Original article

Value of failure to rescue as a marker of the standard of care following reoperation for complications after colorectal resection

A. M. Almoudaris[1,2], E. M. Burns[1], R. Mamidanna[1], A. Bottle[3], P. Aylin[3], C. Vincent[2] and O. Faiz[1]

[1]Department of Surgery and Cancer, Faculty of Medicine, [2]Centre for Patient Safety and Service Quality, and [3]Dr Foster Unit, Department of Primary Care and Public Health, Imperial College London, London, UK

Correspondence to: Mr O. Faiz, Department of Surgery and Cancer, Faculty of Medicine, Imperial College London, St Mary's Hospital, Praed Street, London W2 1NY, UK (e-mail: o.faiz@imperial.ac.uk)

Background: Complication management appears to be of vital importance to differences in survival following surgery between surgical units. Failure-to-rescue (FTR) rates have not yet distinguished surgical from general medical complications. The aim of this study was to assess whether variability exists in FTR rates after reoperation for serious surgical complications following colorectal cancer resections in England.

Methods: The Hospital Episode Statistics (HES) database was used to identify patients undergoing primary resection for colorectal cancer between 2000 and 2008 in English National Health Service (NHS) trusts. Units were ranked into quintiles according to overall risk-adjusted mortality. Highest and lowest mortality quintiles were compared with respect to reoperation rates and FTR – surgical (FTR-S) rates. FTR-S was defined as the proportion of patients with an unplanned reoperation who died within the same admission.

Results: Some 144 542 patients undergoing resection for colorectal cancer in 150 English NHS trusts were included. On ranking according to risk-adjusted mortality, rates varied significantly between lowest and highest mortality quintiles (5·4 and 9·3 per cent respectively; $P = 0{\cdot}029$). Lowest and highest mortality quintiles had equivalent adjusted reoperation rates (both 4·8 per cent; $P = 0{\cdot}211$). FTR-S rates were significantly higher at units within the worst mortality quintile (16·8 *versus* 11·1 per cent; $P = 0{\cdot}002$).

Conclusion: FTR-S rates differed significantly between English colorectal units, highlighting variability in ability to prevent death in this high-risk group. This variability may represent differences in serious surgical complication management. FTR-S represents a readily collectable marker of surgical complication management that is likely to be applicable to other surgical specialties.

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Introduction

The management and prevention of complications has been the focus of increasing research in contemporary surgical literature[1]. This is especially true in patients undergoing major colorectal surgery where serious postoperative morbidity significantly increases the likelihood of death[2]. Similar findings have been observed in other specialties[3]. Silber and colleagues[4] coined the phrase 'failure to rescue' (FTR) to describe patients who died from an acquired complication following surgery. The metric they described represents the proportion of deaths among patients who experience complications. In a study investigating patients undergoing cardiac surgery they ranked hospitals according to their case-relevant mortality, and observed significant differences in FTR rates between the best and worst ranked units despite equivalent complication rates[5]. This suggests that the institutional management of complications is an important determinant of survival after the development of complications. As such, FTR represents a potentially useful descriptive metric for complication management.

The Agency for Healthcare Research and Quality (AHRQ) is the health services research arm of the United States Department of Health and Human Services[6]. It produces freely available indicators of hospital quality, termed patient safety indicators, that make use of inpatient hospital administrative data. Currently, one such indicator is 'death among surgical in-patients with serious treatable complications'[7], which is synonymous with FTR. The AHRQ defines this as the number of deaths in patients suffering one or more events, from a select group of medical or surgical complications, per 1000 discharges. Potentially avoidable complications also represent a significant economic burden. Medicare and Medicaid, two US government programmes that provide medical and health services to non-privately insured US citizens, have introduced measures withholding remuneration for certain perceived avoidable complications[8].

Although FTR is undoubtedly an important concept, current analyses of administrative data sets may not distinguish effectively between pre-existing conditions[9]. Conditions present on admission have an impact on FTR rates when recalculated using refined algorithms[10] or on case-record review[9–11], questioning the fitness for purpose of FTR in such a form. Under these circumstances studies that have included total morbidity (complications of any severity) have yielded complication rates of up to 36·4 per cent[12]. As a result, it may not be immediately apparent to what degree complications in surgical patients are attributable to the surgical processes/decision-making or to conditions present on admission.

