 patients) were excluded because they had zero outcome events (no deaths or no anastomotic leakage (AL)), resulting in 85 hospitals and 13 120 patients included in the analyses.

Predictors and outcome measures

Demographic variables included age and gender. Clinical variables included American Society of Anesthesiologists (ASA) score, Charlson comorbidity index, International Union Against Cancer tumour node metastasis (TNM) classification of malignant tumours (6th edition), histological tumour type and tumour number and distance, in case of double tumour (distant tumours are located in a segment not adjacent to other (hemi left, hemi right and rectum)) and preoperative complications (perforation with fecal peritonitis, abscess, bowel obstruction, blood loss/anemia). The postoperative short-term outcomes assessed were postoperative mortality and anastomotic leakage. Postoperative mortality was defined as dead during the index admission in which the surgery took place or within 30 days after surgery. AL was defined as 'a clinically relevant anastomotic leak requiring a reintervention'. Both radiological and surgical reinterventions were considered.

Statistical analysis

To describe between-hospital differences in operated patients we calculated medians and interquartile ranges for the baseline demographic and clinical characteristics on hospital level. We constructed six different models for each of the two outcomes (postoperative mortality and AL):

1) A crude fixed effects logistic model with taking no patient characteristics or chance into account.
2) A fixed effects logistic multivariable model including generic case-mix factors: age, gender, urgency of surgery, Charlson comorbidity index and year of operation.
3) The extended case-mix adjusted fixed effects logistic model, which consists of model 2 plus additional disease specific factors. The variables considered were age, gender, urgency of surgery, Charlson comorbidity index, year of operation, ASA-score, TNM stage, preoperative tumour complications, histological tumour type, number and distance of tumours.

These three models were also fitted as logistic random effects models with hospital as a random intercept. Such a random effects model takes out the noise in the comparison.

To evaluate the effect of additional case-mix adjustment, the c-statistic (equivalent to the area under the ROC curve)