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Measuring quality of care for colorectal cancer care : comprehensive feedback driving quality improvement

Kolfschoten, N.E.

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Author: Kolfchoten, N.E.

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Chapter 8

Combining process indicators to evaluate quality of care for surgical colorectal cancer patients; are scores consistent with short-term outcome?

N.E. Kolfschoten¹, G.A. Gooiker¹, E. Bastiaannet¹, N.J. van Leersum¹, C.J.H. van de Velde¹, E.H. Eddes³, P.J. Marang-van de Mheen⁴, J. Kievit^{1,4}, E. van der Harst⁵, T. Wiggers⁶, M.W.J.M. Wouters², R.A.E.M Tollenaar¹, on behalf of the Dutch Surgical Colorectal Audit group*

¹ Leiden University Medical Centre, Dept of Surgery,

² Dutch Cancer Institute, Amsterdam, Dept of Surgery,

³ Deventer Hospital, Dept of Surgery,

⁴ Leiden University Medical Center, Dept of Medical Decision Making,

⁵ Maasstadziekenhuis Rotterdam, Dept of Surgery,

⁶ Groningen University Hospital, Dept of Surgery,

* W.A. Bemelman, O.R.C. Busch, R.M. van Dam, M.L.E.A. Jansen-Landheer, Th.M. Karsten, J.H.J.M. van Krieken, W.G.T. Kuijpers, V.E. Lemmens, E.R. Manusama, W.J.H.J Meijerink, H.J.T. Rutten

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Abstract

Objective

To determine if composite measures based on process indicators are consistent with short-term outcome indicators in surgical colorectal cancer care.

Design

Longitudinal analysis of consistency between composite measures based on process indicators and outcome indicators for 85 Dutch hospitals.

Setting

The Dutch Surgical Colorectal Audit database, the Netherlands

Participants

4732 elective patients with colon carcinoma and 2239 with rectum carcinoma, treated in 85 hospitals were included in the analyses.

Main outcome measures

All available process indicators were aggregated into five different composite measures. We investigated the association of the different composite measures with risk-adjusted postoperative mortality and morbidity, at patient and hospital level.

Results

At a patient level, only one of the composite measures was negatively associated with morbidity for rectum carcinoma. At a hospital level, we found a strong negative association between composite measures and hospital mortality and morbidity rates for rectum carcinoma ($p < 0.05$), and hospital morbidity rates for colon carcinoma.

Conclusions

For individual patients, a high score on the composite measures based on process indicators is not associated with better short-term outcome. However, at a hospital level, a good score on the composite measures based on process indicators was consistent with more favourable risk-adjusted short-term outcome rates.

Introduction

Society increasingly demands information on hospitals' quality of care. Quality of health care is defined as "... the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge⁸⁵." Currently, quality indicators play a key role in monitoring quality of surgical care in many countries. Based on the Donabedian paradigm, quality indicators are often characterized as structure, process or outcome indicators.¹⁰ Although outcome indicators are seen as 'the bottom line' of what surgeons do, valid outcome information, adjusted for a hospitals' *case-mix*, is commonly not available. Process indicators on the other hand, usually selected from evidence based guidelines, give a fair reflexion of what is done for a patient, and are more actionable than outcome indicators.⁸⁶ Therefore, most quality indicators are process indicators, based on the assumption that a 'good care process', e.g. being treated according to the evidence-based guideline, will lead to good outcome. At a hospital level this implies that a high percentage of patients treated according to the guideline will be related to favourable outcomes.

Most process indicators are selected on the basis of an assumed or proven relation with long-term or disease-free survival. However, long-term outcome reflects the quality of care delivered years before the outcome measurement and is therefore less indicative for the hospital's performance at that moment. Therefore, outcome of care is often measured by short-term outcome measures such as postoperative mortality, or major morbidity.⁸⁷ However, a clear relation between process indicators and short-term outcome indicators has not been established.^{88,89} Moreover, though an individual process indicator may give useful information for targeted quality improvement programs, it is difficult to assess guideline adherence by means of a list of individual indicators: a hospital may have a high score on one indicator, but a low score on another indicator. Therefore, a summarizing measure is needed to give a comprehensive judgement of the care delivered in individual hospitals. For this purpose, indicators can be aggregated into a composite measure.⁹⁰ Reeves at all summed 5 commonly used methods of constructing composite outcome measures.⁹¹

To monitor and improve the quality of care colorectal cancer patients in the Netherlands, the Dutch Surgical Colorectal Audit (DSCA) was initiated in 2009. In the DSCA, patient and tumour characteristics together with diagnostic, treatment, pathology and outcome data are registered. Using this database, various composite process measures could be tested for their consistency with short-term outcome. The aim of the study was to determine whether a good score on composite process measures is associated with favourable short-term outcomes, on a patient and a hospital level.

