



A Colorectal Unit with an Enhanced Recovery After Surgery (ERAS) Programme Improves Surgical Outcomes in a Major Metropolitan Hospital

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Abstract

Objectives: We aimed to assess the surgical outcomes associated with the introduction of a dedicated colorectal service and newly implemented enhanced recovery after surgery (ERAS) programme at Logan Hospital.

Methods: A prospective database was created to include all patients admitted to Logan hospital for colorectal resections after the establishment of a dedicated colorectal service with two colorectal surgical society of Australia and New Zealand (CSSANZ) trained colorectal surgeons and an ERAS programme. The demographics, pathology and surgical outcomes in this patient group were compared to a historical retrospective patient cohort from the same hospital with resections performed by general surgeons prior to the introduction of the ERAS programme. Primary outcomes included the length of stay, readmission rate, morbidity and mortality.

Results: The prospective database included patients from February to November 2015 with a minimum 30 day follow-up (n = 72). The retrospective patient cohort was from January to December 2012 (n = 68). The average length of stay (LOS) reduced from 10.85 days to 5.74 days (P = 0.037). Thirty day readmission rates decreased from 7.35% to 4.17% (P = 0.485). Morbidity reduced from 41.18% to 11.11% (P < 0.001). Mortality rates of 2.94% pre ERAS and nil post (P = 0.234). Demographic information, co-morbidities and pathology were comparable.

Conclusions: Our results suggest that a dedicated colorectal service with an ERAS program is able to improve surgical outcomes including length of stay, morbidity and mortality. This is in keeping with existing international literature.

Keywords: ERAS, Colorectal

1. Background

ERAS is standard of care for many colorectal units (1). Its universal implementation has been variable on account of surgical expertise, resource availability and individualised institutions abilities to move away from historical beliefs in adapting to change (2).

The first fast track protocol was described by Kehlet in 1999 (2). This has now become widely accepted as standard of care internationally in many colorectal units. ERAS pathways have been developed to accelerate recovery by attenuating the stress response. There is level one evidence showing reductions in length of stay (LOS), morbidity, mortality and reductions in cost to the health care system (3-5). Despite the availability of published literature demonstrating these improved results, widespread use of such protocols throughout many units has still not been implemented (6).

Logan hospital is a 344 bed hospital catering for one of the fastest growing regions in Queensland, Australia. Prior to 2013 it was staffed by eight general surgeons. In January 2013 a dedicated colorectal unit was introduced -initially with one that later became two Colorectal Surgical Society of Australia and New Zealand (CSSANZ) trained colorectal surgeons.

Our aim was to analyse the impact associated with the introduction of a dedicated colorectal unit and the implementation of an ERAS programme. Our primary outcomes were LOS, return to theatre, thirty day readmission rates, morbidity and mortality.

2. Methods

The study included a retrospective review of patient records from 2012 - 12 months prior to the introduction of

the ERAS programme - and a prospective database that was collated after full introduction of the ERAS protocol. The aim of our study was to compare data from patients operated on at Logan Hospital in the year prior to and the year following the introduction of a dedicated colorectal unit and ERAS programme.

2.1. Inclusion Criteria

All elective admissions from 2012 undergoing elective colorectal resections for both malignant and benign disease were compared to colorectal admissions in 2015 post full implementation of the ERAS programme.

2.2. Implementation of Eras Protocol at Logan Hospital

The introduction of an ERAS programme into Logan Hospital took twelve months to develop, with implementation beginning in February 2013. Once designed, a hospital wide education programme was systematically applied.

By February 2014 the ERAS protocol was introduced and in November 2014 a full time ERAS co-ordinating registered nurse (RN) employed. The ERAS RN met all new elective bookings through the outpatient department. By February 2015 we had full initiation of the protocol and a prospective database was established, including all ERAS patients.