Refinement of the FTR paradigm in the surgical context should consider the fact that patients experiencing some of the worst preventable complications are those who return to the operating theatre in the postoperative period. Evidence also suggests that reoperated patients are more likely to die[13]. Patients with the most serious surgical complications (requiring reoperation) represent a well defined group that could be a useful target for quality improvement. Here, the term failure to rescue – surgical (FTR-S) is introduced as the proportion of patients with surgical complications who die during their index admission following an unplanned reoperation. The aim was to assess variability in FTR-S among units in England in patients who had primary resection for colorectal cancer. In addition, the use of FTR-S rates, as a reflection of complication management that is easily obtained from routinely collected data, was investigated as a potential novel marker of surgical quality assessment.

Methods

Patients were identified from the Hospital Episode Statistics (HES) database. The use of HES for similar purposes has been described previously[14]. It is a compulsory, national administrative database that contains patient-level data for every patient episode within a National Health Service (NHS) hospital in England. Each patient record includes information on age, sex, admission and discharge dates, primary diagnosis codes, secondary diagnosis codes, procedural codes and in-hospital mortality, among other data fields. The study was approved under Section 251 by the National Information Governance Board for Health and Social Care (formerly Section 60 by the Patient Information Advisory Group), and by the South East Research Ethics Committee. Application under Section 251 of the NHS Act 2006 was undertaken to permit access to patient-level HES data.

All patients who underwent a primary major colorectal procedure for colorectal cancer between April 2000 to March 2008 in English NHS trusts were considered. Patients were identified using diagnostic and procedural codes from the relevant International Classification of Diseases, tenth revision (ICD-10), and Office of Population, Censuses and Surveys classification of surgical operations and procedures, fourth revision (OPCS-4), codes on the HES database. A detailed methodology of this process has been described previously[13]. Elective and non-elective procedures were considered together. The following resections were analysed: right and extended right hemicolectomies, transverse colectomy, left hemicolectomy, sigmoid colectomy, Hartmann's procedure, subtotal colectomy, panproctocolectomy, total colectomy, anterior resection and abdominoperineal resection. The corresponding OPCS-4 procedural codes are shown in *Table S1* (supporting information). Patients were grouped into four age cohorts for analysis: 17–54, 55–69, 70–79 and more than 79 years.

Risk adjustment models

Carstairs index and Charlson scores were derived from the data set. The Carstairs index as a reflection of social deprivation has previously been shown to be predictive of postoperative outcome in different surgical specialties including patients with colorectal cancer[15,16]. The Carstairs index, which is a composite deprivation score calculated at the output-area level (average population 1500) and converted into population-weighted quintiles, was used as a measure of social deprivation. The score is a good reflection of material deprivation factors and has been used previously by health economists and government agencies for this purpose[17]. The Charlson co-morbidity scoring system has been validated for prediction of patient outcomes based on co-morbidities and was developed for administrative data sets[18]. The secondary diagnosis fields were used to create the Charlson co-morbidity index. Co-morbidities that lead to worse outcomes have greater values. Charlson score was considered in three categories: 0, 1–4 and 5 or more.

Reoperation

Patients were classed as undergoing a reoperation if, on their index admission, they were returned to theatre for one of the procedures listed in *Table 1*. These procedures were chosen as they were most likely to lead to an unplanned return to the operating theatre owing to surgical complications. Time to reoperation was calculated as the number of days between the index operation and reoperation. Returns to theatre until midnight on the same day as the index resection are not discernible from the HES database for any procedure except reopening of abdomen, which is considered in the 'washout of abdomen' category. Examination under anaesthesia was rarely the sole reason for return to theatre; more often there was an additional reason, so these patients were included under the more 'major' code.

Organizational structural information

Information on hospital structural variables was obtained from the Department of Health Hospital Activity Statistics website[19]. Yearly data were collated and averaged over the study period for each trust. Consideration was given to the merging of units by aggregating the median values of merged units over time. To account for differences in unit size, structural factors were calculated per bed number and subsequently compared. For ease of description, median intensive care unit (ICU) and high-dependency unit (HDU) bed numbers and the number of theatres per inpatient bed were each multiplied by a factor of 100. Inclusion of structural data was intended to be reflective of the wider hospital within which the colorectal units function.