Methods

Patients

The dataset was retrieved from the DSCA, a nation wide, web based database in which case-mix, diagnostic, treatment, pathology report and clinical outcome data are registered of patients that undergo a resection of a first presentation of a colorectal carcinoma in the Netherlands. The estimated completeness in the year 2010 compared to the National Cancer registry (NCR) was 93% (www.dsca.nl). Overall comparison with NCR was not suggestive for patient-selection (www.dsca.nl); the results of the comparison are communicated with the hospitals, encouraging completeness and validity of the data. For this study, no ethical approval was required.

Inclusion and exclusion criteria

All elective patients with a date of surgery between the 1st of January 2010 and 31st of December 2010 treated in one of the 92 Dutch Hospitals who were included in the DSCA before March 15th 2011 were evaluated. Patients who underwent an urgent or emergency resection, or were treated for a recurrence of a colorectal carcinoma or multiple synchronous colorectal tumours were excluded.

Hospitals that failed to register all patients in 2010 were excluded. Furthermore, as case-mix correction is imperative for evaluating outcome of care, hospitals that failed to fill in the required case-mix factors for more than 15% of the registered patients were excluded.

Process indicators

As the process of care for colon cancer (CC) encompasses different aspects than for rectal cancer (RC), groups were analysed separately. The indicators used in this study were selected from the dataset of the DSCA. This dataset was constructed based on evidence based guidelines and extensive literature research, which resulted in a large dataset that was reduced to the present dataset by a team of medical experts using the Delphi method.^{92,93} All variables available in the DSCA concerning (preoperative) guideline adherence were selected for evaluation. As postoperative guideline adherence, such as adjuvant chemotherapy for patients with stage 3 colon carcinoma is dependent on postoperative outcome,⁹⁴ postoperative processes of care (except for postoperative pathology reporting) were not included. For CC, four process indicators were selected, for RC, six process indicators were selected. For the indicator 'time to treatment < 7 weeks', records in which the date of first biopsy was not available were excluded for the indicator. As there are several reasons why a biopsy may not be obtained or the date of the biopsy would not be available (e.g. due to referral from another hospital), and no substitute for the date of diagnosis was available, the indicator was considered 'not indicated' for the patient. For all other indicators, the absence of information on the indicator was interpreted as 'indicator has not been met'; ratio being that when information on such important processes of care was unavailable to the caregiver, the process was not completed properly. This is in line with the current policy of the Dutch healthcare inspectorate.

Outcome indicators

Outcome is registered at discharge or 30 days after the resection. Postoperative outcome was assessed by two separate outcome measures: postoperative mortality and major morbidity. Postoperative mortality was defined as mortality within 30 days after resection. Major morbidity was defined as any complication with serious consequences: leading to mortality, a reintervention, or to a length of stay longer than 14 days. Selected processes and outcome measures are shown in table 1.

