

Variation in outcomes and use of laparoscopy in elective inguinal hernia repair

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Background: The early outcomes of inguinal hernia repair in routine practice and the extent to which the laparoscopic approach is used are unknown. The aims of this study were to identify national benchmarks for early reoperation and readmission rates, to identify the degree to which the laparoscopic approach is used for elective hernia surgery in England, and to identify whether there is any variation nationally.

Methods: All adults who underwent publically funded elective inguinal hernia repair in England during the six financial years from 2011–2012 to 2016–2017 were identified in the Surgeon's Workload Outcomes and Research Database (SWORD). Patients were grouped according to whether they had a primary, recurrent or bilateral hernia, and according to sex. Overall rates of readmission, reoperation and laparoscopic approach were calculated, and variation was assessed using funnel plots.

Results: Some 390 777 patients were included. Overall, 11 448 patients (2.9 per cent) were readmitted to hospital as an emergency within 30 days of surgery and 2872 (0.7 per cent) had a further operation. Laparoscopic repair was performed for 65.5 per cent of bilateral inguinal hernias compared with 17.1 per cent of primary unilateral inguinal hernias, 31.3 per cent of recurrent hernia repairs and 14.0 per cent of primary unilateral hernias in women. The unadjusted readmission, reoperation and laparoscopy rates varied significantly between hospitals.

Conclusion: The likelihood of a patient being readmitted to hospital, having an emergency reoperation or undergoing laparoscopic inguinal hernia repair varies significantly depending on the hospital to which they are referred. Hospitals and service commissioners should use this data to drive service improvement and reduce this variation.

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Introduction

Inguinal hernia repair is one of the commonest general surgical procedures, with elective groin and umbilical hernia procedures in adults being estimated to cost the National Health Service (NHS) in England over £130 million (approximately €150 million, exchange rate 1 March 2019) annually¹. RCTs^{2,3} have previously reported on clinical outcomes such as postoperative pain, time to return to

normal activity and hernia recurrence rates. However, there are few reports in the literature of other short-term outcomes such as reoperation and readmission rates in large population-based healthcare settings, and it is not known whether the outcomes observed in small randomized studies are comparable to those observed in larger population-based studies. This could give rise to misinformation during the informed consent process and inaccuracy about the risks associated with surgery.

Table 1 Short-term clinical outcomes of elective inguinal hernia surgery across the whole study period

	<i>n</i>	2-day readmission	7-day readmission	30-day readmission	30-day reoperation
All hernias					
Overall	390 777	2559 (0.7)	6057 (1.6)	11 448 (2.9)	2872 (0.7)
Laparoscopic	90 872	562 (0.6)	1271 (1.4)	2263 (2.5)	608 (0.7)
Open	299 905	1997 (0.7)	4786 (1.6)	9185 (3.1)	2264 (0.8)
Unilateral primary					
Overall	320 653	2024 (0.6)	4824 (1.5)	9177 (2.9)	2286 (0.7)
Laparoscopic	54 902	320 (0.6)	729 (1.3)	1303 (2.4)	349 (0.6)
Open	265 751	1704 (0.6)	4095 (1.5)	7874 (3.0)	1937 (0.7)
Bilateral					
Overall	40 963	300 (0.7)	649 (1.6)	1161 (2.8)	294 (0.7)
Laparoscopic	26 842	183 (0.7)	404 (1.5)	711 (2.6)	182 (0.7)
Open	14 121	117 (0.8)	245 (1.7)	450 (3.2)	112 (0.8)
Recurrent					
Overall	29 161	235 (0.8)	584 (2.0)	1110 (3.8)	292 (1.0)
Laparoscopic	9128	59 (0.6)	138 (1.5)	249 (2.7)	77 (0.8)
Open	20 033	176 (0.9)	446 (2.2)	861 (4.3)	215 (1.1)

Fig. 1 Funnel plot showing interprovider variation in 30-day reoperation rate across the whole study period for all hernias. UK financial year 2011–2016. National mean 0.7 per cent