Statistical analysis

Categorical variables were investigated using the χ^2 test. The Mann–Whitney *U* test was used for non-parametric testing of structural data. Logistic regression analysis was used to investigate predictors of postoperative reoperation and for risk adjustment. Factors with a significance level of $\leq 0{\cdot}100$ on univariable analysis were included in the regression analyses. For tests of significance, $P < 0{\cdot}050$ was considered significant.

The methodology for ranking and comparing units was based on that in a previous study[20]. The overall risk-adjusted mortality was calculated for each unit. The risk adjustment model included patient age and sex, admission status (elective or non-elective), Charlson co-morbidity score, Carstairs index, type of resection and use of laparoscopy as co-variables. Logistic regression was used to predict the probability of death for each patient; these probabilities were summed for patients at each unit to estimate expected mortality rates. The risk-adjusted mortality rate for each unit was then calculated by multiplying the ratio of observed to expected (O/E) mortality by the overall mortality rate for each operation. Units were then stratified into quintiles (30 units per quintile) according to their risk-adjusted overall mortality rates.

Units in the lowest mortality quintile (LMQ) were compared with those in the highest mortality quintile (HMQ) based on overall risk-adjusted mortality rate. Intermediate quintiles were also analysed and demonstrated a stepwise effect in outcome in the same direction. Statistical analyses were carried out using SPSS® version 18.0 (SPSS, Chicago, Illinois, USA).

Table 1 Types of reoperation and association with death in lowest and highest mortality quintiles

	Lowest mortality quintile		Highest mortality quintile			
Primary reason for reoperation	No. of reoperations (n = 1144)	Deaths (n = 127)*	No. of reoperations (n = 1386)	Deaths (n = 233)*	P (reoperations)†	P (deaths)†
Washout of abdomen	177 (15·5)	22 (17·3)	221 (15·9)	45 (19·3)	0·681	0·281
Small bowel resection	75 (6·6)	14 (11·0)	80 (5·8)	19 (8·2)	0·413	0·351
Further colorectal resection	192 (16·8)	26 (20·5)	238 (17·2)	67 (28·8)	0·933	0·073
Drainage of intra-abdominal abscess	45 (3·9)	5 (3·9)	54 (3·9)	5 (2·1)	0·873	0·247
Division of adhesions	86 (7·5)	7 (5·5)	78 (5·6)	14 (6·0)	0·037	0·881
Stoma formation/operation on stoma	351 (30·7)	55 (43·3)	430 (31·0)	105 (45·1)	0·681	0·690
Wound complications	218 (19·1)	18 (14·2)	285 (20·6)	20 (8·6)	0·380	0·094

Values in parentheses are percentages. *Sum of values exceeds 100 per cent as some patients had more than one reoperative procedure before death. †χ^2 test (highest *versus* lowest mortality quintile).

Funnels plots were constructed using the tools available at http://www.erpho.org.uk/topics/tools/funnel.aspx. Funnel plots are validated methods of graphically representing performance data[21]. The control limits use a normal approximation to the Poisson distribution.

Results

A total of 144 542 patients underwent primary colorectal resection for colorectal cancer between April 2000 and March 2008 in 150 English NHS units; there were 80 400 men (55·6 per cent) and 64 142 women (44·4 per cent). Some 110 587 patients (76·5 per cent) had an elective procedure and the remaining 33 955 (23·5 per cent) were admitted as an emergency. Types of resection for the whole cohort are described in *Table 2*.

Table 2 Types of colorectal resection in whole study cohort

	No. of patients ($n = 144\,542$)
Left-sided colectomy*	50 804 (35·1)
Right-sided colectomy	33 354 (23·1)
Subtotal/total colectomy	6174 (4·3)
Rectal resection	54 210 (37·5)

Values in parentheses indicate percentages. *Includes Hartmann's procedure.