No specific exclusion criteria for enrolment into the ERAS programme were stipulated and all patients undergoing major elective colorectal surgery at Logan Hospital were offered enrolment into the programme. During the period of data collection no patients declined enrolment into the programme.

Pre admission information, education and counselling proved vital in the implementation of the ERAS programme. Establishing patient expectations regarding LOS and troubleshooting discharge planning issues prior to hospital admission were examples of this.

Modifiable risk factors such as smoking, alcohol use and chronic diseases were identified and optimised through utilisation of services such as diabetes educators and respiratory consultations.

Our ERAS team consisted of two CSSANZ colorectal surgeons, two anaesthetists and a full-time RN. Our ERAS RN was able to ensure 100% compliance with ERAS protocols - in her absence we assume compliance rates would be lower.

2.3. Preparation

All patients enrolled in the ERAS programme received bowel preparation. The majority of ERAS guidelines avoid bowel preparation and current research suggests it should not be used routinely in colonic surgery (7, 8). However,

a consensus was made amongst the surgeons on the unit, and bowel preparation was administered. Left sided resections received either Picoprep or modified Glycoprep in patients with pre-existing renal and cardiac conditions. Right colonic resections received Bisacodyl. All patients were able to have clear fluids up to 2.5 hours pre-operatively and carbohydrate loading drinks were given pre-operatively.

Thromboembolic prophylaxis included the routine use of low molecular weight heparin, mechanical compression stockings and intra-operative sequential calf compression devices. Routine antibiotic prophylaxis was administered 30-60 minutes prior to skin incision with Cephazolin and Metronidazole where not contraindicated.

2.4. Anaesthetic Protocol

Pre-operative paracetamol was administered as a pre-medication. Single shot spinal anaesthesia was used with either intrathecal morphine or 0.25% bupivacaine. Skin exposure was minimised with the aim of maintaining normothermia throughout the procedure. Anaesthesia was titrated to minimise the use of inotropes- aiming to maintain systolic blood pressure no less than 25% from patients' baseline. Intraoperative fluid restriction was used to optimise cardiac output, while avoiding over resuscitation. In high risk patients non-invasive cardiac monitoring was used to measure stroke volume and further guide fluid therapy. Avoidance of over aggressive fluid resuscitation was strictly adhered to.

2.5. Surgical Technique

Where possible, all cases were performed laparoscopically in the post-ERAS cohort.

2.6. Analgesia

Intraoperative intravenous (IV) morphine 4-10 mg was the preferred means of intraoperative analgesia by one anaesthetist and IV lignocaine by the other. Single intraoperative IV doses of parecoxib 40 mg were administered unless contraindicated. Postoperatively, patient controlled analgesia (PCA) with fentanyl was used. Where possible, this was ceased on day 1. Regular paracetamol was used and sublingual buprenorphine 0.2 mg three times a day (TDS) commenced on day 1 once the PCA had been ceased. The use of non-steroidal anti-inflammatory drugs (NSAIDs) were avoided given links with increased anastomotic leak rates (9). Oral opioids were avoided to facilitate earlier return of gut function and reduce postoperative nausea and vomiting (7).

2.7. Postoperative Management

Nasogastric tubes were avoided post operatively where possible. Indwelling catheters were removed on post-op day 1 (day 2 in low or ultra low anterior resections). All patients had a flowchart of the ERAS protocol in their bedside chart for reference. Final decisions regarding patient care were still left to the discretion of the treating surgical team. IV fluids were kept at 60 mL per hour for day 1. Where possible, fluid resuscitation was limited to no more than 2 litres within the first 48 hours. Urine output of 0.3 mL/kg/hr was expected. Oliguria was only treated in symptomatic patients. Patients were allowed diet as tolerated from 4 hours post operatively. Patients were sat out of bed the day of surgery if power returned after the spinal anaesthesia. Mobilisation - with the aid of a physiotherapist - occurred on day 1. The ERAS RN reviewed all patients daily on weekdays and continued counselling and motivation. The ERAS RN was able to ensure complete compliance with the ERAS protocols was maintained throughout the patient's hospital stay.