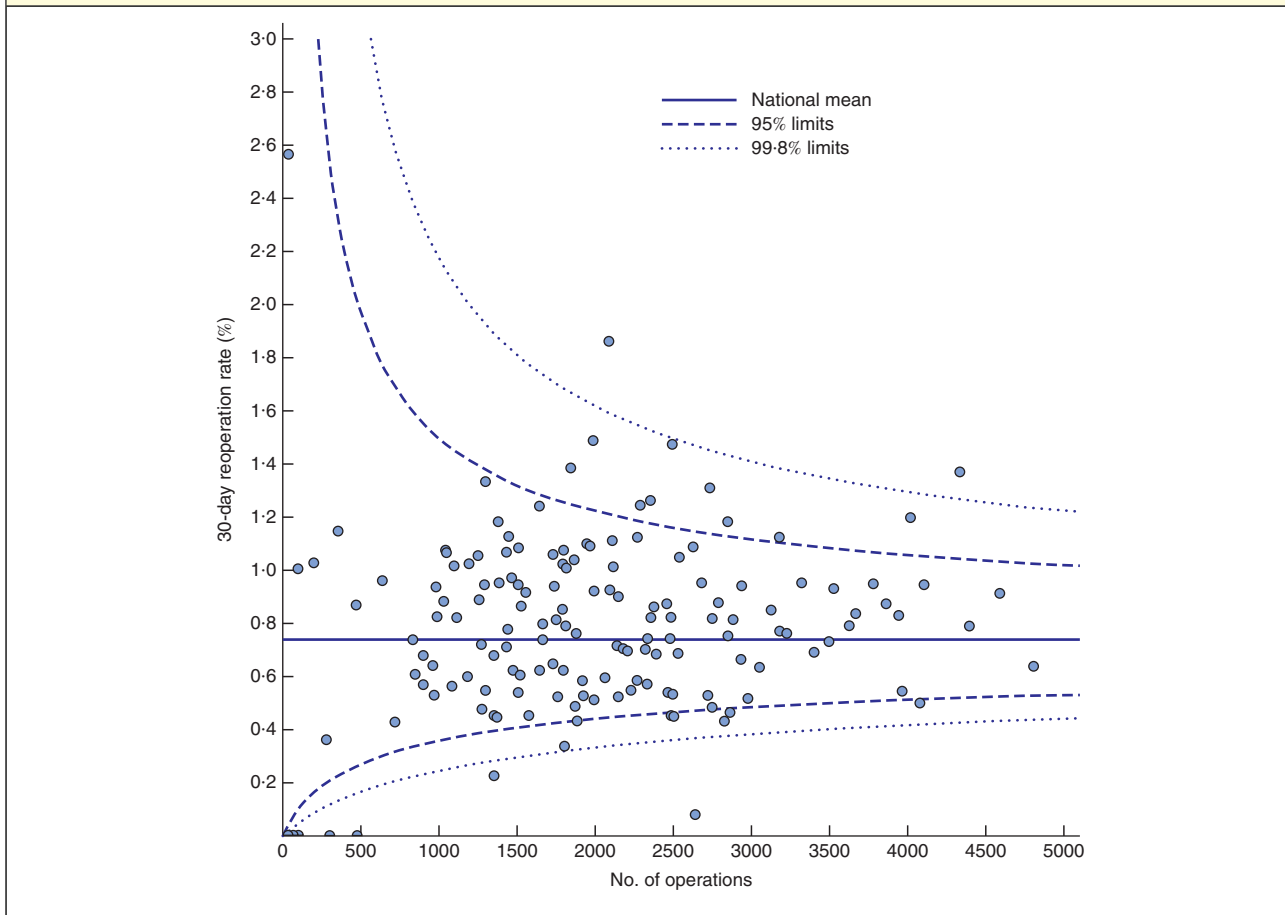
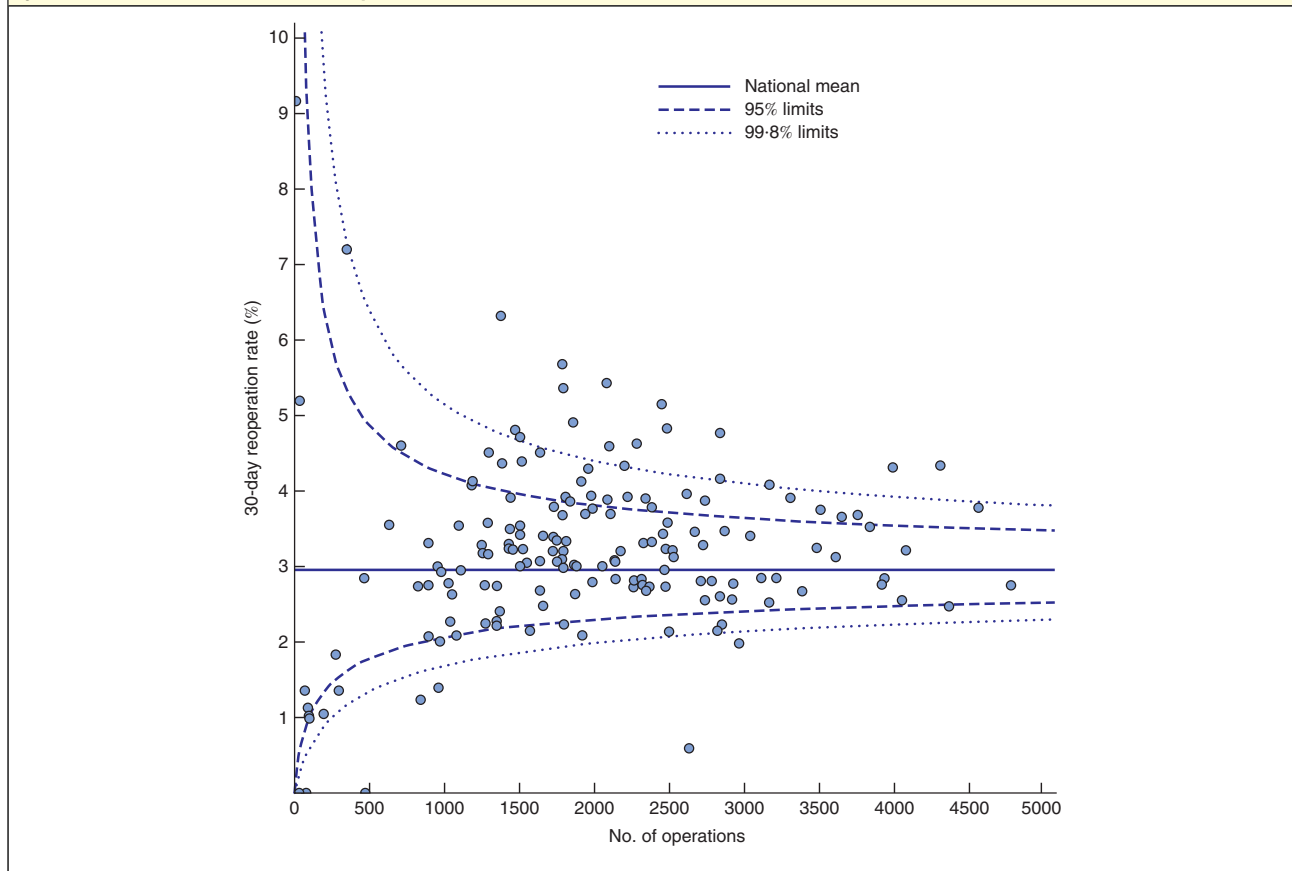


