
Article:
Lee, M.J. orcid.org/0000-0001-9971-1635, Daniels, S.L. orcid.org/0000-0001-9452-3344, Wild, J.R.L. et al. (1 more author) (2017) Readmissions after general surgery: a prospective multicenter audit. Journal of Surgical Research, 209. pp. 53-59. ISSN 0022-4804

https://doi.org/10.1016/j.jss.2016.09.020

Full title: Readmissions After General Surgery (RAGeS): A Prospective Multi-Centre Audit.

Short title: Regional Readmissions

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Initial drafting of manuscript was performed by MJL and SLD, with further editing by JRLW & TRW.

Draft manuscript was reviewed be Collaborative Authors before generation of a final draft, which was approved by all authors.

Funding:

This project has received no funding

Conflicts of interest:

The authors report no conflicts of interest.

Word count : 1980

Data from this project has been presented at: Association of Surgeons in Training Conference, Glasgow, Feb 2015 & Association of Surgeons of Great Britain and Ireland, Manchester, April 2015

Keywords: Readmissions, General Surgery, Quality, Collaborative

Abstract:

Background: Readmission rates following surgical procedures are viewed as a marker of quality of care and as a driver to improve outcomes in the UK, they are not remunerated. However, readmissions are not wholly avoidable. The aim of this study was to develop a regional overview of readmissions to determine the proportion that might be avoidable and to examine predictors of readmissions at a unit level.

Methods: We undertook a prospective multi-centre audit of readmissions following NHS funded general surgical procedures in five NHS hospitals and three independent sector providers over a two-week period. Basic demographic and procedure data were captured. Readmissions to hospitals were identified through acute admissions lists. Reason for readmission was identified, and the readmission data assessed by a senior surgical doctor as to whether it was avoidable.

Results: We identified 752 operations in the study period with all followed-up to 30-days. The overall rate of readmissions was 4.7%, with 40% of these judged as being potentially avoidable. Pain and wound problems accounted for the vast majority of avoidable readmissions. The number of unavoidable readmissions was correlated with the work load of each centre (R=0.63, P=0.06) and as with the higher (BUPA) complexity of surgery (R=0.90, P=0.01). Patient and demographic factors were not associated with readmissions.

Discussion: This prospective audit describes readmission rates following general surgery. Volume and complexity of work are associated with readmission rates. A large proportion of readmissions could be reduced by attention to analgesia and outpatient arrangements for wound management.

Background:

Alongside mortality, readmission following a surgical procedure is increasingly seen as a marker of quality of care [1]. The high rates of readmissions in UK hospitals has been recognised as a target for reduction. [2]. Consequently, the Department of Health (DoH) instructs Clinical Commissioning Groups (CCGs) not to offer payment for 'avoidable' readmissions following elective surgery, with acceptable rates for readmission negotiated at a local level[3]. This results in the operating hospital funding further care including hotel and therapy costs.

Previous work evaluating surgical readmissions in the UK has been limited to single units[4], readmissions of operated and non-operated patients[5], and specific types of surgery[6]. We could not identify prospective data that provided a global view on readmissions following general surgery across multiple centres. Like many other regions, South Yorkshire has a number of challenges relating to the assessment of readmissions, including close geographical proximity of units and the use of independent sector providers of NHS work. This flux of patients between different centres means that the home unit is not always aware of the readmission.

The aim of this study was to determine the rate all general surgical admissions in a single region, to determine the rate of 'preventable' readmissions and to evaluate factors associated with readmission.

Methods:

This project was run by the South Yorkshire Surgical Research Group (SYSuRG), a surgical trainee-led research collaborative. Through this network, the project was registered with the clinical governance departments at five NHS hospitals in our region. With the agreement of local management, NHS funded procedures at independent sector providers were also captured in the audit. For the purposes of analysis, procedures performed in the independent sector providers were grouped as a single unit. Approval from the Caldicott Guardian was obtained where required.

All NHS funded general surgical procedures (elective and emergency) performed during a two-week period were included. General surgical procedures were defined as operations undertaken by general surgeons including (but not limited to) hernia repair, excision of skin lesions, laparotomy and laparoscopy. Procedures excluded were breast procedures (wide local excision, mastectomy, axillary node procedures, reconstruction), endocrine procedures (thyroid/parathyroid, adrenal), vascular procedures (i.e. procedures on veins/arteries or vascular grafts) and urological procedures (procedures on kidney, ureter, bladder, prostate, vagina, scrotum and testes). Upper or lower gastrointestinal endoscopy was included if performed under general anaesthetic by a general surgeon.

