Impact of Surgeon Volume and Sub-Speciality on Cholecystectomy Outcomes: A Ten Year Experience

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Abstract

Introduction: Cholecystectomy guidelines in the UK recommend surgeons perform more than 40 procedures per year. This retrospective study aims to assess variation in outcomes in patients operated by high and low volume surgeons as well as those that work in an upper GI specialist unit.

Methods: Elective cholecystectomies performed between 2003 and 2012 were included. The data was analysed by volume with surgeons performing over 40 per year or fewer, and by specialism with surgeons in the upper GI directorate compared to others. Results were analysed by the Fishers Exact test and Odds Ratios for categorical variables and independent t-test for continuous variables.

Results: During the study period, 5350 patients underwent cholecystectomy. In the low volume group the rate of conversion to an open procedure was significantly higher 4.4 vs. 1.2% OR 3.82 (2.61-5.59), the day case rate was lower 25.2% vs. 46.3% OR 2.56 (2.27-2.89), and the length of stay was longer 1.45 days vs. 1.02 days ($p<0.0001$). These findings were similarly demonstrated in the non upper GI specialist group; conversion to open 3.8% vs. 0.6% OR 6.57 (3.76-11.48), day case rate 31.4% vs. 47.2% 1.95(1.75-2.18), length of stay 1.32 days vs. 1.01 days ($P<0.0001$). In addition, a higher reoperation within 30 days rate 4.8% vs. 2.6%, 1.91 (1.41-2.59) was reported when compared to upper GI specialists.

Conclusions: This data supports the national guidelines for surgeon volume and cholecystectomy, and demonstrates an improvement in outcomes in patients operated by surgeons working within a specialist unit.

Key Words: Morbidity, Mortality, Cholecystectomy.

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Introduction

Gallstone disease is prevalent in approximately 15% of the adult population in the UK. (1) Management for symptomatic gallstone disease in the minimally invasive era is laparoscopic cholecystectomy (LC) with over 60,000 performed in 2014-15 in England (2) LC has historically been considered a common 'general surgical' operation. However, since its advent in the early 1990's there has been wide variation in reported outcomes across the spectrum of key performance indicators.

Evidence drawn from other fields demonstrates that surgical volume is associated with improved outcomes (3). Hobbs et al. 2006 reviewed over 30000 LC undertaken in Australia between 1988 and 1998 demonstrating higher risk for all complications and bile duct injuries in patients whose surgeon had completed less than 200 LC in the preceding 5 years (4).

The following table (Table 1) reports the data from six studies that have assessed surgeon volume and outcomes after LC.

Further to Table 1, Harrison et al. reviewed 59918 LC in Scotland grouped by hospital volume rather than individual surgeon, which showed that a moderate volume hospital had the highest complication rates and 30 day mortality rates, when compared to both high and low volume groups. Length of stay was significantly shorter in the high volume hospital (10).

The NHS Institute for Innovation and Improvement has extrapolated Hobbs study to recommend minimal surgical volume of 40 LC per year per surgeon as a benchmark for improving the quality of patient care (11).

There is however a paucity of contemporary robust direct evidence in UK practice and therefore recommendations have been largely ignored nationally due to the logistic difficulty of implementation allied to surgical 'ego'. The aims of this study were to:

1. Assess outcomes of cholecystectomy when performed by high vs. low volume or specialist vs. non-specialist surgeons;
2. Assess whether adherence to NICE guidelines will improve outcomes.

Materials and Methods

Data were collected from the Hospitals Statistics database for a ten year period between 01/01/2003 - 31/12/2012. The trust serves a heterogeneous population in the West Midlands and the Department of Surgery comprises of specialist Colorectal, Upper GI and Breast surgeons, as well as general surgeons.

6193 cholecystectomies were identified coded as J181, J182, J183, J184, J185, J188, J189. Emergency admissions resulting in cholecystectomy were excluded, leaving 5432 elective cholecystectomies. Of these, cholecystectomies were excluded if the named consultant had performed fewer than 5 cholecystectomies within the 10 year period or worked for the trust for less than 60 days. This was to exclude cholecystectomies performed by incorrectly coded consultants and short term locums. This resulted in 5350 cholecystectomies for analysis.