Fig. 2 Funnel plot showing interprovider variation in 30-day readmission rate across the whole study period for all hernias. UK financial year 2011–2016. National mean 2.9 per cent



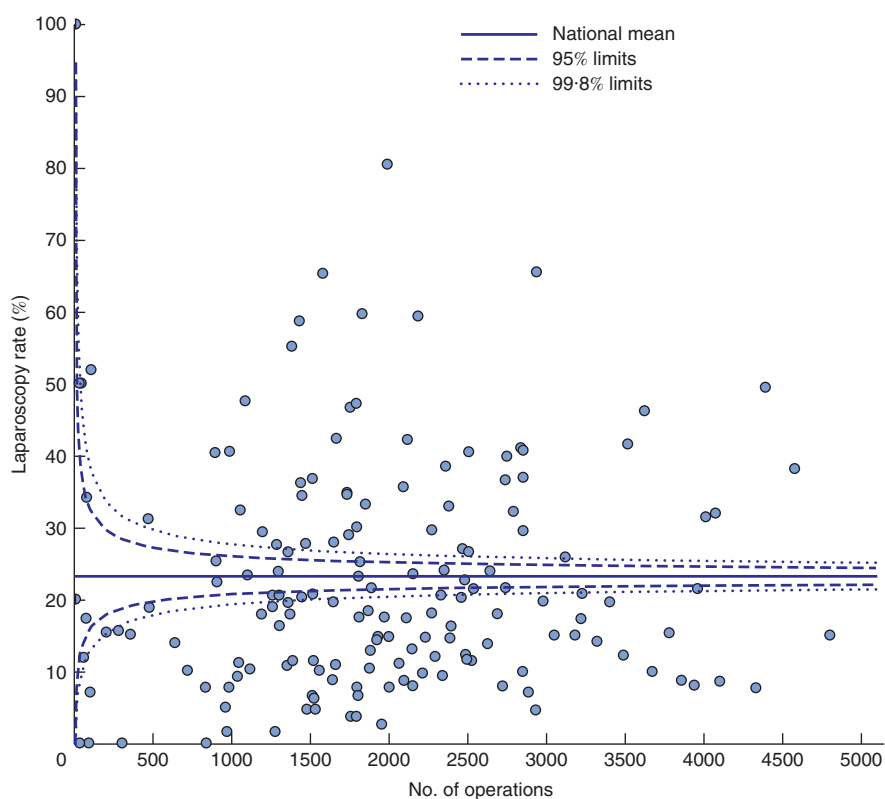
A further contentious issue surrounding inguinal hernia repair is the optimal technique. Both open and laparoscopic (transabdominal or total extraperitoneal) approaches have their own advantages and problems, and, as a result, their proponents and opponents. Most meta-analyses and cohort studies have demonstrated that laparoscopic repair reduces the likelihood of chronic pain and numbness, and that it allows a more rapid return to work. The benefits of laparoscopic over open surgery are most marked in those with bilateral hernias^{4,5}. However, the learning curve for open surgery is shorter, the operation demands fewer consumable instruments and, for the index spell at least, costs less to the health system^{2,6,7}. Given the increasing cost of healthcare globally, the corresponding resource implications and the frequency with which hernia repair is performed, these cost implications must be considered when deciding on the operative approach, particularly on a population basis.

Several guidelines have therefore produced recommendations as to how surgery should be carried

out, although, interestingly, they all vary in the strength to which they recommend the laparoscopic approach, illustrating well the contentiousness of the issue. The Royal College of Surgeons (RCS) Commissioning Guide for hernias recommends⁸ that the laparoscopic approach be used in bilateral hernias and in women (because of the risk of undiagnosed femoral or contralateral inguinal hernia). The European Hernia Society guidelines⁷ further recommend the laparoscopic approach in patients who are employed because of the reduced time off work, whereas the international HerniaSurge guidelines⁹ go even further and recommend it more generally in men with a primary unilateral hernia. For recurrent hernias, all three guidelines recommend that the approach used at the original operation be considered. In general terms, the opposite approach to that employed at the original surgery should be applied.

Following on from these guidelines, the RCS developed quality standards to assist service commissioners and funders in assessing hernia services, and to drive service

Fig. 3 Funnel plot showing interprovider variation in laparoscopy rate across the whole study period for all hernias. UK financial year 2011–2016. National mean 23.3 per cent



improvement⁸. These include 7- and 30-day readmission rates of less than 5 per cent, and laparoscopic rates greater than 40 per cent for women, and patients with bilateral or recurrent hernias. Whether these service specifications are being met is unknown.

