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CLINICAL PRACTICE

Enhanced recovery from surgery in the UK: an audit of the enhanced recovery partnership programme 2009–2012†

J. C. Simpson[1], S. R. Moonesinghe[1,2], M. P. W. Grocott[1,2,3], M. Kuper[4], A. McMeeking[5], C. M. Oliver[1,2], M. J. Galsworthy[1,2], and M. G. Mythen[1,*] on behalf of the National Enhanced Recovery Partnership Advisory Board‡

[1]The Surgical Outcomes Research Centre (SOuRCe), University College London Hospitals NIHR Biomedical Research Centre, London, UK, [2]National Institute of Academic Anaesthesia Health Services Research Centre, Royal College of Anaesthetists, London, UK, [3]Anaesthesia and Critical Care Research Unit, University Hospitals Southampton; Integrative Physiology and Critical Illness Group, University of Southampton and University Hospital Southampton, University of Southampton NIHR Respiratory Biomedical Research Unit, Southampton, UK, [4]Homerton Hospital, Homerton Row, London, UK, and [5]National Cancer Action Team, NHS, London, UK

*Corresponding author. E-mail: m.mythen@ucl.ac.uk

Abstract

Background: The UK Department of Health Enhanced Recovery Partnership Programme collected data on 24 513 surgical patients in the UK from 2009–2012. Enhanced Recovery is an approach to major elective surgery aimed at minimizing perioperative stress for the patient. Previous studies have shown Enhanced Recovery to be associated with reduced hospital length of stay and perioperative morbidity.

Methods: In this national clinical audit, National Health Service hospitals in the UK were invited to submit patient-level data. The data regarding length of stay and compliance with each element of Enhanced Recovery protocols for colorectal, orthopaedic, urological and gynaecological surgery patients were analysed. The relationship between Enhanced Recovery protocol compliance and length of stay was measured.

Results: From 16 267 patients from 61 hospital trusts, three out of four surgical specialties showed Enhanced Recovery, compliance being weakly associated with shorter length of stay (correlation coefficients −0.18, −0.14, −0.25 in colorectal, orthopaedics and gynaecology respectively). At a cut-off of 80% compliance, good compliance was associated with two, one and three day reductions in median length of stay respectively in colorectal, orthopaedic and urological surgeries, with no saving in gynaecology.

Conclusions: This study is the largest assessment of the relationship between Enhanced Recovery protocol compliance and outcome in four surgical specialties. The data suggest that higher compliance with an Enhanced Recovery protocol has a weak association with shorter length of stay. This suggests that changes in process, resulting from highly protocolised pathways, may be as important in reducing perioperative length of stay as any individual element of Enhanced Recovery protocols in isolation.

Key words: anesthesia; general surgery; perioperative care

† This Article is accompanied by Editorial Aev295.
‡ Members Listed in Supplementary Appendix 1 (All Appendices are available online only)
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Editor's key points

- Enhanced recovery protocols are beneficial in colorectal surgery, but there are few data for other surgical specialties.
- This large audit examined the association between the UK national enhanced recovery programme and outcome.
- Compliance with the protocol was weakly associated with shorter length of stay after colorectal, urological and orthopaedic surgery.
- Conclusions should be cautious because of changing compliance over time and missing data.

Enhanced recovery (ER) is an approach to major elective surgery which integrates a series of strategies which work together to minimize perioperative stress for the patient, expediting their recovery.[1 2] This includes thorough preparation for surgery through patient assessment and education, the use of minimally invasive surgery, optimal fluid management and pain control, and the rapid reintroduction of oral nutrition and mobilisation in the postoperative period.[3 4] There is now a considerable body of evidence, demonstrating the beneficial effect of the implementation of ER programmes in colorectal surgery, particularly with regards to reduction in length of stay (LOS).[5–10] The evidence is also growing for its use within other specialties, with one paper showing a mortality reduction with its use in joint replacement surgery.[11]

In the United Kingdom (UK) the Enhanced Recovery Partnership Programme (ERPP) was introduced by the Department of Health in conjunction with National Health Service (NHS) Improvement, the National Cancer Action Team (NCAT) and the NHS Institute for Innovation and Improvement in April 2009, to support the national implementation of Enhanced Recovery for colorectal, orthopaedic, gynaecology and urology major elective surgical pathways. This was a two yr programme which provided education to hospitals, funding to support implementation and perform data collection, to assess its impact nationally. National data show a trend of decreasing LOS for the operations in the ER programme, with LOS being generally lower where ER programmes have been applied. In the UK, the Royal College of Surgeons issued guidelines in 2009 on the implementation of ER[12] and the ERPP aimed to educate and support the implementation of a standardized ER programme nationwide. However, the level of compliance with ER in the UK remains unclear. Furthermore, the association between ER compliance and patient outcome is poorly understood: in one Swedish study, there is a suggestion that the better the compliance with enhanced recovery elements, the better the postoperative outcome in terms of 30-day morbidity, symptoms, readmissions and possibly LOS;[13] however this was a single centre study of only colorectal patients. The aim of this study was to measure the association between ER compliance and LOS in multiple centres across four surgical specialties.