Comparison of demographics between quintiles

There were 25 082 patients (17·4 per cent) in 30 units in the LMQ and 27 630 (19·1 per cent) in 30 units within the HMQ. Overall, older patients were operated on in the LMQ units ($P < 0.001$) (*Table 3*). More men were operated on in HMQ units (55·6 *versus* 54·7 per cent; $P = 0.026$). There were more socially deprived patients in HMQ units and more patients with co-morbidity in the LMQ units (both $P < 0.001$). There were no differences in surgical approach (open or laparoscopic) between the quintiles ($P = 0.927$), but more rectal and subtotal/total procedures were performed in HMQ units ($P = 0.008$).

Table 3 Comparison of demographic and operative data between lowest and highest mortality quintiles

	Lowest mortality quintile ($n = 25\,082$)	Highest mortality quintile ($n = 27\,630$)	P†
Age (years)			< 0·001
17–54	2310 (9·2)	2630 (9·5)	
55–69	8246 (32·9)	9405 (34·1)	
70–79	8863 (35·3)	9845 (35·6)	
> 79	5663 (22·6)	5750 (20·8)	
Sex			0·026
M	13 709 (54·7)	15 369 (55·6)	
F	11 373 (45·3)	12 261 (44·4)	
Admission			0·067
Elective	19 393 (77·3)	21 177 (76·6)	
Emergency	5689 (22·7)	6453 (23·4)	
Charlson co-morbidity score			< 0·001
0	13 536 (54·0)	16 686 (60·4)	
1–4	2105 (8·4)	2379 (8·6)	
> 5	9441 (37·6)	8565 (31·0)	
Carstairs index			< 0·001
1 (least deprived)	5558 (22·2)	5103 (18·5)	
2	6699 (26·7)	6100 (22·1)	
3	5737 (22·9)	6064 (21·9)	
4	4340 (17·3)	5468 (19·8)	
5	2704 (10·8)	4890 (17·7)	
Unclassified	44 (0·2)	5 (0)	
Resection type			0·008
Left-sided colectomy*	5790 (23·1)	6297 (22·8)	
Right-sided colectomy	8978 (35·8)	9588 (34·7)	
Subtotal/total colectomy	1007 (4·0)	1192 (4·3)	
Rectal resection	9307 (37·1)	10 553 (38·2)	
Surgical approach			0·927
Open	23 580 (94·0)	25 970 (94·0)	
Laparoscopic	1502 (6·0)	1660 (6·0)	

Values in parentheses are percentages. *Includes Hartmann's procedure. †χ^2 test.

Table 4 Structural factors according to quintile

	Lowest mortality quintile	Highest mortality quintile	*P*§
Median no. of beds per unit	683·82	791·00	0·196
Imaging*			
Computed tomography	17·33	14·66	0·174
Ultrasonography (non-gynaecological)	27·54	28·90	0·515
Fluoroscopy	9·82	7·40	0·069
Level I + II beds†			
ICU	1·32	1·05	0·425
HDU	1·04	0·78	0·011
Operating theatres‡	2·30	2·20	0·233

Values are median *number of scans requested per patient-bed per year, †number of beds per inpatient bed multiplied by a factor of 100, and ‡number of theatres per inpatient bed multiplied by a factor of 100. ICU, intensive care unit; HDU, high-dependency unit. §Mann–Whitney *U* test.

Organizational structural factors

No significant differences were found between the quintiles in terms of the median number of inpatient beds ($P = 0{\cdot}196$), use of radiological imaging (computed tomography, $P = 0{\cdot}174$; non-gynaecological ultrasonography, $P = 0{\cdot}515$; fluoroscopy, $P = 0{\cdot}069$), or number of available theatres ($P = 0{\cdot}233$) or ICU beds ($P = 0{\cdot}425$) (*Table 4*). A difference was, however, observed in the number of HDU beds available between the LMQ and HMQ units, with more beds in the LMQ units ($P = 0{\cdot}011$).

Overall mortality by quintile

A significant difference was observed between unadjusted mortality rates at LMQ and HMQ units: 4·1 per cent (1016 of 25 082) and 7·6 per cent (2106 of 27 630) respectively ($P < 0{\cdot}001$) (*Table 5*). After adjustment for the co-variables listed in *Table 3* the overall risk-adjusted mortality rate for the best and worst quintile units was 5·4 and 9·3 per cent respectively ($P = 0{\cdot}029$).