The aims of the present study were to report on compliance with these national benchmarks (early reoperation and readmission rates) and on the use of laparoscopic surgery for elective hernia surgery, as well as to identify the magnitude of any variation between centres.

Methods

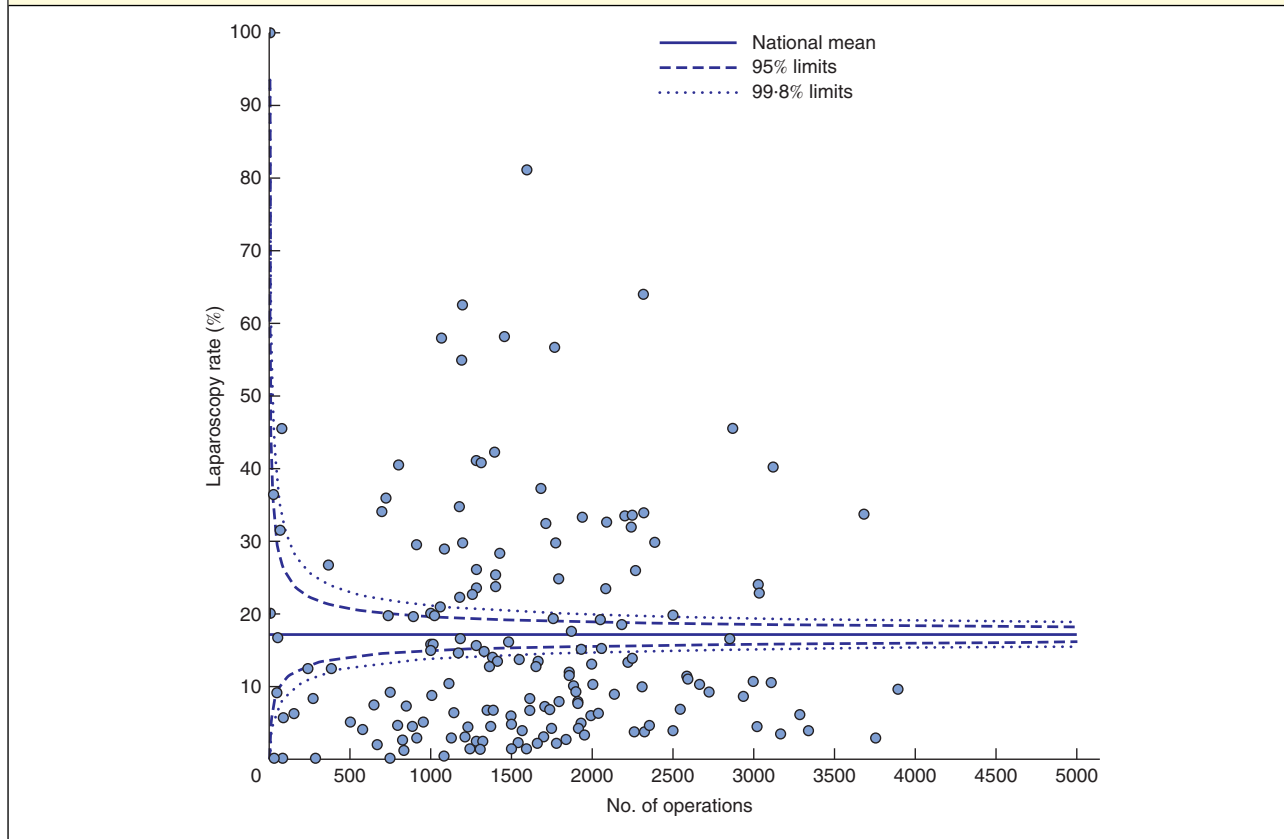
The study used the Surgeon's Workload Outcomes and Research Database (SWORD). This is a web-based monitoring system run by Methods Analytics under the auspices of the Association of Upper Gastrointestinal Surgeons of Great Britain and Ireland (AUGIS) and the Association of Laparoscopic Surgeons of Great Britain and Ireland (ALSGBI). Its basis is NHS England Hospital Episode Statistics (HES) (©2013, reused with permission

of the Health and Social Care Information Centre). Using prewritten analysis algorithms, SWORD allows users to examine the HES database for several different metrics in a variety of general surgical conditions. Centres can compare their performance to the national mean using funnel plots.

This study included all adults (those aged 18 years or more) who had an elective inguinal hernia repair funded by the government health system in England between 1 April 2011 and 31 March 2017. Patients undergoing elective treatment funded by the NHS at any institution (public or private) were included. Patients who received treatment funded by private health insurance are not included in the HES database. Patients who underwent emergency surgery (identified from the 'admission method' item) were excluded.

Eligible patients were identified by the relevant OPCS-4 codes in the procedure data items of the database (T198, T199, T201, T202, T203, T204, T208, T209 for primary inguinal hernia; T211, T212, T213, T214, T218, T219 for recurrent inguinal hernia). Patients were categorized

Fig. 4 Funnel plot showing interprovider variation in laparoscopy rate across the whole study period for unilateral primary hernias. UK financial year 2011–2016. National mean 17.1 per cent



according to whether they underwent surgery for a unilateral primary hernia, bilateral hernias or a recurrent hernia based on the primary code above and the secondary site codes (Z942, Z943, Z944 for unilateral; Z491, Z492 and Z493 for bilateral). Patients were also categorized by sex (which is coded specifically in HES). They were defined as having had a laparoscopic procedure if the secondary procedure codes Y751 (laparoscopically assisted approach to abdominal cavity) or Y752 (laparoscopic approach to abdominal cavity not elsewhere classified (NEC)) were present.