Consultant surgeon data was analysed for total number of urgent and elective cholecystectomies within the study period. This was combined with the number of days between the first and last cholecystectomy performed by that surgeon in the study period to give a cholecystectomy/day ratio. This was extrapolated to give a cholecystectomy per annum ratio (Figure 1).

Table 1 Cholecystectomy and Surgeon volume.

Author and year of publication	Year data collected	Surgery	N	High Volume/ Low volume group	Outcomes	Difference
Hobbs et al 2006 (4)	1980-1999	LC and OC	33309	Stratified 1-50 51-100 101-200 201-300 >300 (over 5 years)	All complications	OR 1.72(1.21-2.46) 1.52(1.03-2.25) 1.35(0.97-1.89) 1.10 (0.78-1.55) Reference group
Boddy et al 2006 (5)	1996-2005	LC and OC	4139	Upper GI surgeons vs. Other	Conversion rate Length of stay	3.4 vs. 14.1% (p<0.001) 2.0 vs. 3.6% (p<0.001)
Csikesz et al 2009 (6)	1999-2005	Urgent LC and OC	80149	>15 per year 1-15 per year	Conversion rate Prolonged length of stay Bile duct injury	8.0 vs. 11.8% (p<0.0001) 12.8 vs. 11.1% (p<0.0001) 0.15 vs. 0.22 (p=0.03)
Lee et al (7)	1998 – 2002	Elective LC	916	By each surgeon 502 192 147 75 (over 4.3 years)	All complications (adjusted)	OR (95% CI) Reference Group 7.3 (1.47 36.7) NS 5.43 (0.77-38.48)
Murphy et al (8)	1998 – 2006	Elective and Urgent LC	1102071	<12 per year 12-35 per year >35 per year	Major post op complication	Low 7.0% Medium 6.8% High 6.7% (p<0.0001)
Donkervoort et al (9)	2004-2008	Elective and urgent LC	942	<10 11-20 >30	Mortality Major post op complication	No significant difference between groups

The data were examined in two different analyses. The first analysis was to compare cholecystectomy outcomes when grouped by surgeons that performed ≥ 40/annum and <40/annum. The second analysis was to compare outcomes when grouped by upper GI surgeons or others. Upper GI surgeons were defined as being employed in the upper GI directorate, which in this trust provides a gallbladder, bariatric and oesophagogastric benign and cancer service.

Data was interrogated for demographics, conversion rate, complication rate, day case rate, length of stay, reoperation rate, readmission within 30 day rate and significant bile duct injury (BDI) rate. Significant BDI was defined as bile duct injury requiring surgical reconstruction. Results were analysed by the Fishers Exact test and Odds Ratios with 95% Confidence Intervals for categorical variables and the independent t-test for continuous variables. Data was analysed with SPSS software version 22.0 (IBM Corp 2013, Armonk, NY).

No consent or IRB approval was needed for this study.

Results

5350 cholecystectomies were included, the mean age was 49 years and 79.3% were female. The data was examined in two separate analyses as outlined in the methods and tabulated below (Tables 2, 3 and 4).

Conversion to open and open cholecystectomy rates

In this centre the intention for elective LC was 99.0%, with only 1% of cases planned as open procedures. Both the high and low volume groups had an equivalent rate of planned laparoscopic and open cholecystectomy. However in the low volume group there was a significantly higher odds of conversion from laparoscopic to open cholecystectomy OR 3.82 (2.61-5.59). There was an even higher odds ratio in the non specialist unit OR 6.57 (3.76-11.48) when compared to the upper GI unit.

Day case rates

The overall day case rate was 38.3% for cholecystectomy. The day case rate was significantly higher in the high volume group OR 2.56 (2.27-2.89) and upper GI unit OR 1.95 (1.75-2.18).

Reoperation rates

The overall 30 day reoperation rate was 3.9% rising to 5.8% at 90 days. The 30 and 90 day reoperation rates were equivalent in the high and low volume groups. The 30 day reoperation rate was significantly higher in the non specialist unit OR 1.91 (1.41-2.59), but by 90 days the reoperation rate was equivalent.