Reoperation rates

The overall reoperation rate, including all quintiles, was 4·8 per cent (6911 of 144 542). When units were stratified into quintiles for overall risk-adjusted mortality, reoperation rates were similar at LMQ and HMQ units: 4·6 per cent (1144 of 25 082) and 5·0 per cent (1386 of 27 630) respectively ($P = 0{\cdot}125$) (*Table 5*). After risk adjustment they remained similar (both 4·8 per cent; $P = 0{\cdot}211$).

Table 5 Unadjusted and adjusted rates per quintile for mortality, reoperation and death after reoperation

Quintile	Mortality (%)	Reoperation (%)	FTR-S (%)
1st (lowest mortality)	4·1 (5·4)	4·6 (4·8)	11·1
2nd	5·3 (5·2)	4·7 (4·7)	13·0
3rd	6·2 (5·5)	6·0 (5·0)	14·4
4th	7·2 (6·7)	5·1 (4·8)	15·4
5th	7·6 (9·3)	5·0 (4·8)	16·8

Values in parentheses are adjusted rates. FTR-S, failure to rescue — surgical.

Time to reoperation

Fig. 1 shows the distribution of time from index procedure to reoperation between quintiles. Patients were returned to the operating theatre at similar times after the index procedure in LMQ and HMQ units (median 6·5 *versus* 7·0 days; $P = 0{\cdot}858$); there were peaks for both types of unit at 24–48 h and 7–9 days.

Reasons for return to the operating room

The frequency of reoperation for each primary cause in LMQ and HMQ quintiles is shown in *Table 1*. There was a small statistical difference in frequency of reoperations for division of adhesions between the quintiles, but not for returns to theatre for any other cause.

Failure to rescue after serious surgical complications

Despite differences in overall risk-adjusted mortality, there were few significant differences in patient demographics, availability of structural factors, reoperation rate, types and lead time to reoperation between the extreme quintiles. However, the FTR-S rate was significantly higher in HMQ units; when patients underwent a reoperation, 11·1 per cent (127 of 1144) died in LMQ units *versus* 16·8 per cent (233 of 1386) in HMQ units based on risk-adjusted mortality ($P = 0{\cdot}002$) (*Fig. 2*). Overall, patients requiring further surgery in the HMQ units were 1·7 times

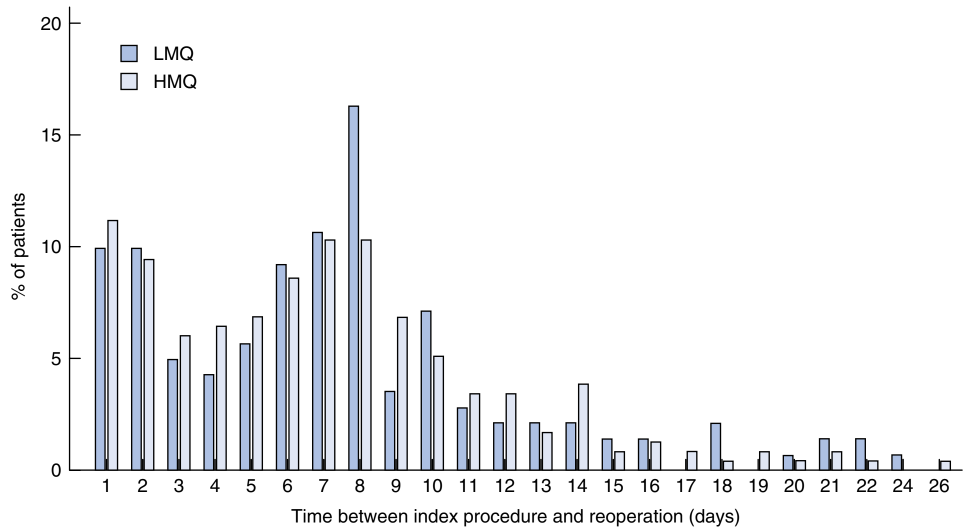

Fig. 1 Time between index procedure and reoperation in 127 patients in lowest mortality quintile (LMQ) unit and 233 in highest mortality quintile (HMQ) unit who died following reoperation