Table 1. Process indicators in the Dutch Surgical Colorectal Audit

Process indicator	Definition	Inclusion	Measures
Complete Colonoscopy	Was the colon completely visualized, caecal intubation performed, by colonoscopy or CT-colonography before the resection?	CC and RC	Staging
Diagnostic tests	Was preoperative visualisation of lungs and liver by either CT-thorax or X-thorax and CT-abdomen or ultrasound respectively, or Pet-CT performed?	CC*	Staging
MRI	Was the pelvis adequately staged with MR imaging before the resection?	RC	Staging
MDT	Was the patient discussed in a multidisciplinary team meeting? In a multidisciplinary team meeting at least a surgical oncologist, a medical oncologist, a pathologist a radiologist and a radiotherapist had to participate	RC	Staging
Radiotherapy	Did the patient receive adequate neoadjuvant radiation therapy?	Patients with RC with a clinical T2 (TNM classification)	Treatment
Time to treatment	Was the start of treatment within 7 weeks of diagnosis? [www.treeknorm.nl]. The date of diagnosis was defined as the date of the first tumour positive biopsy, the date of the start of treatment was the date of surgery, or, when neo-adjuvant treatment was given, the date of the first radiation therapy or chemotherapy	CC and RC	Waiting time
10+ lymph nodes	Were 10 or more lymph nodes described in the pathology report? The required number of lymph nodes for adequate postoperative staging defined by the national guideline is 10 or more	CC	Treatment and pathology report
CRM reported	Was the involvement of the circumferential resection margin adequately reported pathology report?	RC	Pathology report
Outcome			
Mortality	Mortality within 30 days after resection, adjusted for case-mix variations	CC and RC	Outcome
Morbidity	Any complication resulting in a length of stay longer than 14 days, a reintervention, or mortality, adjusted for case-mix variations	CC and RC	Outcome

CC = coloncarcinoma, RC = rectumcarcinoma, pTNM = pathological stage Tumour Node Metastasis system
CRM = circumferential resection margin

*due to an error in the database the imaging of lung and liver of patients with a rectumcarcinoma was not registered.

Combining indicators

We evaluated all methods of combining indicators as described by Reeves and their relation to postoperative outcome, at a hospital level and a patient level [Table 2].⁹¹ At a hospital level we tested five measures: the 'all or none', the '70% standard', the 'patient average', the 'indicator average' and the 'overall percentage' measure. Differences between the score on the latter three composite measures are defined by the proportion of indicators that are only relevant for a select group of patients, and the proportion of patients in a hospital for whom the indicator is relevant. At a patient level, we tested three measures: the 'all or none', the '70% standard', and the 'patient average'. The other two composite measures, 'Indicator Average', and 'Overall Percentage' were not applicable at the patient level, as they would give the same score as the 'patient average'. As pointed out by Reeves et al,

Table 2. Composite measures at hospital and patient level.

Patient level		
All-or-None	'were all relevant indicators met for this patient?'	This is the strictest measure, as no points are given when one indicated process is missed.
70% Standard	'were 70% or more of all relevant indicators met for this patient?'	A less strict measure, the standard is met when, 70% or more of the indicated care is given.
Patient Average	'the percentage of relevant indicators that were met for this patient.'	An analogue measure for the percentage of indicators that are met for a patient.
Hospital level		
All-or-None	'the percentage of patients for whom all relevant indicators were met.'	This is the strictest measure, as no points are given when one indicated process is missed. Nolan and Berwick found this score to be the most patient-centred score, as it represents the likelihood that 'all goes well' in a patients process ⁹⁰ .
70% Standard	'the percentage of patients for whom 70% of more of all relevant indicators were met.'	A less strict measure, the standard is met when, 70% or more of the indicated care is given.
Patient Average	'the mean rate at which relevant indicators were met for each patient.'	The percentage of relevant indicators met is averaged across all patients. This score represents the mean percentage of indicated care patients receive in the hospital ¹⁰⁸ .
Indicator Average	'the mean rate at which each indicator was met.'	For each indicator, the percentage of patients for whom the indicator was met is computed. The scores are averaged across all indicators ¹⁰⁹ . This is the most commonly used method used by commercial parties in the Netherlands, as the individual indicator scores are usually the only publicly available information.
Overall Percentage	'the percentage of relevant indicators that were met.'	The overall percentage of indicated care that was given in a hospital. Example: for 100 patients and 4 audited indicators, a total of 340 indicators were relevant, and 260 indicators were met, the overall percentage was 76% ^{90,110,111} .

distributional properties of the composite measures are unknown, so that standard errors could not be calculated,⁹¹ measures are presented as mean and range.

Analyses

Outcomes were adjusted for case-mix factors including: age, gender, comorbidity (Charlson-score),⁹⁵ previous abdominal surgery, Body Mass Index (BMI), American Society of Anaesthesiologists (ASA) classification, procedure type (right hemicolectomy, left hemicolectomy including transversectomy, sigmoid resection, low anterior resection, abdominoperineal resection), local tumour invasiveness (T-stage), disseminated disease (M-stage) and additional resection for tumour invasion and/or metastasis.