Readmission rates

The overall emergency readmission within 30 days was 5.0%. This was not significant in either analysis.

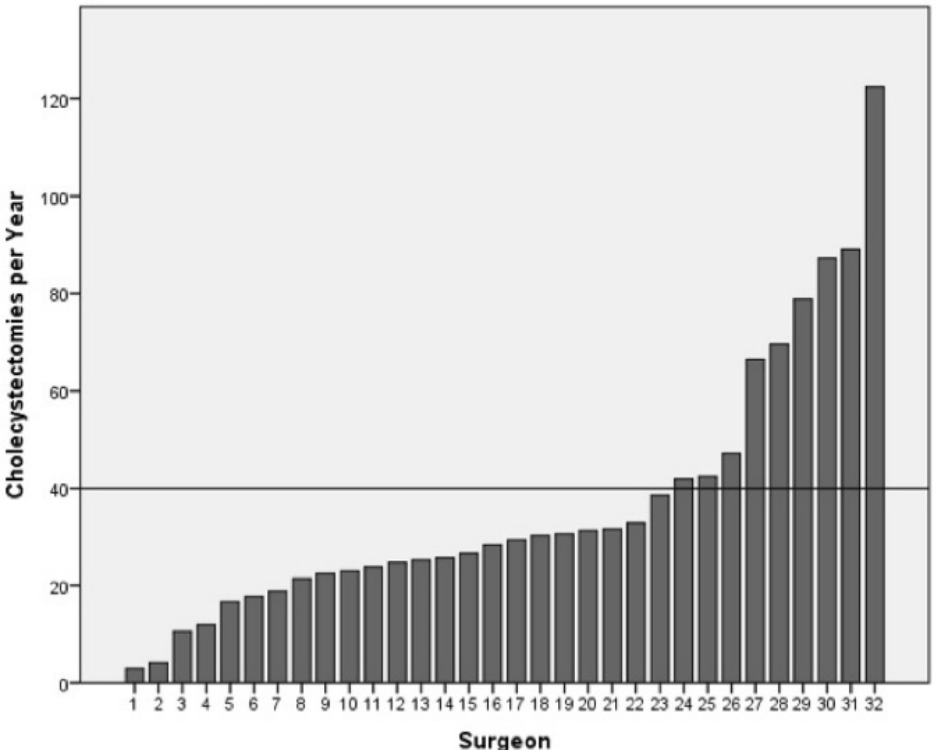

Figure 1. Graph to show surgeon volume per year.

Table 2 Population characteristics by group.

	≥ 40 per annum	<40 per annum		Upper GI Directorate	Non Upper GI Directorate	
N	n = 3325	n = 2025		n = 2351	n = 2999	
Mean Age	49.12	49.88	p=0.079	50.40	48.15	p<0.0001
Female	2660 (79.3%)	1585 (78.3%)	p=0.134	1894 (80.6%)	2351 (78.4%)	p=0.053

Fishers Exact Test

Table 3 Comparison between high and low volume groups.

	≥ 40 per annum n = 3325	<40 per annum n = 2025	P value	OR (95% CI)
Intention LC	3290 *(98.9%)*	2007 *(99.1%)*	p=0.670	0.843 (0.48-1.50)
Conversion to open	39 *(1.2%)*	88 *(4.4%)*	p<0.0001	3.82 (2.61-5.59)*
Day case	1540 *(46.3%)*	510 *(25.2%)*	p<0.0001	2.56 (2.27-2.89)*
Reoperation within 30 days	129 *(3.9%)*	77 *(3.8%)*	p=0.942	0.979 (0.77-1.36)
Reoperation within 90 days	192 *(5.8%)*	119 *(5.9%)*	p=0.904	1.02 (0.81-1.29)
Readmission within 30 days	154 *(4.6%)*	115 *(5.7%)*	p=0.094	0.807 (0.629-1.034)
In-hospital Mortality	1 *(0.03%)*	1 *(0.05%)*	p=1	0.61 (0.04-9.74)
CBD injury rate	2 *(0.06%)*	2 *(0.10%)*	p=0.636	0.609 (0.09-4.33)
Mean Length of Stay (days)	*1.02*	*1.45*	p<0.0001*	

Fishers Exact Test and Odds Ratios are given for categorical variables, *indicates significance
Mean independent t-test are given for non-categorical variables *indicates significance

Table 4 Comparison between Upper GI and Non Upper GI directorate.