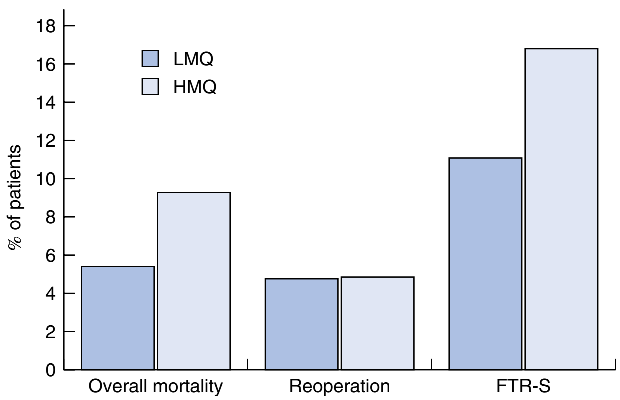

Fig. 2 Overall mortality, reoperation rates and failure to rescue – surgical (FTR-S) rates in highest mortality quintile (HMQ) and lowest mortality quintile (LMQ) units

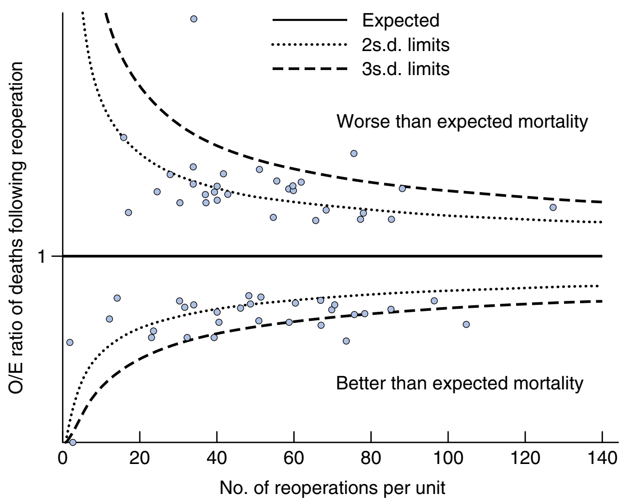

Fig. 3 Funnel plot demonstrating the observed to expected (O/E) ratio of deaths after reoperations in relation to unit volume of reoperation. All units with an O/E ratio below 1 are in the lowest mortality quintile

more likely to die than had they undergone reoperation in a LMQ unit.

Type of reoperation before death

Table 1 shows deaths in relation to type of reoperation, for LMQ and HMQ units. Reoperations for wound complications were more likely to be performed before death in LMQ units than in HMQ units (14·2 *versus* 8·6 per cent; $P = 0{\cdot}094$) as was drainage of intra-abdominal abscesses (3·9 *versus* 2·1 per cent; $P = 0{\cdot}247$); however, among patients who died after reoperation, there were no significant differences between the quintiles in the type of reoperation that led to death.

Failure to rescue – surgical in relation to volume

Fig. 3 is a funnel plot showing the O/E FTR-S ratio in relation to the number of reoperations per unit for both quintiles. The O/E FTR-S ratio was not clearly related to the overall reoperation volume. FTR-S at 14 units lay above the 2s.d. control limit, signifying greater than merely random variation in this outcome measure.

Discussion

In this national study of outcome from all English NHS institutions undertaking colorectal resections for cancer, reoperation rates were similar among institutions classified within the HMQ and LMQ groups. Moreover the types of complication that resulted in reoperation were similar among units in these extreme quintiles, as was the time lag between the index operation and reintervention. However, high- and low-mortality units were distinguished by their ability to rescue patients following reoperation, with low-mortality units demonstrating an enhanced ability to prevent death in this context.

The management of emergency patients who develop complications may involve some different care processes (and teams) than those employed for elective patients. Nonetheless elective and emergency admissions were combined in the present study as this reflects actual practice. Elective colorectal resections are associated with low mortality but high morbidity rates, whereas emergency resections have both high morbidity and mortality rates. Units that are inherently poor at managing complications are likely to be poor in dealing with both sets of patients, with the converse also being true. Combination of these patients was anticipated to demonstrate differences in FTR-S to a greater extent.