We investigated the association of each of the three composite measures and postoperative outcome at a patient level and each of the five composite measures and postoperative outcome at a hospital level.

At the patient level, to test which of the composite measures was an independent predictor for mortality major morbidity, each composite measure was tested in a separate multivariable random effects logistic regression model, either for mortality or major morbidity. Odds ratios were adjusted for all case-mix factors mentioned above. Hospital of treatment was included as a random effect in the analyses. To take in account any possible complex relation between patients and the hospital of their treatment influencing the estimated effect of composite measures on outcome on a patients level, a sensitivity analysis was performed by means of a multivariable, multilevel hierarchical logistic regression model.

As the relationship between composite measures and outcome may be different on a hospital level, and possibly even have a different meaning, the data were also analyzed on a hospital level. At the hospital level, outcome was adjusted for case-mix by computing an expected outcome for each hospital. The hospitals' expected outcome was derived from logistic regression analysis in which all case-mix factors as listed above were included. The risk-adjusted mortality or major morbidity rate was computed by multiplying the observed/expected mortality and major morbidity ratio with the population average mortality and major morbidity rate.^{33,34} We tested the relation of each of the five composite measures with hospitals' risk-adjusted mortality and major morbidity rate using Poisson regression analyses. As it is known that small volume hospitals are more prone to statistical chance fluctuations, and are therefore more likely to be outliers, the analysis was repeated for large volume hospitals (>50 CC or RC resections).

Statistical significance was defined as $p < 0.05$, a trend towards significance was defined as $0.05 > p < 0.10$. All statistics were performed in PASW Statistics, Rel 18.0.2009. Chicago: SPSS inc. and Stata.

Results

Patients

At March 15th 2011, 92 hospitals (8 university hospitals, 46 teaching hospitals and 38 non-teaching hospitals) registered a total of 8835 eligible patients with a date of surgery between January 1 and December 31 2010 in the DSCA. After exclusion of hospitals that failed to register all patients (3 hospitals, 16 patients), patients with multiple synchronous tumours (253 patients) and urgent and acute patients (1228 patients) and hospitals that had not recorded case-mix details factors for more than 15% of their patients (367 patients, 4 hospitals) a total of 6971 patients (4732 CC and 2239 RC) treated in 85 hospitals were included in the analyses. Of these hospitals, 43 were high volume (>50 procedures) for CC and 9 were high volume for RC.

Process indicators and outcome

Table 3 shows the indicators and outcome, at patient and hospital level, with their respective 95% confidence intervals. For all indicators missing data were less than 2%, except for time to treatment, in which date of first tumour positive biopsy was missing in 9.2%. For these patients, the indicator was considered irrelevant. Average scores on separate indicators were more than 80%, except for 'complete colonoscopy' (70-77%), 'time to treatment' for

Table 3. Average scores for the indicators and outcome for the patient population (patient level) and at a hospital level

Level	Colon cancer Indicator	Population average		Rectal cancer Indicator	Population average	
Patient	Complete Colonoscopy	70%		Complete Colonoscopy	77%	
	Diagnostic tests	90%		MRI	90%	
	10+ lymph nodes	79%		MDT	89%	
	Time to treatment	86%		CRM reported	59%	
				Time to treatment	75%	
				Radiotherapy	88%	
	Outcome			Outcome		
	Mortality	3%		Mortality	2%	
	Morbidity	21%		Morbidity	28%	
			Hospital average	Range		Hospital average
Hospital	Complete Colonoscopy	71%	47-100%	Complete Colonoscopy	77%	33-100%
	Diagnostic tests	91%	22-100%	MRI	88%	0-100%
	Time to treatment	85%	41-100%	MDT	90%	0-100%
	10+ lymph nodes	79%		Time to treatment	75%	
				Radiotherapy	86%	
				CRM reported	62%	
	Outcome			Outcome		
	Mortality [§]	3.6%	0-19%	Mortality	2.1%	0-19%
	Morbidity [§]	21%	6.4-39%	Morbidity	27%	0-58%

[§] risk adjusted outcome rate: observed outcome/expected outcome multiplied by the population average.

RC (75%), '10+ lymph nodes' (79%) and 'Circumferential Resection Margin (CRM) reported' (59%). Population mortality rate for CC was 3.6 and 2.1% for RC; Major morbidity rate was 20.8% for CC and 27.2% for RC.