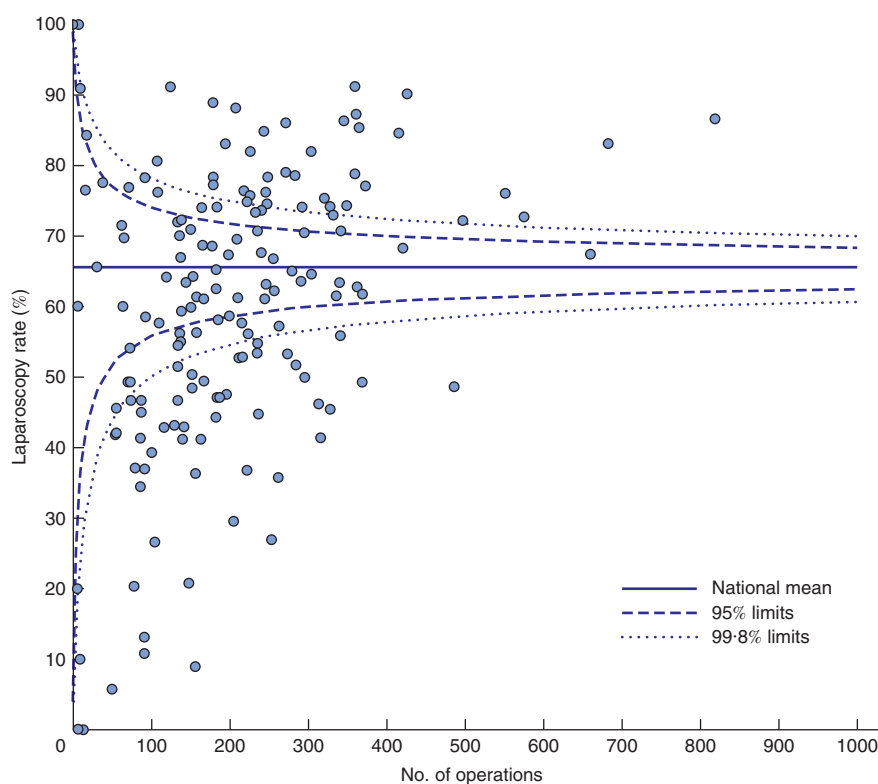
Metrics assessed included rates of laparoscopic surgery, 2-, 7- and 30-day readmission rates, and 30-day reoperation rates. Patients were classified as being readmitted if they had an emergency admission to hospital (for any reason, defined by the admission type in the patient record) within the relevant time frame. The SWORD database enables patients to be tracked longitudinally, so patients were included even if they were readmitted to a different hospital to that in which they had undergone the initial

procedure. Patients were classified as having a reoperation if they had an emergency abdominal operation (at any hospital) within 30 days.

Statistical analysis

Differences between proportions were tested using the χ^2 test. Statistical analysis was performed using STATA® version 10 (StataCorp, College Station, Texas, USA). Variation in outcomes among hospitals was assessed using funnel plots, which test whether hospital rates differ significantly from the overall national rate¹⁰. Hospital rates are plotted on the vertical axis and the number of operations per hospital is shown on the horizontal axis. The graph also includes the mean rate for England. The two control limits indicate the ranges within which 95 and 99.8 per cent of the hospital rates would be expected to fall if differences from the mean English rate arose from random variation alone. Hospitals outside the 99.8 per cent confidence limit were considered to be outliers.

Fig. 5 Funnel plot showing interprovider variation in laparoscopy rate across the whole study period for bilateral hernias. UK financial year 2011–2016. National mean 65.5 per cent



Results

Number of procedures

Some 390 777 elective inguinal hernia procedures were performed in England during the 6-year study interval. Of these, 320 653 (82.1 per cent) were unilateral primary inguinal hernia repairs, 29 161 (7.5 per cent) were for recurrent hernias and 40 963 (10.5 per cent) were for bilateral hernias. The number of procedures remained broadly constant throughout the study period, with the lowest annual number being 63 045 (in the 2012–2013 UK financial year, the period from 1 April 2012 to 31 March 2013) and the highest being 67 313 operations (in the 2013–2014 UK financial year).

Number of operations performed in private *versus* public hospitals

Some 86 674 of the operations (22.2 per cent) were performed in non-NHS or private hospitals. This proportion showed a small but consistent increase over the study period, from 19.3 per cent in the first year of the study

to 26.3 per cent in the last. These were 72 147 (83.2 per cent) primary unilateral hernia repairs, 8640 (10.0 per cent) bilateral hernia repairs and 5887 (6.8 per cent) operations for recurrent hernias. As with the overall trend, the proportion in each group increased slightly over time in all three groups.