The results suggest that FTR-S is a more precise marker of surgical complication management than the more general FTR measure, which may include previously acquired medical complications. Application of FTR to patients experiencing surgical complications that necessitate a return to theatre represents a meaningful measure of clinical and organizational ability to manage serious complications successfully. Moreover it is derivable from currently available data sources.

Most organizational structural factors did not appear to contribute to the observed differences in FTR-S rates between hospitals in the present study, although LMQ units had a greater number of HDU beds. The significance of this finding is uncertain as greater resource availability could not be linked directly to greater HDU use among patients requiring reoperation. It is, however, likely that this compromised patient group would benefit from a HDU facility if it were available following reintervention. Moreover, there is published evidence to suggest that managing patients in a surgical HDU leads to reduced morbidity, with a trend towards shorter length of hospital stay[22]. In addition, low patient to nurse ratios are associated with a decreased risk of death within 30 days of admission among surgical patients[23]. One might expect that hospitals with low-quality perioperative care processes might fail to recognize patient deterioration promptly, thereby leading to delayed reintervention. No difference was found, however, in the time to return to theatre between the two extreme mortality quintiles in this series. Nor was a relationship observed between ability to rescue patients following reoperation type and number of reoperations. This suggests that institutional experience does not necessarily determine mortality risk in the event of a complication requiring reoperation.

FTR-S reflects processes of care other than traditional markers of surgical quality. For example, anastomotic leak rates may reflect a surgeon's propensity to perform a defunctioning procedure or anastomosis, case selection and technical factors. Such variables may also have an impact on mortality, but if a surgical complication arises further explanation is needed. An understanding of how well resourced units are, the intensity and seniority of ward care, access to radiology and other such factors is required. Mortality following complications is not fully explained by other metrics. For this reason FTR-S may explain why some units are able to prevent the conversion of serious morbidity to mortality. The rationale of a metric such as FTR-S is to understand why some institutions are better at preventing this conversion.

Overall, the reoperation rates reported in this study are consistent with those in the contemporary literature[24]. Patients who underwent reoperation were approximately 1·7 times more likely to die in HMQ than in LMQ units. No explanatory differences were found between the timing of reintervention or operative caseload at HMQ and LMQ hospitals. As such, FTR-S is perhaps more a reflection of the quality of care after reoperation than recognition of complications and prompt intervention.

In this study, the primary reason for return to theatre was generally in keeping with those reported in the literature, although direct comparisons are difficult owing to discrepancies in definitions. Morris and colleagues[25] found that 21·1 per cent of patients who had surgery for colorectal cancer required reintervention for wound complications, compared with 19·1 and 20·6 per cent for LMQ and HMQ units in the present study. Patients who died in this study were most likely to have required either stoma formation, further colorectal resection, abdominal washout or a combination of these procedures (*Table 1*). These are likely to represent procedures undertaken in the management of an anastomotic leak, although there are no specific data to support this assertion as there are no specific HES codes for anastomotic leak. In contrast, among patients who died, only 11·0 and 8·2 per cent (depending on quintile) had small bowel resection as a contributory reoperative procedure before death. Similarly, relatively small numbers underwent division of adhesions before eventual death.

These results raise some interesting questions regarding the quality of surgical decision-making and postoperative care of surgical patients. Further work is necessary to understand better the processes that underlie these findings which are not discernable from information recorded in administrative databases. This would probably involve more qualitative methods to elucidate salient factors such as patterns of on-call cover, availability of and seniority of specialist colorectal surgeons, and access to interventional radiology.