Composite measures

Although the 'patient average' was high (75% for CC and 80% for RC) for only 45% of CC patients and 29% of RC patients all indicators were met ('all or none' measure) [Table 4]. Similarly, average hospital scores on composite measures were high, but there was a wide range in performance. For CC, there were hospitals in which fewer than 10% of patients received all the indicated care ('all or none' measure), but also hospitals in which for 83% of patients all indicators were met. For RC, hospital score on the 'all or none' measure ranged from 0 to 100%.

Table 4. Average scores for the composite measures at patient and hospital level

Level	Colon cancer Indicator	Population average		Rectal cancer Indicator	Population average	
Patient level	All or none	45%		All or none	29%	
	70% standard	78%		70% standard	69%	
	Patient average	75%		Patient average	80%	
		Hospital average	Range		Hospital average	Range
Hospital level	All or none	45%	8-83%	All or none	29%	0-100%
	70% standard	78%	41-96%	70% standard	71%	0-100%
	Patient average	81%	59-95%	Patient average	80%	50-100%
	Indicator average	81%	61-95%	Indicator average	80%	47-100%
	Overall percentage	81%	60-95%	Overall percentage	80%	50-100%

Composite measures and outcome, patient level

Table 5 shows the odds ratios of the three composite measures for mortality and major morbidity at patient level: the 'all or none', '70% standard' and 'patient average', after adjustment for case-mix and hospital effect in a multivariable analysis. This table shows that, for CC, none of the composite measures was associated with outcome. However, for RC the '70% standard' measure showed a negative association (OR =0.8, p=0.04) with major morbidity. A sensitivity analysis using a multilevel hierarchical model did not change the results substantially (table 5).

Composite measures and outcome, hospital level

At hospital level, all composite measures were associated with lower risk-adjusted major morbidity rates for CC. However none of the composite measures for guideline adherence was associated with hospital risk-adjusted mortality, although the 'all or none' method showed a trend towards a negative association (p=0.07) [Table 6]. For RC, a high score on guideline adherence measured by any of the composite measures was significantly associated

Table 5. Odds ratios of composite measures for outcome, at a patients' level, as derived from a multivariable random-effects logistic regression model, and from multivariable multilevel hierarchical logistic regression model.

	Patient level All or none		70% standard		Patient average	
	Log regression OR (95%CI)	Multilevel model OR (95%CI)	Log regression OR (95%CI)	Multilevel model OR (95%CI)	Log regression OR (95%CI)	Multilevel model OR (95%CI)
Colon carcinoma						
Mortality	1.0 (0.7-1.4) p=0.9	1.0 (0.1-7.4) p=0.9	0.8 (0.6-1.3) p=0.4	0.8 (0.1-8.0) p=0.9	0.9 (0.4-2.1) p=0.8	0.9 (0.1-107) p=0.9
Morbidity	0.9 (0.8-1.1) p=0.2	0.9 (0.8-1.1) p=0.3	1.1 (0.9-1.2) p=0.6	1.1 (0.9-1.3) p=0.6	0.8 (0.6-1.2) p=0.5	0.9 (0.6-1.3) p=0.5
Rectum carcinoma						
Mortality	0.4 (0.1-1.2) p=0.1	0.4 (0.0-218) p=0.8	0.6 (0.3-1.3) p=0.2	0.6 (0.01-33.7) p=0.8	0.2 (0.04-1.6) p=0.1	0.2 (0.0-7952) p=0.8
Morbidity	0.9 (0.7-1.1) p=0.4	0.9 (0.7-1.1) p=0.4	0.8 (0.6-1.0) p=0.04	0.8 (0.6-1.1) p=0.06	0.7 (0.4-1.4) p=0.3	0.7 (0.4-1.4) p=0.4

Table 6. Rate ratios of composite measures for outcome, at hospital level, as derived from a Poisson regression model.