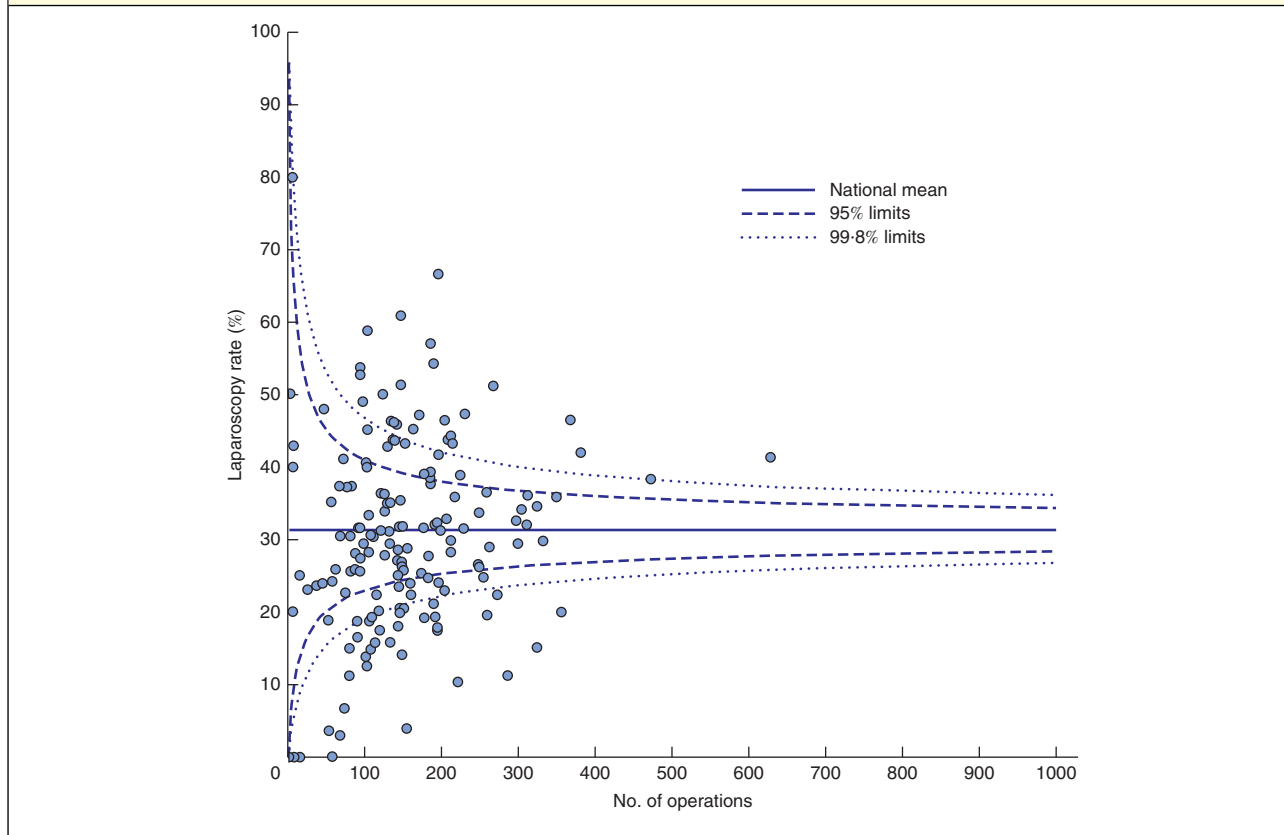
Early reoperation and readmission rates

The short-term outcomes of elective inguinal hernia repair across the whole period are shown in *Table 1*. Overall, 2.9 per cent of patients were readmitted to hospital as an emergency within 1 month of surgery and 0.7 per cent required an emergency reoperation. Among patients treated for recurrent hernia, the 30-day readmission rate was slightly higher after open than laparoscopic surgery (4.3 *versus* 2.7 per cent respectively). There were no other differences in unadjusted outcomes between the two approaches.

Use of laparoscopy

Overall, 90 872 operations (23.3 per cent) were performed laparoscopically. This percentage remained constant over

Fig. 6 Funnel plot showing interprovider variation in laparoscopy rate across the whole study period for recurrent hernias. UK financial year 2011–2016. National mean 31.3 per cent



time: 22.4 per cent in the first year of the study to 23.1 per cent in the last. The laparoscopy rate varied depending on the procedure being performed. Some 26 842 (65.5 per cent) of bilateral inguinal hernias were repaired laparoscopically, compared with 54 902 (17.1 per cent) of primary unilateral inguinal hernias and 9128 (31.3 per cent) of recurrent inguinal hernias. The laparoscopic rate increased only slightly across the study period in all three groups: from 62.2 per cent in the first year of the study to 65.5 per cent in the last year for bilateral hernias; from 16.5 to 17.3 per cent for unilateral primary hernias; and from 29.5 to 31.0 per cent for recurrent hernias.

Overall, women were slightly less likely than men to undergo laparoscopic surgery, with 14.0 per cent of women having laparoscopic surgery for primary unilateral inguinal hernia compared with 17.4 per cent of men ($P < 0.001$). This pattern persisted over time, with rates in the last year of the study being 15.4 and 17.5 per cent respectively.