At the point of operation, data on demographics, comorbidities and body mass index were collected. Type of operation and British United Provident Association (BUPA) classification[7] were recorded. The patients were followed to discharge and date of discharge, presence of surgical site infection, new stoma and discharge blood results were recorded.

During the 30-day follow-up period from discharge, medical and surgical 'take' lists were reviewed by the local team to identify post-operative readmissions. When an unplanned readmission was identified, patient notes were reviewed by a senior member of the surgical team (registrar or above). The admission was classified as related or unrelated to the index procedure. Where the readmission was related to the index procedure, it was classified as avoidable or unavoidable. An unavoidable readmission was one where the patient could be assessed or managed without readmission to a hospital bed e.g. in an ambulatory manner. An unavoidable readmission required hospital admission for treatment or investigation. To address cross-over between units, admissions following a procedure carried out in another unit were kept in a separate log and reconciled at the end of the study.

At the end of the follow-up period, local data was returned to the originating unit to facilitate quality improvement work.

Results:

All five NHS and three independent sector providers in the region participated. Due to small numbers, independent sectors providers were considered as one unit for analysis. Data was captured for 752 operations from which there were 35 readmissions (4.7%). Patient demographics and their spread across units are presented in Table 1. There was one 30-day mortality in the group. Thirty day follow-up from discharge was achieved in all cases.

Table 2 shows the reasons for readmissions and the associated index procedures. Of the 35 readmissions, 20 (57.1%) were deemed unavoidable, as they required further inpatient investigation or treatment. The commonest reason for readmissions in this group were collections requiring drainage (n=10), of which 6 were wound related and 4 were intra-abdominal. Postoperative viscus leak (n=4) and pain requiring investigation (n=3) were the next most common. Patients with unavoidable readmissions had a median length of stay for their readmission of 5 days (0.08-22 days).

Of the 35 readmissions, 15 (42.9%) were deemed avoidable, as they could be managed in an ambulatory setting. The commonest reasons for readmissions in this group were pain (n=7) and superficial wound infections (n=6). Patients with avoidable readmissions had a median length for their readmission of stay of 1 day (0.08-14 days). The 14-day length of stay was associated with an altered care package and delays in subsequent discharge rather than surgical management.

The median time to readmission was 7.5 days, ranging from 0-30 days. Median time to avoidable readmission was 7 days (0-18 days) and median time to unavoidable readmission was 8.5 days (1-30 days). This approached statistical significance (p=0.08, Mantel-Cox test).

Just over half of all readmissions were related to gastrointestinal visceral surgery with the rates of readmission in major colorectal, upper GI and hepatobiliary procedures of 11.9%, 10.0% and 7.4% respectively. The overall readmission rate in hernia surgery was 3.6%, with a relatively high

readmission rate in laparoscopic inguinal (8.5%) and incisional (8.7%) hernia repairs. Other notable readmission rates were seen after appendicectomy (6.4%) and cutaneous procedures (5.9%).

Unit workload factors

The relationship between volume of work and rates of readmission was assessed. A positive linear correlation was observed between volume of work and number of readmissions (Figure 1). This approached statistical significance for total readmissions (R=0.61, p=0.06) and unavoidable readmissions (R=0.63, p=0.06). Despite this, there was a degree of variability in the proportion of readmissions between the units, with a three-fold difference in unavoidable (Range: 1.4% to 5.0%) and avoidable readmissions (Range: 0% to 4.2%). Private treatment centres had the lowest rate of readmissions, but otherwise there was no noticeable relationship between the nature of the hospitals (tertiary referral centre, district hospital) and readmissions.

Patient factors

Table 3 shows the patient demographics for those with readmissions and those without. Readmissions were not significantly associated with any of these patient factors.

Operative Factors

The relationship between the complexity of operative cases performed (as assessed by the BUPA classification) and readmissions is shown in Figure 2. There was a positive correlation between the total number of readmissions and complexity of cases performed, although this did not reach statistical significance (Spearman R=0.9, p=0.08). No significant correlation was seen between avoidable readmissions and complexity of cases (R=0.28, p=0.35), but unavoidable readmissions were significantly correlated with complexity of surgery (R=0.90, p=0.01).

Acute operations (CEPOD 1 or 2) were performed in 188 (25%) patients and fully elective operations were (CEPOD 4) were performed in 539 (72%). Of these, 21 (3.9%) of elective patients and 10 (5.3%) of acute patients were readmitted. There was no significant difference in readmissions between these two groups (p=0.40, X^2).The CEPOD 3 category included a heterogenous group of 27 patients comprising major gastrointestinal resections (n=19), diagnostic procedures (n=4) and other emergent surgery (n=4), and were consequently excluded from this analysis.