	All or none RR (95% CI)	70% standard RR (95% CI)	Patient average RR (95% CI)	Indicator average RR (95% CI)	Overall % RR (95% CI)
Colon Carcinoma					
Mortality\$	0.5 (0.2-1.1) p=0.07	1.0 (0.4-2.8) p=0.9	0.4 (0.1-2.0) p=0.2	0.3 (0.1-1.8) p=0.2	0.3 (0.1-1.8) p=0.2
Morbidity\$	0.5 (0.4-0.7) p<0.001	0.5 (0.3-0.7) p=0.001	0.3 (0.1-0.6) p=0.001	0.3 (0.1-0.5) p<0.001	0.3 (0.1-0.8) p=0.001
Rectum Carcinoma					
Mortality\$	0.02 (0.01-0.1) p<0.001	0.6 (0.3-1.1) p=0.1	0.07 (0.02-0.3) p<0.001	0.1 (0.03-0.5) p=0.003	0.07 (0.02-0.3) p<0.001
Morbidity\$	0.4 (0.3-0.5) p<0.001	0.6 (0.5-0.8) p<0.001	0.4 (0.2-0.5) p<0.001	0.4 (0.3-0.7) p<0.001	0.4 (0.2-0.6) p<0.001

RR: rate ratio; CI: confidence interval; \$ risk adjusted hospital mortality or major morbidity rate: Observed / Expected * population average

with a lower risk-adjusted mortality and major morbidity rate, except for the '70% standard' measure, which showed a trend towards a negative association with mortality (p=0.10). When the analysis was repeated for high volume hospitals only (50 or more procedures), all composite measures, except for the '70% standard', were also significantly associated with risk adjusted mortality for CC. All other associations remained significant (data not shown).

Discussion

The aim of this study was to measure consistency of composite measures based on process indicators, and outcome indicators. This study shows that a high hospital score on composite process measures is consistent with better risk-adjusted short-term outcome rates. However,

for the treatment of an individual patient, a high score on composite process measures was not clearly associated with better outcome. This indicates that being treated according to the guideline is not necessarily predictive for a better postoperative outcome for the individual patient, but a hospital's score on guideline adherence gives a good indication of the quality of care in a hospital.

The results of this study should be interpreted in the light of some limitations. First, although the dataset of the DSCA 2010 was more complete than several other national registries⁹⁶, the estimated completeness of the DSCA in 2011 was 93%. However, comparison with the NCR showed no overall differences in patient, tumour, procedural and outcome data. Therefore, it is unlikely that the results would have been influenced to a great extent by the missing 7%. Second, the indicators used in this study were similar to the indicators used in previous studies.⁹⁷⁻¹⁰² The validity of some of these indicators is still under debate,¹⁰³ as some of the selected processes, such as 'complete colonoscopy' and 'radiotherapy' are influenced by case-mix and patients preferences. However, as non-elective patients were excluded and outcome data were adjusted for differences in patient and tumour characteristics, it is unlikely that case-mix and patient preferences affected our results to a great extent. Another limitation is the absence of long-term follow-up results. As most quality indicators are based on evidence-based guidelines and a relation with long-term outcome, an association with long-term outcome would be expected. Unfortunately, long-term results were not yet available when this study was completed. However, although long-term outcome, combining both operative and oncologic outcome, may be a more valid outcome measure, it reflects the quality of care delivered one to five years before the outcome measurement and is therefore less indicative for the hospital's performance at that moment. Short-term outcome on the other hand, reflects the quality of recently delivered care, and is therefore commonly used for performance measurements.

Currently, hospital performances in the Netherlands are compared based on a list of process indicators. Previous studies have investigated the relation between process and outcome, with inconsistent results.^{88,89} Possible explanations for the inconsistent results are sample sizes too small to reliably assess hospital performances on outcome indicators, and variation in hospital performances on different indicators.^{89,104,105} Bradley et al. investigated the relation of individual indicators and outcome after acute myocardial infarction, and found varying results. However, when indicators were aggregated into a composite measure, there was a significant relation with outcome.¹⁰⁶ Similarly, Stullberg et al. found a significant association between a composite process measure for infection-prevention and a lower probability for postoperative infection, but could not reproduce this finding for any of the individual process measures.¹⁰⁷ Habib et al found no association between a composite measure based on process indicators and outcome for colorectal cancer resections in Australia.¹⁰² However, outcome measures were not adjusted for hospital variations in case-mix.