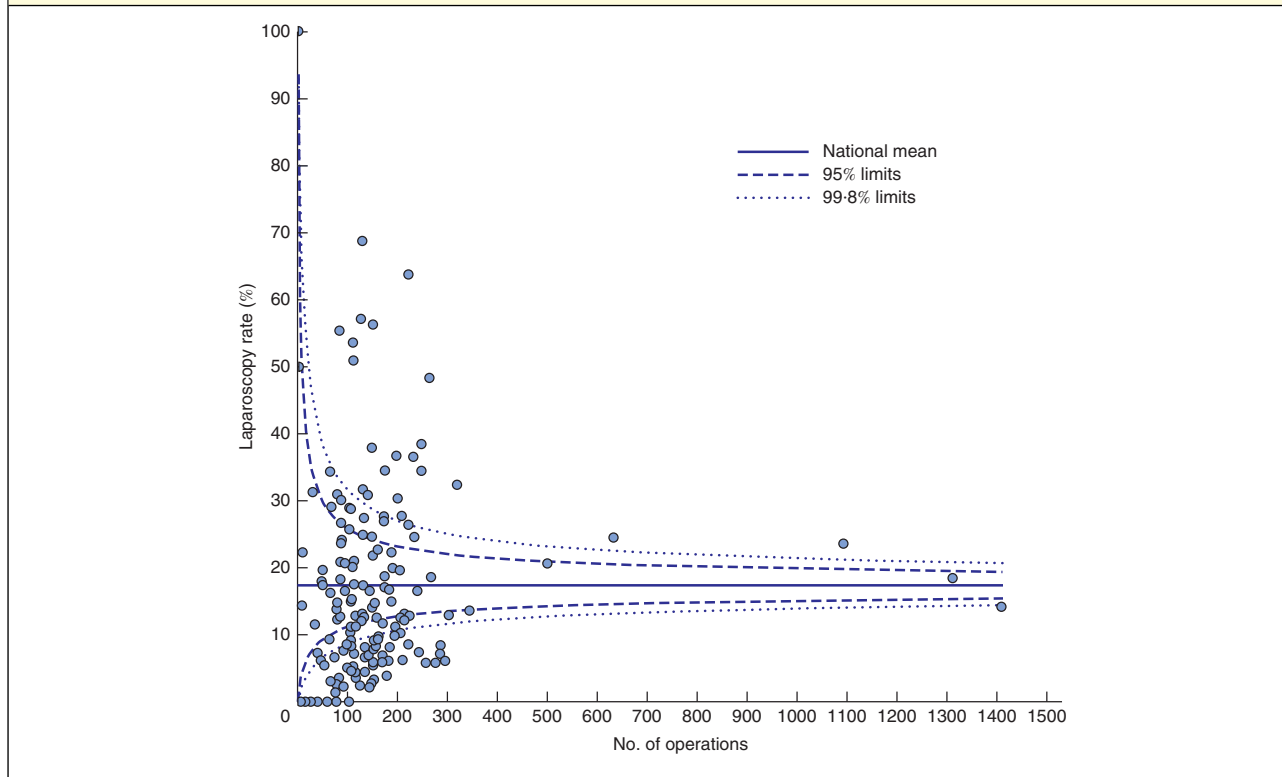
There was no difference between NHS and private hospitals in laparoscopy rates in any of the subgroups. The overall laparoscopy rate in NHS hospitals for the whole study group was 22.8 per cent, and that for private hospitals was 24.5 per cent.

Interhospital variation – unadjusted outcomes

The unadjusted 30-day reoperation, and 7- and 30-day readmission rates varied significantly between hospitals (Figs 1 and 2), with the overall 30-day reoperation rate ranging from 0 to 2.3 per cent. Eleven hospitals were outside the upper 95 per cent confidence limit, of which two were above the 99.8 per cent confidence limit.

Similarly, the unadjusted 7- and 30-day readmission rates varied between 0 and 20.0 per cent and 0 and 9.1 per cent respectively. Some of these outliers were hospitals with a very low volume of activity. If the analysis is limited to hospitals with a mean annual volume of over 12 procedures, the variation was between 0 and 4.5 per cent and

Fig. 7 Funnel plot showing interprovider variation in laparoscopy rate across the whole study period for women with a hernia. UK financial year 2011–2016. National mean 17.3 per cent



0 and 8.0 per cent respectively. Some eight of 175 hospitals were above the 99.8 per cent confidence limit for 7-day readmissions and 15 of 175 for 30-day readmissions. Two of 175 trusts (1.1 per cent) failed to meet the RCS target of a 7-day readmission rate of less than 5 per cent, and 24 of 175 (13.7 per cent) failed to meet the RCS target for 30-day readmissions (also less than 5 per cent).

Interhospital variation – laparoscopy rates

The proportion of procedures performed laparoscopically varied significantly between hospitals (*Fig. 3*) and was independent of hospital procedure volume. For example, for providers performing a mean of 200 or more procedures per year, the rate varied from 0 to 80 per cent. This variation was consistent over the study period.

Likewise, the variation was consistent across all procedure types and patient groups. *Figs 4–7* demonstrate significant variation between hospitals in the laparoscopic rate for primary unilateral hernias, bilateral hernias, recurrent hernias and women respectively. Overall, 16 of 174

hospitals (9.2 per cent) met the RCS target of a laparoscopy rate of 40 per cent for unilateral hernias, 147 of 170 (86.5 per cent) met the 40 per cent target for bilateral hernias, 37 of 170 (21.8 per cent) met the 40 per cent target for recurrent hernias, and ten of 170 (5.9 per cent) met it for women. Again, this variation was consistent across the study interval. In the final year of the study, the values were 16 of 160 (10.0 per cent) for unilateral, 126 of 153 (82.4 per cent) for bilateral, 42 of 154 (27.3 per cent) for recurrent hernias, and 17 of 156 centres (10.9 per cent) for women.