2.8. Discharge Criteria

Discharge was considered from day 2 post op. Patients were considered safe for discharge home if they were mobilising independently, tolerating diet, passing flatus and felt comfortable going home.

Patients received follow up phone calls from the ERAS RN the day following discharge to ensure they were managing well. All patients then received a phone call from the ERAS RN 1 week post discharge. All patients were given a telephone contact number in the event of questions or concerns. All patients were seen in the outpatient clinic at 6 weeks. Further follow up was based on clinical need.

2.9. Statistical Analysis

Patient demographic and clinical characteristics were summarized using means and standard deviations (SDs) for quantitative variables, and using frequencies and percentages for categorical variables. Independent-sample t tests were used to compare the differences in quantitative variables between the two cohorts pre ERAS and post ERAS, while the chi-square test was adopted to compare the differences in categorical variables between the two cohorts. The Fisher's exact test was used to replace the chi-square test when the minimum expected frequency was less than 2 or more than 20% of the cells had expected frequencies of less than 5. Levene's test was adopted to assess the difference in variability for quantitative variables. Results were considered statistically significant when P value was < 0.05. Data analyses were performed using IBM SPSS-23 (IBM, Chicago, IL).

3. Results

3.1. Cohort Characteristics

Our pre ERAS retrospective cohort was from January to December 2015 consisting of 68 patients. Our prospective post ERAS cohort from February to November 2015 consisted of 72 patients. Table 1 shows the patient's demographics and clinical characteristics in these two cohorts. The post ERAS cohort was 4.8-years younger than the pre ERAS cohort ($P = 0.042$); the mean (SD; range) age was 64.4 (13.6; 32 - 91) for the pre ERAS cohort compared to 59.6 (13.6; 28 - 86) for the post ERAS cohort. In the pre ERAS cohort, 32 (47.1%) were men, while 38 (52.8%) were women in the post ERAS cohort ($P = 0.499$). The majority of patients were ASA 2 (57.4% vs. 63.4% in the pre and post ERAS cohorts, respectively, $P = 0.650$). However, there were significant differences in the proportion of elective surgeries between the two cohorts (100% elective vs. 90.3% elective in the pre and post ERAS cohorts, respectively, $P = 0.014$). The post ERAS cohort also had a higher proportion of benign tumours (43.1%) than malignant tumours (56.9%) compared to the pre ERAS cohort (26.5% and 73.5%, respectively) with $P = 0.040$.

Table 1. Demographic and Clinical Characteristics of Patients in the Pre and Post ERAS Cohorts

Characteristics	Pre ERAS (N = 68)	Post ERAS (N = 72)	P Value ^a
Age, y ^b	64.4 (13.6), Range: 32 - 91	59.6 (13.6), Range: 28 - 86	0.042 ^c
Gender ^d			0.499
Male	32 (47.1)	38 (52.8)	
Female	36 (52.9)	34 (47.2)	
ASA ^d			0.650
1	9 (13.2)	10 (14.1)	
2	39 (57.4)	45 (63.4)	
3	20 (29.4)	16 (22.5)	
missing	0	1	
Surgery ^d			0.014 ^{ce}
Elective	68 (100)	65 (90.3)	
Emergency	0 (0)	7 (9.7)	
Tumour ^d			0.040 ^c
Benign	18 (26.5)	31 (43.1)	
Malignant	50 (73.5)	41 (56.9)	

^aP value for independent-samples t test (quantitative variables) or chi-square test (categorical variables).

^bData are mean (SD).

^cP value < 0.005.

^dData are frequency (%).

^eFisher's exact test.

3.2. Impact of Eras Protocol

Table 2 presents the case mix of procedures performed. After the introduction of a colorectal unit and ERAS protocol, there were significant increases in the number of rectal procedures (from 7.4% to 30.6%; $P = 0.002$) being performed.