Method

This was a multicentre national clinical audit, using prospectively collected data from surgical patients on ER pathways within the ERPP in England between January 2009 and July 2012.

Data acquisition and dataset

The ER toolkit database was developed by the National Cancer Services Analysis Team (NATCANSAT; www.natcansat.nhs.uk). Data were collected prospectively by each institution and entered into the ER toolkit database via a web-based data-entry portal. For the first yr, pilot data were collected from 12 sites; from January 2010, data collection was invited from all institutions implementing ER. Data collection was voluntary; however, in London, from April 2011 onwards this was incentivised by an NHS London regional Commissioning for Quality and Innovation (CQUIN) payment to hospitals providing these data. Ethics committee approval was not sought for this study as it fulfilled the criteria for clinical audit.[14] No patient identifiable data were collected.

Inclusion/Exclusion criteria

All patients undergoing surgery on an ER pathway were eligible for inclusion in the database. This analysis considers data collected on specialty, compliance with elements of the ER protocol and the hospital length of stay from admission to discharge. Details of which ER elements are applicable to each specialty and definitions of each ER element are included in Supplementary Appendix 2. Colorectal surgery has 19 compliance elements and the other surgery types have 15. Exclusion criteria were any patient who had not undergone colorectal, orthopaedic, gynaecological or urological surgery; and patients aged less than 16 yrs of age. Patients with a preoperative LOS of greater than three days (to allow for admission on Friday for surgery on Monday) were removed as they were likely to represent non-elective surgery.

Missing data

Patients with missing age, LOS, operation date or missing ER compliance data were excluded from analyses. For the multivariable analysis, risk adjustment for laparoscopic surgery and ASA Physical Status (PS) grade was performed, therefore further patients were excluded that were missing these data. LOS refers to hospital length of stay, from admission to discharge. Imputation of missing data was not appropriate because of uncertainty as to whether data were missing at random and the large number of missing data points.

Statistical analysis

Normally distributed data are reported as mean and standard deviation; non-normally distributed data are reported as median and interquartile range, except for LOS data which is presented as both mean and median. We first checked whether there was a change in compliance with ER elements over the course of the data collection period, using smoothed mean analysis. We then investigated the possibility of a 'dose response' effect, (that is, compliance with a greater number of elements being associated with shorter LOS). This was assessed using a Spearman's rho correlation coefficient between the number of ER elements with which a patient was compliant and LOS. We also performed this analysis looking at LOS after surgery to ensure that the effect of admission on day of surgery was not the sole determinant of the variance suggested by the correlations between number of ER components and LOS. To look at this another way, the difference in median length of stay between those patients with good ER protocol compliance (≥70%, ≥80%, ≥90% compliance)[13] and those without, was calculated using the Hodges-Lehmann estimate technique and tested statistically using Wilcoxon rank sum tests. We also looked at those patients with very prolonged lengths of stay (more than 2SD>mean, therefore >36 days in colorectal, >18 days in gynaecology, >17 days in

orthopaedics and >51 days in urology). Using Wilcoxon rank sum tests with a Bonferroni correction, we compared these patients at compliance levels of 70, 80 and 90%.

Univariate analyses of the relationships between ER elements and LOS were performed using Wilcoxon rank sum tests. In order to identify which elements of ER protocols are independently associated with reduced LOS, multivariable analyses, using multiple linear regression were conducted for each specialty. Adjustment was made for patient-risk factors: age, gender and ASA PS- grade, and the surgical factor, whether or not the surgery was laparoscopic. All ER compliance variables were entered into the initial model, and sequentially dropped on the basis of significance, initially at $P>0.1$ and finally $P>0.05$. For each analysis, only patients with complete data for that particular analysis were included and no data were imputed.

All data were analysed using Microsoft Excel 2010 and Stata IC 12 (StataCorpLP, Texas, USA).