This study has several limitations, principally concerning the use of an administrative data set. The accuracy of the database is reliant on the data entry process. The accuracy of HES data has, however, been shown to be reliable in a systematic review of the accuracy of routinely collected hospital data[26]. For data inaccuracy to have affected the present findings, reoperation rates would have had to be consistently over- or under-recorded by most institutions and in the same manner by units within one quintile, with the opposite occurring in units within the contrasting quintile. As these institutions are geographically and managerially separate from one another, the likelihood of such coding errors affecting the outcome is extremely low. Furthermore, the outcome measures demonstrated a stepwise tendency in the same direction when intermediate quintiles were analysed, suggesting that differences between the quintiles did not arise through chance alone. Given the administrative nature of the data set, treatment intention was not specified. Therefore, it cannot be stated definitively that the reoperations were unplanned, although the chosen procedures are likely to represent unplanned reinterventions. Surgeon experience cannot be derived from HES data. In the present study complication rates were similar in low- and high-mortality units, suggesting that surgeon seniority is a less important factor. Seniority may impact on leak rates, oncological outcome and complications attributable to surgical technique. However, it is questionable whether the outcome from established complications is influenced by the seniority of the operating surgeon.

One final limitation concerns risk adjustment. Although adjustment was made for all available parameters, there may still have been differences in case mix including stage of presentation. Any differences in case mix that persisted over the study period could in part account for the observed differences in outcome between units. Although individual surgeon case mix may vary significantly within institutions, it is unlikely that the case mix presenting to trusts varies widely across England.

The reoperations selected in this study represent commonly occurring surgical morbidity following colorectal resection. This group of procedure codes defines a homogeneous group of patients who experience severe surgical complications demanding specialist expertise and intervention to enhance their chance of survival. A surgical provider's ability to have an impact on this group is therefore a potentially important measure of service quality. FTR-S has four criteria that strengthen its use as a quality metric. First, use of a discrete event such as reoperation is not open to interpretation – a patient is either returned to the operating theatre or not. Attempted addition of less discrete medical complications from administrative data sets, such as wound infection not requiring intervention or chest infection, could perhaps render this metric a less reliable measure of quality. Second, FTR-S is more likely to be based on discrete surgical complications derived from the index operation as opposed to medical conditions possibly present before surgery (although it is acknowledged that pre-existing conditions may make certain postoperative complications more likely). Third, given that reoperation is relatively uncommon, it should be feasible and practical to target these patients by using FTR-S primarily in quality improvement programmes. Finally, FTR-S may be derived from currently available routinely collected administrative data.

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Supporting information

Additional supporting information may be found in the online version of this article:

Table S1 OPCS-4 and ICD-10 codes used in the study (Word document)

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Commentary

Value of failure to rescue as a marker of the standard of care following reoperation for complications after colorectal resection (*Br J Surg* 2011; 98: 1775–1783)

Failure to rescue (FTR) surgical patients from any complication increases the likelihood of in-hospital death and this is a valuable metric of care[1,2]. Whether measuring rates of failure to rescue patients specifically from complications treated with further surgery (FTR-S) provides supplementary data, however, is unknown. Almoudaris and colleagues have investigated this by linking rates of death following unplanned operations within the same admission as primary colorectal cancer surgery with overall hospital risk-adjusted mortality. Units with the lowest and highest overall mortality groups had similar rates of reoperation, but overall high mortality rates were significantly associated with FTR-S (rates of death following reoperation, $P = 0{\cdot}002$), supporting the view that FTR-S is a valid metric, because it shows that poor outcomes of serious surgical and non-surgical complications are linked.

This is an excellent example of how an epidemiological database can be used to explore issues of direct relevance to surgical practice. Data from 144 542 elective and emergency surgical operations in 150 English National Health Service (NHS) trusts were included, and mortality rates were adjusted for sociodemographic, clinical and co-morbidity variables. Whether the findings are true (and they are very plausible) requires further investigation. Confounders that are unknown, and therefore not adjusted for, may explain associations, and provision and coordination of services such as interventional radiology and intensive care need careful consideration.

Identifying and treating all complications (whether medical or technical in origin) requires time and expertise. Judging how benefits and risks from further interventions weigh against the inevitable associated physiological insults is critical, and requires high-level communication between surgeons, intensivists, radiologists and others involved in provision of services. This paper should initiate studies to understand how these factors are provided for, and interact within hospitals with high and low rates of failure to rescue patients from medical and surgical complications (FTR and FTR-S).

J. M. Blazeby
Surgical Research Unit, School of Social and Community Medicine, University of Bristol and University Hospitals NHS Foundation Trust, Bristol BS8 2 PS, UK
(e-mail: j.m.blazeby@bris.ac.uk)
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