Table 2. Case Mix of Procedures Performed in the Pre and Posts ERAS Cohorts^a

Procedure	Pre ERAS (N = 68)	Post ERAS (N = 72)	P Value ^b
Location			0.002 ^c
Right	29 (42.6)	19 (26.4)	
Left	26 (38.2)	19 (26.4)	
Rectum	5 (7.4)	22 (30.6)	
Other	8 (11.8)	12 (16.7)	
Operation			0.001 ^c
Lap	49 (72.1)	67 (93.1)	
Open	19 (27.9)	5 (6.9)	
Location and operation			< 0.001 ^{c,d}
Right, Lap	23 (33.8)	17 (23.6)	
Right, Open	6 (8.8)	2 (2.8)	
Left, Lap	20 (29.4)	17 (23.6)	
Left, Open	6 (8.8)	2 (2.8)	
Rectum, Lap	3 (4.4)	21 (29.2)	
Rectum, Open	2 (2.9)	1 (1.4)	
Other, Lap	3 (4.4)	12 (16.7)	
Other, Open	5 (7.4)	0 (0)	

^aData are frequency (%).

^bP value for chi-square test (categorical variables).

^cP value < 0.005.

^dFisher's exact test.

In our pre ERAS cohort 49/68 (72.1%) cases were performed laparoscopically. In our post ERAS cohort 67/72 (93.1%) cases were performed laparoscopically- which was a significantly higher percentage ($P = 0.001$).

Table 3 presents other outcome indicators for assessing the impact of the ERAS protocol. After the introduction of a colorectal unit and ERAS protocol, the length of stay (LOS) was significantly shorter, where the mean (median) LOS was 10.8 (7) days pre ERAS vs. 5.6 (5) days post ERAS ($P = 0.037$), and the variability of LOS was significantly smaller (SD (IQR) of LOS was 20.1 (7) days pre ERAS vs. 4.1 (3) days post ERAS; $P = 0.022$). Moreover, the morbidity rate was significantly smaller (from 41.2% to 11.1%, $P < 0.001$). There

were also smaller but not statistically significant rates in readmission within 30 days (from 7.4% to 4.2%; $P = 0.485$) and mortality (from 2.9% to 0%; $P = 0.234$). Among the five readmissions in our pre ERAS cohort, two readmissions were for wound infections and three patients had acute kidney injuries secondary to high output stomas (one of these patients also had a lower leg DVT). In the post ERAS cohort two patients were readmitted with wound infections and one with high output stoma. Of the two mortalities one patient sustained stomal infarction and subsequent short bowel and died from multi organ failure and the second patient was ASA 3 with known metastatic disease who died from respiratory failure. This result did not reach statistical significance.

Table 3. Impact of ERAS Protocol

Outcome Indicator	Pre ERAS (N = 68)	Post ERAS (N = 72)	P Value ^a
LOS, day^b	10.8 (20.1), Range: 2 - 166, Median: 7	5.6 (4.1), Range: 2 - 26, Median: 5	0.037 ^c , <0.001 ^{c,d}
Morbidity^e			<0.001 ^c
Yes	28 (41.2)	8 (11.1)	
No	40 (58.8)	64 (88.9)	
Readmission in 30 days^c			0.485 ^f
Yes	5 (7.4)	3 (4.2)	
No	63 (92.6)	69 (95.8)	
Mortality^e			0.234 ^f
Yes	2 (2.9)	0 (0)	
No	66 (97.1)	72 (100)	

Abbreviation: LOS, length of Stay.

^aP value for independent-samples t test (quantitative variables) or chi-square test (categorical variables).

^bData are frequency (%).

^cP value < 0.005.

^dMann-Whitney U test

^eData are mean (SD).

^fFisher's exact test.