Results

A total of 24 513 patients were recorded on the ER toolkit database between January 2009 and July 2012. After removing patients according to our inclusion/exclusion criteria, initially excluding those with all compliance data missing, a total of 22 760 patients remained. When we excluded those with any compliance data missing, a total of 16 267 patients from 72 hospital sites, from 61 hospital trusts (listed in Supplementary Appendix 3), were eligible for inclusion in the analysis. For multivariable analysis adjustment for laparoscopic surgery and ASA-PS grade was made, leaving 10 098 patients once patients with missing data were removed. The flowchart for this is depicted in Fig. 1.

Descriptive analysis

For the 16 267 patients with no missing compliance data, there was considerable variation in the number of patients reported by each hospital site (maximum 2076 patients; median 105.5 patients, interquartile range 36.5–330.5). Colorectal procedures were mainly colectomies and excision of rectum. Gynaecological procedures were mainly vaginal and abdominal hysterectomies, salpingo-oophorectomies and vaginal repairs. Orthopaedic procedures were mainly hip or knee arthroplasties. Urological procedures were mainly nephrectomies, cystectomies and prostatectomies. A full list of the case mix is shown in Table 1. Details of sample size, age, gender and LOS, by specialty, are shown in Table 2.

There appears to be little change in compliance with ER protocols over the data collection period (see Fig. 2).

Association between ER compliance and hospital length of stay

A dose response effect is apparent, whereby greater compliance with ER elements is associated with shorter LOS (see Table 3).

In all specialties increased ER compliance was associated with decreased LOS. These relationships were statistically significant in all specialties except gynaecology ($P=0.0796$). Figure 3 presents the relationship between ER compliance and median LOS. When we considered only postoperative LOS, again these relationships remain statistically significant ($P<0.01$) except in gynaecology ($P=0.1884$) (also shown in Table 3). However the coefficients are small suggesting this association to be a weak one.

Where the patients are divided into those compliant with ER protocols (compliant with ≥70, ≥80 and ≥90% of ER elements), and those who are not, good compliance was associated with a significantly ($P<0.001$) shorter LOS in all patients, except gynaecology and urology at ≥90% compliance (when considering total LOS). When considering postoperative LOS, good compliance was associated with shorter LOS ($P<0.001$), except in gynaecology at all compliance levels and urology at ≥90% compliance. At a cut-off of 80% compliance, good compliance was associated with two days, one day and three days saving in median LOS respectively in colorectal, orthopaedic and urological surgeries, with no saving in gynaecology. The median LOS and median differences at compliance ≥70, ≥80 and ≥90% are shown in Table 4. In those with 'long' lengths of stay (>mean+2 SD days), we found there to be no significant difference in LOS between those who were compliant and those who were not for colorectal, orthopaedic and gynaecology patients (except at 70% compliance in gynaecology where compliant patients stayed significantly longer). There were too few urology 'long-stayers' by these criteria to test.

Supplementary Appendix 4 shows (of the 22 760 patients after initial exclusions) the percentage compliance for each ER element, the amount of missing data for each element and the univariate analysis of the effect of each element on LOS. The results of the multivariable analysis are shown in Table 5. For each specialty, the ER elements that demonstrated a significant effect are listed.

Discussion

Principal findings

This paper reports data from a cohort of 24 513 (minus exclusions) patients in the UK undergoing colorectal, orthopaedic, gynaecology and urology surgery on ER protocols. A weak 'dose-response' effect is demonstrated for the relationship between greater compliance with ER elements and shorter LOS. This effect is weak but evident in all specialties and reaches statistical significance in three of the four specialties. Good compliance with ER protocols (≥80% compliance), is associated with a shorter median LOS by two days, one day and three days saving in median LOS respectively in colorectal, orthopaedic and urological surgeries, with no saving in gynaecology. We believe that this represents an important difference, as even one day saved across such large numbers of patients is likely to represent a clinically important reduction in morbidity and significant cost-savings.

The multivariable analyses reveal the complexity of this association. In colorectal surgery, laparoscopic technique, admission on the day of surgery, early mobilisation, and not using regional analgesia, were all independently associated with shorter LOS. In orthopaedic surgery, individualised fluid therapy and early mobilisation were associated with shorter LOS. In gynaecological surgery, no individual ER elements proved significant; in urological surgery, laparoscopic surgery, admission on day of surgery, early mobilisation and lack of avoidance of systemic opiates were associated with shorter LOS.