Discussion

In this study examining the patterns and short-term outcomes of inguinal hernia surgery in England and the extent to which they vary across the country, approximately one in 30 patients were readmitted to hospital as an emergency within 1 month of surgery and one in 100 underwent a subsequent (emergency) operation. The use of laparoscopy for bilateral hernias was moderately high (and well above the national target of 40 per cent), although nearly one-third of bilateral inguinal hernia repairs were still performed by the open approach. For recurrent hernias

and hernias in women the rates were much lower, with the national rate being less than half the 40 per cent national target. All rates varied widely across the country, with only one-quarter of hospitals meeting the 40 per cent target for use of laparoscopy in recurrent hernias and women.

The SWORD database uses HES as its basis. This administrative database includes all NHS-funded treatment in England, including that performed in private hospitals, and as such one of the strengths of the study is the complete national coverage that this allows. In doing so it avoids the selection bias inherent in national registries^{11,12}. The procedure and diagnosis codes in HES have been shown to be highly accurate for surgical procedures (it is very good at determining what procedure a patient had, when they had it and for what disease, and whether they were readmitted to hospital or had another procedure), and so the treatment patterns and outcomes reported here are likely to be accurate^{13–15}.

A potential weakness of the study is that data quality is likely to vary between hospitals, with smaller hospitals in particular having been shown to be more affected by data quality issues¹³. Historically, the approach codes were coded less well than the main procedure and diagnosis codes, although this has not been examined recently and coding accuracy in general is known to have improved¹⁵. It is possible that some of the variation observed, particularly in the smaller hospitals, was due to coding inaccuracies rather than being a real effect. A second potential weakness is that the findings were not adjusted for patient factors such as age, co-morbidity and size of hernia. The current iteration of SWORD does not yet include specific risk-adjustment models for each condition, and so it is possible that some of the variation observed (although not the overall national rates) is due to variations in these factors.

However, two factors make it unlikely that the observed findings are artefactual. First is the size of the observed variation. Given the documented improvements in coding, it is unlikely that differences of the scale observed are due simply to differences in coding accuracy. Second is the difference in the observed laparoscopy rate for bilateral hernias *versus* unilateral and recurrent hernias. If the observed findings were due to coding error, all three types of hernia would be expected to have similar rates. In fact, the rates varied widely, both overall and within hospitals. Finally, this study did not access the national patient-reported outcomes for elective hernia surgery, so the authors cannot comment on other short-term outcomes such as pain and health-related quality of life.

Direct comparison with other studies is difficult as this is the first study either in the UK or internationally specifically to examine both national trends and variation in

early readmission and reoperation rates, and in the use of laparoscopy in elective inguinal hernia repair. A recent study¹⁶ from the German Herniated registry, comparing the results of open repair in primary and recurrent hernias, found a 1.2 per cent complication-related reoperation rate after primary hernia repair and a 2.2 per cent rate after a recurrent hernia repair, rates comparable to the present results. With regard to laparoscopy rates, a 2008 study from Denmark¹⁷ demonstrated an overall rate of 16 per cent, which is likewise comparable to the present findings. The Danish authors did not specifically examine interhospital variation in procedure numbers, but instead studied it by proxy, using a questionnaire to identify how many hospitals had surgeons performing laparoscopic hernia repair. Similar to the present study, they found significant variation in laparoscopic hernia provision and training, with ten of 25 departments (40 per cent) not having any surgeons who performed laparoscopic hernia repair¹⁷.

One previous study¹⁸ specifically examined variation in the outcomes of inguinal hernia surgery. This American study considered variation in surgery for recurrent hernias in New York State and found a 27-fold variation in recurrence rate. The finding of significant variation in short-term outcomes in the present study is likewise consistent with work showing significant interhospital variation in other areas of surgery, such as complications after bariatric and colorectal surgery¹⁹ and the use of thoracoscopy (video-assisted thoracoscopic surgery, VATS) in lobectomy for lung cancer in the USA²⁰. Consistent with this work, the authors of the latter study concluded that 'the benefits of the VATS approach may not be available to some patients based solely on available expertise at the hospital at which the patients seek medical care'.

It is interesting to note the difference in the strength of the recommendations by the three guidelines. This cannot be accounted for purely on the basis of time of publication (the HerniaSurge guidelines⁹ were published only 2 years after the RCS commissioning guide⁸). A more likely explanation is the different audiences for which they were intended. The former is primarily an evidence-based guideline for clinicians, whereas the latter is aimed at providing recommendations at a service or population level and is directed largely at service leads and commissioners. It therefore may place more weight on the economic factors (whilst still being based on available evidence). Although it may be true that, for an individual patient, the laparoscopic approach may be slightly better, commissioners have to decide on the best value care they can purchase for their limited budget. This may underlie the difference in the strength of the recommendations, particularly for unilateral hernias in men, although the reason why the RCS

guidelines suggest 40 per cent as the target for bilateral hernias and hernias in women, given the strength of the evidence in those groups, is unclear.

These data act as useful ‘real-world’ values for services in the UK and internationally, to use both as a benchmark for comparison and for use in accurate patient information. Although confounder variables were not accounted for specifically, the low overall rates of laparoscopy and the high degree of variation in both readmission, reoperation and laparoscopy rates are notable and concerning. They suggest that a patient’s outcome, particularly their likelihood of having laparoscopic hernia surgery, varies strongly depending on the hospital to which they are referred. Hospitals and service commissioners should use initiatives such as SWORD to identify how their practice compares with national benchmarks and act to reduce this variation.

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