	≥ 40 per annum n = 3325	<40 per annum n = 2025	P value	OR (95% CI)
Intention LC	2333 *(99.2%)*	2964 *(98.8%)*	p=0.165	1.53 (0.87-2.71)
Conversion to open	14 *(0.6%)*	113 *(3.8%)*	p<0.0001*	6.57 (3.76-11.48)
Day case	1109 *(47.2%)*	941 *(31.4%)*	p<0.0001*	1.95 (1.75-2.18)
Reoperation within 30 days	61 *(2.6%)*	145 *(4.8%)*	p<0.0001*	1.91 (1.41-2.59)
Reoperation within 90 days	129 *(5.5%)*	182 *(6%)*	p=0.378	1.11 (0.88-1.40)
Readmission within 30 days	103 *(4.4%)*	166 *(5.5%)*	p=0.059	0.78 (0.61-1.01)
In-hospital Mortality	1 *0.04%*	1 *0.03%*	p=1	(0.08-20.4)
CBD injury rate	2 *(0.09%)*	2 *(0.06%)*	p=1	1.28 (0.18-9.06)
Mean Length of Stay (days)	1.01	1.32	p<0.0001*	

N(%) and Fishers Exact Test are given for categorical variables, *indicates significance
Mean independent t-test are given for non-categorical variables *indicates significance

Bile Duct Injury
The overall significant bile duct injury rate was 0.07% and this was not significantly different in any group.

In-hospital Mortality
Overall In-hospital mortality was 0.04%, with 1 patient in each group.

Length of Stay
Length of Stay was significantly shorter in both the upper GI unit and in surgeons with a volume of more than 40 cases per annum, 1.01 vs. 1.32 days (p<0.0001) and 1.02 vs. 1.45 days (p<0.0001) respectively.

Discussion

An increasing volume of evidence supports the concept of high surgical volume (unit and individual) being directly correlated with improved patient outcomes. The volume effect has been demonstrated most convincingly in major surgery (3) but this has not been universally accepted or fully implemented within the NHS.

The recommendations for cholecystectomy have previously been extrapolated from an historic Australian study (4) and largely corroborated by heterogeneous retrospective papers (5,6,8). Critical review would question the use of sub group analysis of a continuous variable that has been levelled at other volume studies. However, results appear to translate to improved length of stay, complication and conversion rates but additionally highlight a high degree of random cause variation, which is particularly demonstrated in the variation in the major complication of bile duct injury (10).

This study reports on a large single centre cholecystectomy series that reflects NHS practice. This data confirms that LC is a safe procedure with an associated mortality of 0.4 per 1,000 and a major bile duct injury rate of 0.7 in 1,000. However this data does describe variability in outcomes related to surgeon volume and specialty. There is a 3-fold higher risk of conversion to open procedure in surgeons that perform less than 40 LC per year, and 6 fold increase in risk of requiring conversion in surgeons that do not work in a specialist upper GI unit. Open cholecystectomy is associated with longer in patient stays and morbidity including pneumonia and wound infection (12).

There is also a doubling of patients that stay one night or more if the cholecystectomy is performed by a low volume or non-specialist surgeon. Performing LC as day surgery has become the 'gold standard' of care. Again the evidence base to support this on clinical outcome is limited (13) and subject to relatively small sample sizes that are potentially amenable to random error and risk of bias. There is however a number of major drivers relating to reduced bed occupancy and significant cost savings, estimated to be £6.1 million for the NHS if fully delivered reflected in 'Best Practice Tariff'. Despite this, there is an 8-fold variation in day-case LC rates across hospitals in England largely attributable to common cause variation (11).

The difference in surgeon volume and experience has been reported in other fields (14,15) and variably in cholecystectomy, however this study adds to the data of five previous studies (4-8) that surgeon volume and specialism does positively improve outcome. Although this may be influenced by special case variation in low volume surgeons, a sample group sub analysis looking at case selection suggests this bias would exacerbate positive differences seen. Future work to control for this would require prospective data collection to enable an analysis for features such as previous episodes of cholecystitis, pancreatitis, pain profile prior to cholecystectomy and medical co-morbidities as well as history of previous ERCP.