Setting this data in the national context, our dataset made up just over 3% of the 481 068 similar patients that occurred nationally over the same time period (as recorded by Hospital Episode Statistics). Mean LOS for each specialty according to Hospital Episode Statistics data are comparable with our own data. The national data show a progressive reduction in LOS for surgery types included in the enhanced recovery programme between 2009–2012, with no increase in readmission.[15]

Interpretation of findings

These findings support the notion that the success of enhanced recovery protocols in reducing length of stay arises through

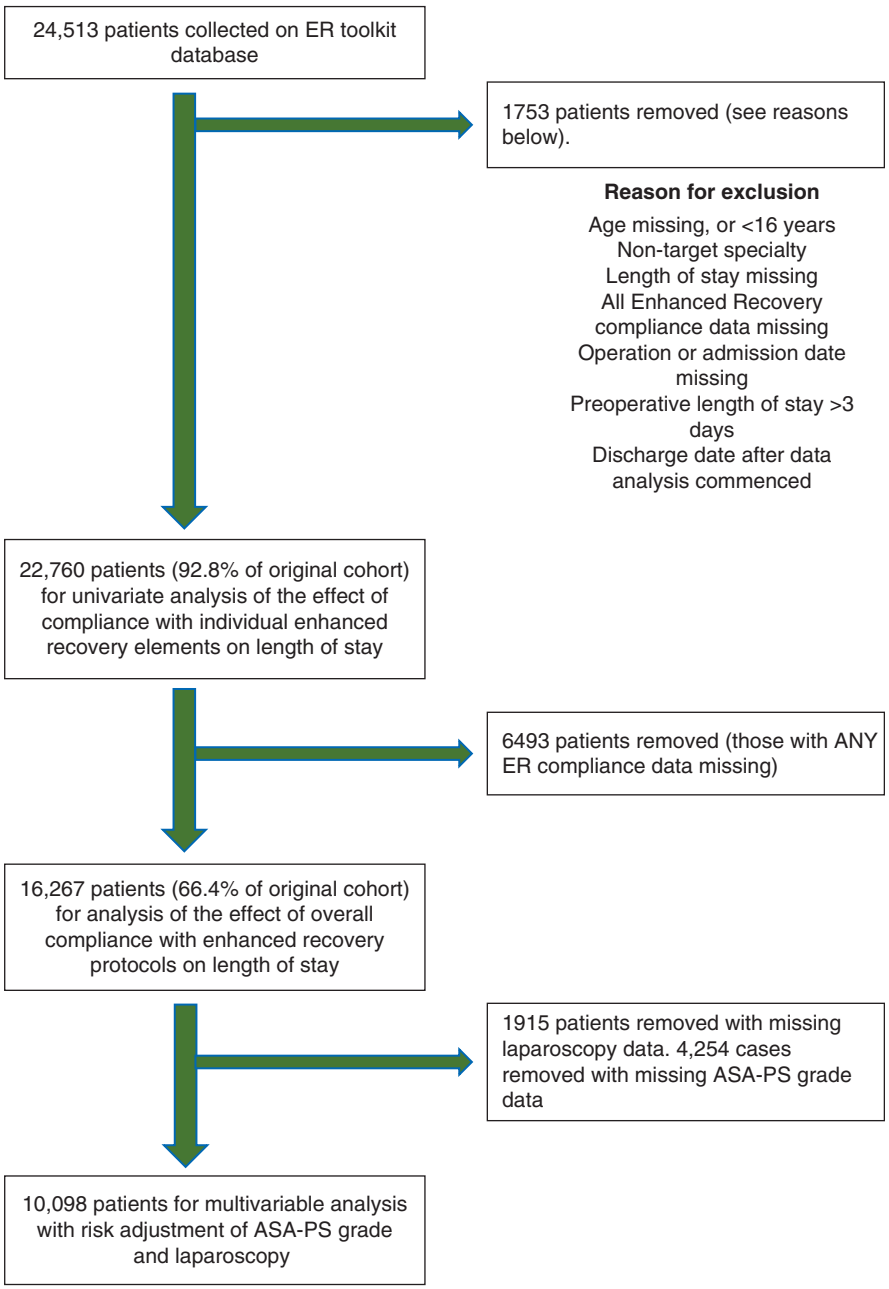

Fig 1 Flow chart to illustrate the application of exclusion criteria.

delivery of a consistent, protocolised, pathway of care. The amount of evidence for each individual element of the enhanced recovery elements is variable; however these data would suggest that, certainly in colorectal and orthopaedic surgery, there is perhaps a small overall benefit from the 'whole package'. The lack of a definite effect of ER compliance on LOS in gynaecology, may be because in gynaecology the LOS is already short. Therefore in order to demonstrate a significant benefit, the LOS would perhaps need to be measured in hours.