Clavien Dindo classification was used to grade surgical complications. **Table 4** shows the complication rates between the pre and post ERAS cohorts. After the introduction of a colorectal unit and ERAS protocol, the rate of complications significantly reduced (from 39.7% to 9.7%; $P < 0.001$). The distributions of complication grades between the pre and post ERAS cohorts however were not different. The grade II complications included hospital acquired pneumonia, urinary tract infections and wound infections. Of the grade IIIb complications in our pre ERAS cohort, 6 cases returned to theatre. Three of these were for anastomotic leaks, one for stomal infarction, one for a

presumed small bowel obstruction and one for an intra-abdominal bleed. In the post ERAS group one patient returned to theatre for an anastomotic leak while a second returned for a mesenteric bleed.

Table 4. Complication in the Pre and Post ERAS Cohorts^a

Complication	Pre ERAS (N = 68)	Post ERAS (N = 72)	P Value ^b
Complication			< 0.001 ^c
Yes	27 (39.7)	7 (9.7)	
No	41 (60.3)	65 (90.3)	
Complication			< 0.001 ^{c,d}
Grade I	4 (5.9)	1 (1.4)	
Grade II	15 (22.1)	4 (5.6)	
Grade III ^d	6 (8.8)	2 (2.8)	
Grade V	2 (2.9)	0 (0)	
No	41 (60.3)	65 (90.3)	
Complication^e			1.000 ^d
Grade I	4 (14.8)	1 (14.3)	
Grade II	15 (55.6)	4 (57.1)	
Grade IIIb	6 (22.2)	2 (28.6)	
Grade V	2 (7.4)	0 (0)	

^aData are frequency (%).

^bP value for chi-square test (categorical variables).

^cP value <0.005.

^dFisher's exact test.

^ePercent is reference to only patients who experienced a complication.

The results of our study have been compared with those of similar international studies in [Table 5](#).

4. Discussion

The introduction of a dedicated colorectal unit and the application of an ERAS programme has made a significant impact on patient care in our institution. Length of stay (LOS) and morbidity were both reduced with statistical significance. Reductions in mortality and thirty day readmissions were observed, although these did not reach statistical significance.

A statistically significant greater percentage of colorectal resections were performed laparoscopically following the introduction of a dedicated colorectal unit with ERAS programme. Likewise, a greater proportion of rectal resections were performed (also reaching statistical significance). One would expect increased LOS, morbidity, mortality and readmissions associated with increasing volumes of more complex rectal surgery. However, our results did not correlate with these expectations suggesting potentially even greater significance to our findings.

Weaknesses of our study relate to study size and the retrospective nature of our comparative database being compared with the prospectively collated post ERAS data. Comparisons between the retrospective patient cohort and the prospective ERAS patient cohort also revealed increases in the proportions of rectal surgery post ERAS. The presumed greater complexity of the post ERAS cohort (rectal cases) therefore makes direct comparisons between those groups difficult. The impact attributed to the higher portion of laparoscopic cases was not analysed independent of ERAS.

Meta-analyses have confirmed that ERAS protocols in colorectal surgery positively impact on postoperative outcomes ([4](#), [5](#), [16-18](#)). Despite this, a recent survey of New Zealand and Australian colorectal surgeons found that 55% of responders did not care for patients in a formalised ERAS pathway ([3](#)). It seems when compared internationally Australia has been slow to take up formal ERAS protocols despite the evidence supporting it ([3](#)). The addition of a laparoscopic approach to an ERAS programme for colorectal patients undergoing elective resection independently shortens hospital stay, and reduces morbidity and readmission rates ([19](#), [20](#)).

Our study demonstrated an increased number of laparoscopic procedures performed and hence presumably impacted on our LOS in conjunction with the ERAS protocol. The ERAS compliance group published the beneficial effect of laparoscopic surgery on hospital stay and complications ([21](#)). They also found restrictive intravenous fluid prescription, pre-operative carbohydrate and fluid loading were independent associations with improved outcomes which were also part of our protocol ([13](#)).