In this dataset, none of the composite measures were associated with outcome on a patients level. However, we did find an association between composite measures and outcome on a hospitals' level. Possibly, on a patient level, other factors, such as patient related factors, are stronger predictors for outcome than the number of indicated process indicators met for the patient, while on a hospital level, composite measures for process indicators may reflect the underlying quality of care in a hospital. All composite measures showed a negative association with major postoperative morbidity. In the full analysis (including small volume hospitals), none of the composite measures was associated with hospital mortality rates for CC, but when analyses was repeated in only high volume hospitals, we found a strong relation with all but one of the composite measures. As outcome rates in low volume hospitals are more susceptible to chance fluctuations, results of small volume hospitals may have weakened the association between guideline adherence and mortality for CC at the hospital level. For RC the relation between guideline adherence and postoperative mortality was also clear in the full analysis. This may be the effect of the larger number of indicators used to assess guideline adherence for RC, but it may also reflect the more complex process of care for patients with an RC, in which only well organized and more dedicated hospitals succeed. As the association between guideline adherence and short-term outcome on a hospital level is unlikely to be explained by a causal relation, there may be other underlying processes and structural differences between hospitals, responsible for this association. Identification of these underlying processes and structures may help to improve quality of care in all hospitals.

As all composite measures showed a strong association with hospital major morbidity rates, we cannot recommend one specific composite measure based on our results. However, the '70% standard' was the only measure which was not consistent with mortality for RC and CC (high volume hospitals only). Possibly, the percentage of patients who received 70% of indicated care is an insufficiently strict measure to identify good quality hospitals. These results support the ideas advocated by Nolan and Berwick,⁹⁰ that the relationship between the completeness of the process and outcome is not continuous, but determined by the completion of all indicated processes. These ideas are also adopted by the Institute for Healthcare Improvement (IHI, www.ihl.org), which developed 'bundles': a set of evidence based practices, that, when performed collectively and reliably, have been proven to improve patient outcomes. The IHI advocates measuring compliance as 'the percentage of patients who receive all elements of the bundle': the 'all or none' measure. Although our results do not support one of the remaining four measures, the choice for a composite measures may be dictated by other factors such as the availability of data at patient level, required for all measures but the 'indicator average', and patient's preferences. Future research should be directed to identifying the composite measure most comprehensible and informative for healthcare consumers.

Conclusions

Guideline adherence in the process of care for colorectal cancer patients is not associated with better short-term outcome for the individual patient. However, hospitals with favourable scores on guideline adherence also have better postoperative outcome rates. When measuring quality of care for colorectal cancer patients by means of composite process measures, the 'all or none' the 'patient average', 'indicator average' or 'overall percentage' seem equally suitable measures as they were all consistent with hospital outcome indicators. However, the drive to have a good score on process indicators should never compromise good, personalized medicine: giving the right treatment at the right time to the right patient.