The multivariable analysis raises questions about the mechanisms by which each element confers benefit. Admission on the day of surgery by definition reduces the LOS by at least one day, however, the significant relationships remained when using only the postoperative length of stay. Early mobilisation may reduce LOS by reducing the likelihood of postoperative complications, or may simply reflect the absence of complications and hence increased likelihood of hospital discharge.

Two areas which have been open to much debate, are the use of epidural/ regional analgesia and the use of individualised fluid therapy.[16] Epidural/regional analgesia is associated with a longer LOS in colorectal surgery, but this was not seen in the other specialties. Interestingly, the colorectal surgery result concurs with a

recent randomised controlled trial of 99 patients having laparoscopic colorectal surgery, where epidurals were associated with longer LOS than spinal or PCA analgesia, though our database did not distinguish between epidural and spinal analgesia.[17] We attempted to account for patient-related risk factors, by including age and ASA-PS grade in our multivariable analyses. The ASA-PS has limitations as a risk-adjuster, including variable accuracy in different cohorts.[18] However, in spite of these, a more recent study does support its validity as a measure of a patient's premorbid status, and suggests moderate inter-rater variability.[19] In addition, in this dataset, it was not possible to adjust for the severity of surgery. It is likely that the use of epidurals/regional analgesia was more prevalent in those having more major colorectal surgery, and this may explain the association with longer LOS. In support of the use of central neuroaxial blockade, a previous systematic review demonstrates a reduction in mortality and serious complications in patients receiving neuroaxial blockade,[20] and a large cohort study from 2008 suggested a very modest reduction on 30-day mortality epidural anaesthesia, implying that epidurals are unlikely to cause harm.[21] A recent consensus view on ER obtained using the Delphi technique suggested that epidurals may be appropriate for certain patients having specific types of surgery.[16] Therefore, the association between epidural/regional analgesia and longer lengths of stay seen in this study should be interpreted with caution. A significant group of patients, particularly those having major open procedures may still benefit from epidural analgesia.

This analysis does not provide conclusive evidence that individualised fluid therapy is associated consistently with shorter LOS, although this effect is seen in the musculoskeletal patients. The systematic review and meta-analysis of perioperative goal-directed fluid therapy by Hamilton and colleagues[22] did suggest that this intervention may reduce mortality and complications, though effect diminished over time. A Cochrane review looking at perioperative increase in blood flow to explicit defined goals, also supports a reduction in complication rate and LOS, though does not demonstrate a mortality benefit.[23] A recent consensus report regarding ER[16] suggested that though there is no consensus for routine use of the oesophageal Doppler to achieve individualised fluid therapy, there is evidence supporting its use in selected patients. Our data would appear to support this.

It was not possible in this analysis to attribute the beneficial effect of ER protocols on LOS to a limited subset of ER elements. Given the observational nature of the data it is perhaps unsurprising that the particular elements were not consistently demonstrated as significant, as a patient's surgical journey involves a number of steps, all of which may have a bearing on outcome. Such an observational study necessarily entails a high risk of confounding, particularly with such a large number of variables. There is also possible variation between specialties. Nonetheless, there is a consistent theme across specialties that increased compliance is weakly associated with reduced LOS.

Table 1 Operations performed, by surgical specialty

Specialty	Operation	Total
Colorectal	Anterior resection	1530
	Abdominoperineal excision	233
	Colectomy	2130
	Colorectal - other	470
Gynaecology	Hysterectomy	1831
	Hysterectomy (vaginal)	532
	Laparotomy (other)	221
	Salpingo-oophorectomy/ oophorectomy	90
	Transvaginal mesh repair	38
	Vaginal repair	186
Orthopaedics	Hip arthroplasty	3996
	Hip and knee arthroplasty	2
	Knee arthroplasty	4625
	Shoulder arthroplasty	1
Urology	Open cystectomy	94
	Other urological operation	158
	Radical prostatectomy	130

Comparison with other studies

We searched Medline for research undertaken since 2000 assessing the effect of adherence with Enhanced Recovery elements on postoperative patient outcomes. Search terms used were 'enhanced recovery' and 'fast track surgery' and the search was restricted to human studies and English language papers. Publications were screened by title, abstract and full review for relevance to the objectives of our study. We identified three original papers[13 24 25] and one meta-analysis[8] detailing assessment of the relationship between protocol adherence postoperative outcomes. All of these papers included only patients undergoing colorectal surgery. To our knowledge this is the first study to assess the relationship between ER compliance and outcome following a variety of surgical subspecialty procedures. It also greatly exceeds the cohort size of previous studies and the number of participating centres.