Conclusion

NICE guidelines recommend that LC should be performed by surgeons performing more than 40 procedures per year. This data

supports that recommendation, with better outcomes in patients treated by high volume and/or specialist surgeons. These findings should be considered when redesigning gallbladder services. It is therefore reasonable to suggest that surgery should be performed by surgeons attaining a set surgical volume, allied to assurances of training and outcome monitoring.

References

1. Gallstone disease: Diagnosis and Management. The National Institute for Health and Care Excellence (NICE) 2014; Available at: https://www.nice.org.uk/guidance/cg188. Accessed 23/06/2018
2. Gallstone Commissioning Guidelines - 2016. Association of Upper Gastrointestinal Surgeons of Great Britain and Ireland. Available at: http://www.augis.org/augis-guidelines. Accessed 23/06/2018
3. Maruthappu M, Gilbert BJ, El-Harasis MA, et al. The influence of volume and experience on individual surgical performance: a systematic review. A***nnals of Surgery*** 2015;**261(4)**:642-7.
4. Hobbs MS, Mai Q, Knuiman MW, Fletcher DR, Ridout SC. Surgeon experience and trends in intraoperative complications in laparoscopic cholecystectomy. ***British Journal of Surgery*** 2006;**93(7)**:844-53.
5. Boddy AP, Bennett JM, Ranka S, Rhodes M. Who should perform laparoscopic cholecystectomy? A 10-year audit. Surgical ***Endoscopy*** 2007;**21(9)**:1492-7.
6. Csikesz NG, Singla A, Murphy MM, Tseng JF, Shah SA. Surgeon volume metrics in laparoscopic cholecystectomy. ***Digestive Diseases and Sciences*** 2010;**55(8)**:2398-405.
7. Lee KT, Chang WT, Huang MC, Chiu HC. Influence of surgeon volume on clinical and economic outcomes of laparoscopic cholecystectomy. ***Digestive Surgery*** 2004;**21(5-6)**:406-12.
8. 8. Murphy MM, Ng SC, Simons JP, et al. Predictors of major complications after laparoscopic cholecystectomy: surgeon, hospital, or patient? ***Journal of the American College of Surgeons*** 2010;**211(1)**:73-80.
9. 9. Donkervoort SC, Dijksman LM, Versluis PG, Clous EA, Vahl AC. Surgeon's volume is not associated with complication outcome after laparoscopic cholecystectomy. ***Digestive Diseases and Science*** 2014;**59(1)**:39-45.
10. 10. Harrison EM, O'Neill S, Meurs TS, et al. Hospital volume and patient outcomes after cholecystectomy in Scotland: retrospective, national population based study. ***British Medical Journal*** 2012;**344**:e3330.
11. 11. NHS Institute for Innovation and Improvement. Focus on: cholecystectomy: delivering quality and value. 2006. Available at: https://www.qualitasconsortium.com/index.cfm/reference-material/delivering-value-quality/focus-on-cholecystectomy/ Accessed 23/06/2018.
12. 12. Coccolini F, Catena F, Pisano M, et al.Open versus laparoscopic cholecystectomy in acute cholecystitis. Systematic review and meta-analysis. ***International Journal of Surgery*** 2015;18:196-204.
13. 13. Gurusamy KS, Junnarkar S, Farouk M, Davidson BR. Day-case versus overnight stay for laparoscopic cholecystectomy. ***Cochrane Database of Systemic Reviews*** 2008;(3):CD006798. doi(3):CD006798.
14. 14. Borowski DW, Kelly SB, Bradburn DM, et al. Northern Region Colorectal Cancer Audit Group. Impact of surgeon volume and specialization on short-term outcomes in colorectal cancer surgery. ***British Journal of Surgery*** 2007;**94(7)**:880-9.
15. 15. Burns EM, Mamidanna R, Currie A, et al.The role of caseload in determining outcome following laparoscopic colorectal cancer resection: an observational study. ***Surgical Endoscopy*** 2014;**28(1)**:134-42.