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References

- Institute of Medicine. Committee to Design a Strategy for Quality Review and Assurance in Medicine. The Institute of Medicine Report. In Medicare: A Strategy for Quality Assurance/Committee to Design a Strategy for Quality Review and Assurance in Medicare. Division of Health Care Services, Institute of Medicine, Vol 1, report of a study, p 468 Washington, DC: National Academy Press 1990
- Donabedian A. Evaluating the quality of medical care. The Milbank Memorial Fund quarterly 1966;44:Suppl:166-206.
- Birkmeyer JD, Dimick JB, Birkmeyer NJ. Measuring the quality of surgical care: structure, process, or outcomes? *J Am Coll Surg* 2004;198:626-32.
- Khuri SF, Daley J, Henderson WG. The comparative assessment and improvement of quality of surgical care in the Department of Veterans Affairs. *Arch Surg* 2002;137:20-7.
- Thomas JW, Hofer TP. Research evidence on the validity of risk-adjusted mortality rate as a measure of hospital quality of care. *Med Care Res Rev* 1998;55:371-404.
- Pitches DW, Mohammed MA, Lilford RJ. What is the empirical evidence that hospitals with higher-risk adjusted mortality rates provide poorer quality care? A systematic review of the literature. *BMC Health Serv Res* 2007;7:91.
- Nolan T, Berwick DM. All-or-none measurement raises the bar on performance. *JAMA* 2006;295:1168-70.
- Reeves D, Campbell SM, Adams J, et al. Combining multiple indicators of clinical quality: an evaluation of different analytic approaches. *Med Care* 2007;45:489-96.
- Powell C. The Delphi technique: myths and realities. *J Adv Nurs* 2003;41:376-82.
- Linstone HA TM. The Delphi method: techniques and applications [<http://isrjtedu/pubs/delphibook/>], 2002- Accessed on the 31/05/2011.
- Hendren S, Birkmeyer JD, Yin H, et al. Surgical complications are associated with omission of chemotherapy for stage III colorectal cancer. *Dis Colon Rectum*;53:1587-93.
- Charlson ME, Sax FL, MacKenzie CR, et al. Assessing illness severity: does clinical judgment work? *J Chronic Dis* 1986;39:439-52.
- Daley J, Khuri SF, Henderson W, et al. Risk adjustment of the postoperative morbidity rate for the comparative assessment of the quality of surgical care: results of the National Veterans Affairs Surgical Risk Study. *J Am Coll Surg* 1997;185:328-40.
- Khuri SF, Daley J, Henderson W, et al. Risk adjustment of the postoperative mortality rate for the comparative assessment of the quality of surgical care: results of the National Veterans Affairs Surgical Risk Study. *J Am Coll Surg* 1997;185:315-27.
- van Gijn W, van de Velde CJ, members of the Ec. Improving quality of cancer care through surgical audit. *Eur J Surg Oncol*;36 Suppl 1:523-6.
- Jackson GL, Melton LD, Abbott DH, et al. Quality of nonmetastatic colorectal cancer care in the Department of Veterans Affairs. *J Clin Oncol*;28:3176-81.
- Chung KP, Chang YJ, Lai MS, et al. Is quality of colorectal cancer care good enough? Core measures development and its application for comparing hospitals in Taiwan. *BMC Health Serv Res*;10:27.
- Gagliardi AR, Simunovic M, Langer B, et al. Development of quality indicators for colorectal cancer surgery, using a 3-step modified Delphi approach. *Can J Surg* 2005;48:441-52.
- Schneider EC, Nadel MR, Zaslavsky AM, et al. Assessment of the scientific soundness of clinical performance measures: a field test of the National Committee for Quality Assurance's colorectal cancer screening measure. *Arch Intern Med* 2008;168:876-82.
- Vergara-Fernandez O, Swallow CJ, Victor JC, et al. Assessing outcomes following surgery for colorectal cancer using quality of care indicators. *Can J Surg*;53:232-40.
- Habib MR, Solomon MJ, Young JM, et al. Evidence-based and clinical outcome scores to facilitate audit and feedback for colorectal cancer care. *Dis Colon Rectum* 2009;52:616-22; discussion 22-3.
- Patwardhan M, Fisher DA, Mantyh CR, et al. Assessing the quality of colorectal cancer care: do we have appropriate quality measures? (A systematic review of literature). *J Eval Clin Pract* 2007;13:831-45.
- Dimick JB, Welch HG, Birkmeyer JD. Surgical mortality as an indicator of hospital quality: the problem with small sample size. *JAMA* 2004;292:847-51.
- Lilford R, Mohammed MA, Spiegelhalter D, et al. Use and misuse of process and outcome data in managing performance of acute medical care: avoiding institutional stigma. *Lancet* 2004;363:1147-54.
- Bradley EH, Herrin J, Elbel B, et al. Hospital quality for acute myocardial infarction: correlation among process measures and relationship with short-term mortality. *JAMA* 2006;296:72-8.
- Stulberg JJ, Delaney CP, Neuhauser DV, et al. Adherence to surgical care improvement project measures and the association with postoperative infections. *JAMA* 2010;303:2479-85.
- Campbell SM, Roland MO, Middleton E, et al. Improvements in quality of clinical care in English general practice 1998-2003: longitudinal observational study. *BMJ* 2005;331:1121.
- Jha AK, Li Z, Orav EJ, Epstein AM. Care in U.S. hospitals—the Hospital Quality Alliance program. *N Engl J Med* 2005;353:265-74.
- McGlynn EA, Asch SM, Adams J, et al. The quality of health care delivered to adults in the United States. *N Engl J Med* 2003;348:2635-45.
- Premier. Inc. Summary of the composite quality scoring methodology. Available at: <http://www.premierinc.com/quality-safety/tools-services/p4p/hqi/resources/top-performer-summary.pdf>. Accessed April 17, 2007.