Only one identified study indicated a dose-response relationship between protocol adherence and outcome[13] and this was restricted to colorectal surgical patients.

Strengths and limitations of this study

This study's major strength is its size. It uses data from 24 513 (minus exclusions) patients, which is many times more than have previously studied, particularly with respect to compliance with ER protocols.[13] This study also examines data for four surgical specialties, whereas previous work focuses mainly on the

Table 2 Details of age, sex and length of stay, by specialty

Specialty	Colorectal	Orthopaedics	Gynaecology	Urology
N	4363	8624	2898	382
Mean Age (range) in yrs	64.7 (17–99)	67.7 (18–100)	53.2 (16–91)	63.0 (19–90)
Number male (%)	2480 (56.8)	3327 (38.6)	n/a	294 (77.0)
Mean (SD) LOS	9.6 (13.0)	5.7 (5.9)	3.5 (7.2)	8.3 (21.5)
Median (IQR) LOS	7 (5–11)	5 (3–7)	3 (2–4)	5 (3–9)

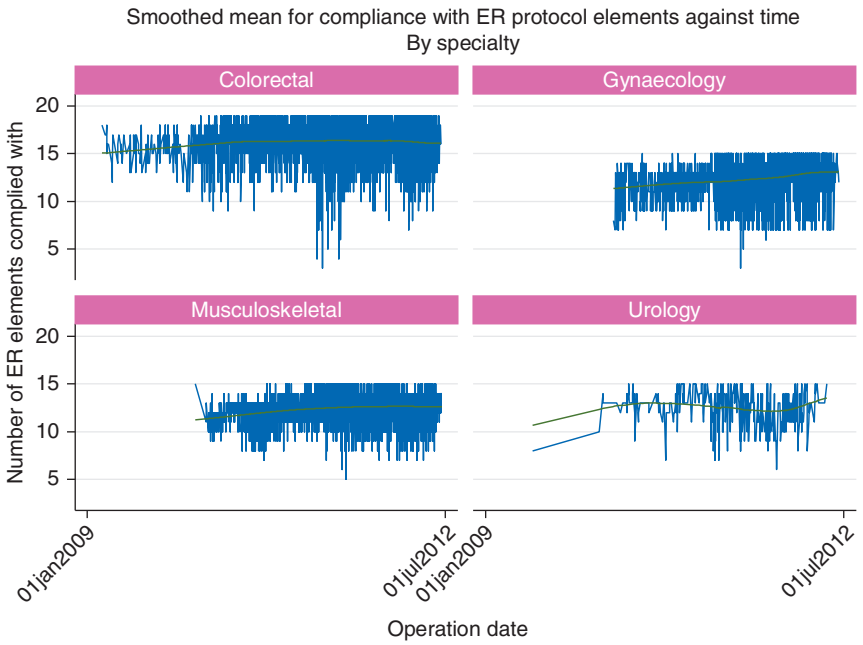

Fig 2 Smoothed mean for compliance with ER protocol elements against time.

Table 3 Correlation between ER score and length of stay (total, and postoperative)

Specialty	Number of Patients	Spearman's rho coefficient	
		Total length of stay with enhanced recovery protocol compliance	Post-operative length of stay with enhanced recovery protocol compliance
Colorectal	4363	−0.18 (P<0.0001)	−0.15 (P<0.0001)
Orthopaedics	8624	−0.14 (P<0.0001)	−0.12 (P<0.0001)
Gynaecology	2898	−0.03 (P=0.0796)	−0.02 (P=0.1884)
Urology	382	−0.25 (P<0.0001)	−0.22 (P<0.0001)

association between ER implementation and LOS in colorectal surgery patients.

However, our results should be taken in the context of a number of limitations of this study.

The first is the missing data within the variables analysed. This resulted in a large proportion of patients being excluded from the analyses. The complete dataset analysis method used here, with consequent exclusion of patients with missing data, may introduce bias. The alternative, imputation of data, was considered inappropriate because of difficulty determining the reasons for data being missing. An examination of the correlation matrix of missing data appeared to show no notable clustering (with mean intercorrelation being 0.175). In spite of the excluded patients, this study remains the largest reported single assessment of enhanced recovery compliance and outcome.

Another limitation is the possibility of data entry error, and the lack of standardization of data collection between institutions. There was no verification of data accuracy. The effect of these problems is minimized by the large sample size and number of institutions contributing data. As with any such observational analysis, association does not prove causation. However on consideration of the Bradford-Hill criteria, there is a consistent 'biological gradient' demonstrated across the different specialties, in that increased exposure to the ER protocol items is associated with decreased LOS and we believe this association has a plausible mechanism.