Longer hospital stay for index procedure was associated with readmission; median stay 2.5 (0-38) for readmitted patients versus median stay 0 days (0-62) for non-readmitted patients (p=0.006, Mann-Whitney U-test). Day case procedure had a lower readmission rate (4.0%) compared to inpatient procedures (8.2%). This approached statistical significance (p=0.07, X^2).

Discussion

This paper has reported readmission rates in a UK general surgical cohort on a region-wide basis. The overall rate of readmission of 4.7% compares very favourably with the 6.8% readmission rate found in a recent study based on the NSQIP database[8]. The majority of readmissions (57%) were related to surgical site or abdominal septic complications, with most of these (70%) requiring surgical or radiological intervention. Most of the remaining readmissions (29%) were for pain, which only required investigation in a small number of patients. Unlike previous work in this area, this study attempts to qualify readmissions in terms of whether they are avoidable or unavoidable. Our data suggests that up to 40% of readmissions may be potentially avoidable through management in the ambulatory setting. The vast majority of these had either pain or surgical site infections that did not require invasive intervention.

Despite basing our data collection on a large number of data points identified from previous studies[6,9], this study did not find any patient factors that were associated with readmissions. The only procedure related factors that were significantly associated with readmissions were complexity of surgery and length of stay, though it is likely that both factors are measuring the same attribute. Over

half of all readmissions, resulted from gastrointestinal surgery and these patients were more likely to have unavoidable readmissions. The failure to identify more predictive factors for readmissions, is at odds with the findings of a number of other studies looking at readmissions. we have avoided some factors identified in previous readmission studies, including socioeconomic issues and chronic diseases[10,11]. However, these studies often reviewed one type of operation[12-14] or were undertaken on non-UK populations[14-16]. This might explain why they have not demonstrated the same significance in our cohort.

Although the number of participating units was small, this study has examined unit factors that are linked to higher readmissions. As would be expected, increased volume of work is associated with a higher number of readmissions. Previous studies based on both UK and US data have similarly demonstrated that readmission rates in different cohorts are fairly constant across centres, meaning that the more operations performed, the higher the number of readmissions[6,17,18]. Despite this, the proportion of readmissions between different units does show a degree of variability, that cannot be explained by case mix (more complex work or emergency work). Whilst, variability in the proportion of avoidable admissions may be due to systems put in place by hospitals to detect and manage these problems before they are admitted, this should not influence the rate of patients who will require admission based on the severity of their complication. As the period of data collected was relating to procedures in a two week window, variability may ultimately be related to statistical variation rather than poor performance or other unknown factors. Previous studies have focussed heavily on patient factors associated with readmission, generating models and risk scores to identify those at risk [19-21]. The benefit of these is clear, as they might identify the groups where we can target high impact interventions to reduce readmissions. However, our study suggests that at a regional level, institutional factors relating to volume and complexity of work appear to be more important predictors.

This study was tightly co-ordinated at the regional level through the local research network, with all researchers trained in appropriate data collection. All patients were prospectively identified and followed up using common hospital electronic data records. Consequently, we believe that our data

provides a true representation and is not biased from missing data, which can often affect audits requiring retrospective case note review. However there are other limitations to this study. It was our initial intention to undertake multivariate logistic regression modelling of our data. The two week window of data collection was chosen to capture sufficient data for this, based on an 8% readmission rate which was suggested by a pilot study. However, the number of readmissions seen in the final study (4.7%) was much lower than expected and the study was insufficiently powered for this analysis.

Conclusion

Readmissions after general surgery are relatively common affecting about 1 in 20 patients. However, up to 40% of readmission may be preventable. Volume and complexity of work appear to be important predictors of readmission rates at the institutional level.

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Figure titles

Figure 1: Number of operations and corresponding number of i) Total readmissions (R=0.61, p=0.06), ii) avoidable readmissions (R=0.51, p=0.11) and iii) unavoidable readmissions (R=0.63, p=0.06).

Figure 2. Graph showing relationship between complexity of work using linear regression i) overall readmissions (R=0.9, p=0.08), ii) avoidable readmissions (R=0.28 p=0.35) and iii) unavoidable readmissions (R=.9, p=0.01). BUPA group defined as 1 – Minor, 2- Intermediate, 3-Major, 4-Major+, 5-Complex Major.