It has been reported that the implementation of four or more elements of the ERAS pathway leads to a reduction in LOS by more than two days and almost a 50% reduction in complication rates ([4](#)). Levelone evidence supporting reductions in LOS and morbidity associated with the introduction of ERAS programmes exists ([5](#), [13](#), [17](#), [18](#), [22](#)). Conflicting data exists between meta-analyses regarding reductions in readmission rates ([5](#), [16](#)).

Compliance rates to ERAS protocols in other larger studies have been variable. Several studies have also failed to publish their protocol compliance rates ([15](#)). It has also been demonstrated that low compliance with perioperative ERAS elements led to a prolonged LOS ([1](#)).

We believe early indwelling catheter removal in our study contributed to our low incidence of urinary tract infections. The literature regarding urinary infection rates and early catheter removals is however conflicting.

A Cochrane review in 2011 concluded that quantity and quality of data regarding improved outcomes associated with ERAS programmes were low. The analysis showed a reduction in overall complications, while major compli-

Table 5. Comparison with Published Series

Author	Number of Patients	LOS Improvement, day		Morbidity Improvement, %		Readmission Rate Improvement, %		Mortality Improvement, %	
		Pre ERAS	Post ERAS	Pre ERAS	Post ERAS	Pre ERAS	Post ERAS	Pre ERAS	Post ERAS
Anderson et al. (10), 2003	25	4-10	2-7	45.5	28.6	Nil	Nil	Nil	Nil
Gatt et al. (11), 2005	39	6-10	4-9	75	47.4	20	5.3	Nil	5.3
Khoo et al. (12), 2007	70	7	5	45.7	25.7	2.9	8.6	5.7	Nil
Muller et al. (13) 2009	151	9	5	49.3	21.1	2.7	3.9	1.3	1.3
Ionescu et al. (14), 2009	96	9.16 +/- 2.67	6.43 +/- 3.41	22.9	12.5	Nil	Nil	Nil	Nil
Nelson et al. (15), 2016	1333	6	4.5	56.9	45.3	17.5	9.6	0	0
Cooper et al. 2016	140	10.8	5.6	41.2	11.11	7.4	4.2	2.9	0

cations were not reduced. LOS was reduced significantly. They concluded that ERAS seemed safe but that given the lack of quality trials its implementation as standard of care could not be justified (16).

Implementation of an ERAS programme requires intensive education and a multidisciplinary team with full ownership and involvement of ward allied and nursing staff. Awareness within the hospital is crucial as a full time ERAS RN and our education and information dissemination was an important aspect of our program's success. A business plan development to show cost effectiveness and empowerment of those implementing the programmes is essential. It has been well demonstrated that implementation of an ERAS programme is cost-effective (23).

Our improvement post ERAS with statistical significance in reduced LOS and morbidity and a reduction in mortality and readmission rates are likely multi-factorial in origin. The application of an ERAS protocol, the development of a specialised colorectal unit with dedicated anaesthetists has certainly led to our improved outcomes. Our ERAS RN was vital to ensure 100% compliance. Increased laparoscopic surgery likely contributed significantly to the decreased LOS. Improved postoperative fluid prescription, avoiding fluid excess was also a highly significant contributor. The change from eight general surgeons performing the colorectal workload to a smaller dedicated unit with two colorectal trained surgeons performing a higher case volume also likely added to our improved outcomes.

4.1. Conclusion

Implementation of a dedicated colorectal service with an ERAS protocol improved outcomes for our colorectal surgical patients. Our length of stay was reduced which proved an economical advantage to our institution. Our morbidity improved with a significant reduction in complications. We have been able to expand our service with

more rectal procedures being performed. Overall the introduction of a colorectal unit and the ERAS protocol at Logan hospital has had a positive impact. Further research is required to identify which aspects of the ERAS programme made the biggest difference to our patient's improved outcomes

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