A potential source of bias is that those patients who died would appear to have relatively short LOS. We do not have adequate data to express the mortality rate for this cohort; however data from a recent report of surgical data in the UK[26] suggests that 30-day mortality rates after elective surgery are less than one percent, and therefore the effect of this is likely to be small. Another potential source of bias is that ER patients may be more frequently readmitted, particularly if they are discharged too early. We do not have adequate readmission data from this cohort, but a report on ER in the UK over the same period states there was no demonstrated increase in readmissions.[15]

Finally, while LOS is an important resource utilisation measure, and has often been used as a surrogate measure for postoperative complications,[18] it is not necessarily directly related to postoperative morbidity. While the aim of enhanced recovery programmes are to help patients recover sooner after

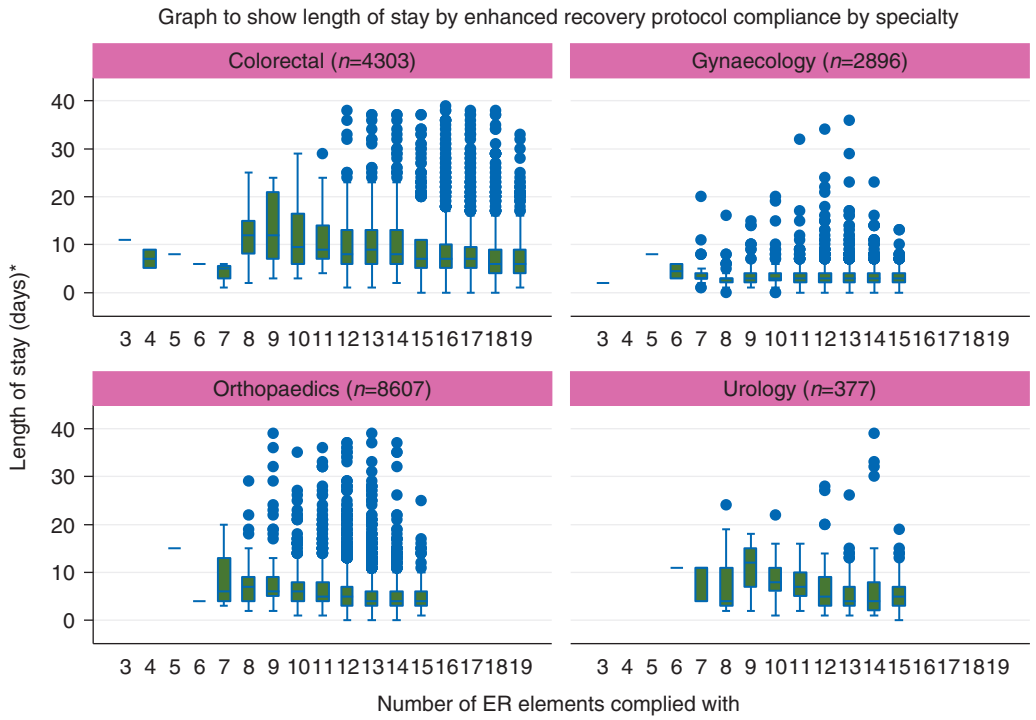

Fig 3 Graph to show length of stay by enhanced recovery protocol compliance by specialty. *For the purposes of illustration, only those with a LOS <40 days are represented on this box plot, therefore 99.5% of data is shown (*n*=16 183, instead of the *n*=16 267 in Table 1). The limits of each box represent the first and third quartiles and the line in the box, the median. The lower whisker extends to 1.5 times the interquartile range below the first quartile, or the lowest recorded value. The upper whisker extends to 1.5 times the inter-quartile range above the third quartile, or the highest recorded value. The dots represent outliers.

Table 4 Median LOS and median differences in LOS at compliance ≥70, ≥80 and ≥90%, by specialty. The median differences and their confidence intervals were calculated using the Hodges-Lehmann estimate technique. Statistical significance of the difference between groups was assessed using the Wilcoxon rank sum test. * indicates a significance level of *P*<0.001 (with Bonferroni corrections, therefore, *P*<0.00033 in order to reach significance in each specialty)