Tables:

Unit	Total Number of Cases	Median Age	Gender Male: Female	Total Number of readmissions	Number of Avoidable Readmissions	Number of Unavoidable readmission	Ratio of unavoidable: avoidable readmissions
1	267	51 (17-85)	138:129	10 (3.7%)	4 (1.5%)	6 (2.2%)	1.5
2	80	50.5 (17-91)	41:39	6 (7.5%)	2 (2.5%)	4 (5.0%)	0.6
3	94	50.5 (9-90)	55:39	8 (8.5%)	4 (4.2%)	4 (4.2%)	1.0
4	81	47 (14-84)	32:49	2 (2.8%)	1 (1.4%)	1 (1.4%)	1.0
5	175	52 (12-89)	86:89	8 (4.5%)	4 (2.2%)	4 (2.2%)	1.0
6	55	45.5 (22-70)	31:24	1 (1.8%)	0 (0%)	1 (1.8%)	-
Total	752	59 (9-91)	383:369	35 (4.7%)	15 (2.0%)	20 (2.6%)	1.3

Table 1: Workload, demographics and rates of readmission by unit, including total, number of avoidable readmissions and number of unavoidable readmissions

Operation	Total No.	No. of avoidable readmissions	Reason for avoidable readmission	No. of unavoidable readmissions	Reason for unavoidable readmission
Emergency					
- Laparoscopic Appendicectomy	47			3	2 SSI, 1 Collection
- Open Appendicectomy	7				
- Diagnostic laparoscopy	10				
- Patch repair Duodenal ulcer	2				
- Emergency Laparotomy	11	1	1 pain		
- Drainage Perianal abscess	53	1	1 pain		
- Drainage pilonidal abscess	11				
- Other General	32				
Cutaneous/Proctology					
- Excision of skin lesion/biopsy	51	1	1 SSI	2	2 SSI
- Examination Anorectum	42				
- Haemorrhoidal surgery	24				
- Excision lesion of anus	8			1	1 SSI
- Fistula Surgery	7				
- Sacral nerve stimulation	2				
Major Colorectal					
- Right hemi-colectomy	7	2	1 pain, 1 SSI		
- Left colon resection	11	1	1 SSI		
- Panproctocolectomy	6			1	1 collection
- APER	1				
- Closure of stoma	15				
- Formation colostomy	2	1	1 Stoma problem		
- Other colorectal procedure	35				
Upper Gastro-intestinal					
- Fundoplication	10				
- Oesophagogastrectomy	1				
- Partial Gastrectomy	4				
- Gastric Bypass	4				
- Hiatus hernia repair	3			2	2 leak
- Cardiomyotomy	3				
- Formation jejunostomy	1			1	1 leak
- Other upper GI procedure	14			1	1 anastomotic bleed
Hepato-biliary					
- Laparoscopic Cholecystectomy	118	2	1 Pain, 1 SSI	6	2 pain, 1 leak, 2 collection, 1 CBD stone
- Open Cholecystectomy	11				
- Partial Hepatectomy	4	2	2 Pain		
- Whipple's Procedure	2				
Hernia					
- Open inguinal	91	1	1 Constipation	1	1 UTI
- Laparoscopic inguinal	34	2	1 pain, 1 seroma	1	1 pain
- Bilateral open inguinal	13				
- Recurrent inguinal	3				
- Umbilical hernia	32			1	1 SSI
- Femoral hernia	3				
- Incisional hernia	12	1	1 SSI		
- Epigastric hernia	4				
- Other hernia	1				
Total	**752**	**15**	**-**	**20**	**-**

SSI = Surgical site infection, APER=Abdominoperineal excision of rectum, CBD=Common bile duct, UTI = urinary tract infection

Table 2: Summary of procedures and reasons for readmissions.

	Readmissions	*Non Readmission*	*P Value*
Age	*46**	*21**	*0.32[a]*
Gender (Male:Female)	*14 (40%) : 21 (60%)*	*369 (51%) : 348 (49%)*	*0.19*
Diabetes	*3(9%)*	*48 (7%)*	*0.63*
COPD	*0 (0%)*	*28 (4%)*	*0.26*
Ischaemic Heart disease	*2(6%)*	*57 (8%)*	*0.69*
WCC on discharge ($x10^9$/L)	*8.5**	*7.9**	*0.62[a]*
*All data are patient numbers (%) with P value from Chi squared test,unless stated. * = Median. † = Mann Whitney U test. COPD = Chronic Obstructive Pulmonary Disease, WCC = White Cell Count*			

Table 3: Patient factors *and association with readmission.*