Specialty	≥70% compliant			≥80% compliant			≥90% compliant		
	Yes	No	Difference	Yes	No	Difference	Yes	No	Difference
	Median (IQR) LOS in days		Median (95% CI)	Median (IQR) LOS in days		Median (95% CI)	Median (IQR) LOS in days		Median (95% CI)
Colorectal, *n*=4363	7 (5–10)	9 (6–14)	2* (1–2)	7 (5–10)	8 (6–13)	2* (1–2)	6 (4–9)	7 (5–11)	1* (1–1)
Orthopaedics, *n*=8624	4 (3–6)	6 (4–9)	1* (1–1)	4 (3–6)	6 (4–8)	1* (1–1)	4 (3–6)	5 (3–7)	1* (0–1)
Gynaecology, *n*=2898	3 (2–4)	3 (2–4)	0* (0–0)	3 (2–4)	3 (2–4)	0* (0–0)	3 (2–4)	3 (2–4)	0 (0–0)
Urology, *n*=382	5 (3–8)	10 (6–12)	4* (2–5)	4 (3–8)	8 (5–12)	3* (2–4)	4 (3–8)	6 (3–10)	1 (0–2)

surgery, and thereby to reduce LOS, it would also be useful to know if they are reducing morbidity, and therefore be able to demonstrate the benefit to patients both in the short and long-term.[27]

Future work and conclusions

On-going data collection would benefit from a data entry mechanism which minimizes the amount of missing data. A more complete dataset for patient comorbidity might facilitate risk-adjustment in a multivariable model, which may allow us to study the effects of individual elements of ER. Collection of additional outcome data, such as postoperative morbidity and mortality would allow us to look in more detail at the clinical impact of ER protocols. On-going data collection is important, to facilitate continued audit of our practice, to ensure that the benefits of rigorous implementation of ER continue to be realised.

In conclusion, this study shows that despite the observational nature of the data, greater compliance with ER protocols is weakly associated with shorter LOS. This implies that the more stringent the implementation of an ER protocol, the more health benefit there will be for the patients, and the more cost savings there will be for institutions.

Table 5 The ER elements that demonstrated a significant effect on LOS, from the multivariable analysis. *Any variable where compliance was >95% has been removed, because of probable lack of validity

Effect	Colorectal (*n*=2917)	Orthopaedics (*n*=5733)	Gynaecology (*n*=1178)	Urology (*n*=270)
Reduced LOS* (% compliance)	Laparoscopic (59.9) Admission on day of surgery (61.5) Early mobilisation (87.7)	Early mobilisation (90.7) Individual fluid therapy (52.1)		Laparoscopic (55.9) Admission on day of surgery (70.2) Early mobilisation (91.5)
Increased LOS* (% compliance)	Epidural or regional analgesia (80.2)			Avoidance of systemic opiates (64.1)

Supplementary material

Supplementary material is available at *British Journal of Anaesthesia* online.

Authors' contributors

J.S. and S.R.M. contributed to conception and design of the work, led the analysis and interpretation of the data, and the drafting and revisions of the manuscript. M.J.G. developed some of the core analyses and data presentations, assisted JS in further analyses and contributed to the formation of the manuscript. M.P.W.G. contributed to conception and design of this work, interpretation of the data and revision of the manuscript. M.K. and A.M. contributed to the commissioning, design, implementation and support of the study database, including designing the data fields and definitions. M.K. designed the London CQUIN that incentivised data collection of a large proportion of the data analysed. M.K. and A.M. performed the initial data analysis and advised on subsequent analysis, and contributed to drafting the manuscript. C.M.O. acquired, analysed and interpreted comparative study data, identified using accepted systematic review methodology and contributed to drafting and revision of the manuscript. M.G.M. contributed to the commissioning, design, implementation and support of the study database, including designing the data fields, definitions and contributed to conception of the work, interpretation of the data and drafting the manuscript. All of the authors read and approved the final manuscript.

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Data from 72 hospitals, from 61 hospital trusts (listed in Supplementary Appendix 3) were used.

Declaration of interest

M.G.M. was National Clinical Lead for Enhanced Recovery in the UK until 2013 and is an editorial board member of the BJA. M.K. was a member of the National ER advisory board and a National Clinical Advisor on ER to NHS Improvement. A.M. was Associate Director of the National Cancer Action Team and member of the National ER advisory board. J.C.S., S.R.M., M.P.W.G., C.M.O., M.G. have no financial or non-financial interests that may be relevant to the submitted work. S.R.M. and M.G.M. works within the University College London Hospitals/University College London Joint Comprehensive Biomedical Research Centre, which receives funding from the UK Department of Health's National Institute for Health Research Centres' funding scheme. M.P.W.G. is funded in part by the University Hospitals Southampton NHS Foundation Trust – University of Southampton Respiratory Biomedical Research Unit, Southampton, UK, which received a portion of its funding from the United Kingdom Department of Health's National Institute of Health Research Biomedical Research Unit funding scheme.

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