

Cholecystectomy for people aged 50 years or more with mild gallstone pancreatitis: predictors and outcomes of index and interval procedures

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The known: Cholecystectomy during the index (first) admission of people with mild gallstone pancreatitis is recommended by international guidelines.

The new: More than three in five NSW patients aged 50 years or more with mild gallstone pancreatitis underwent interval rather than index cholecystectomy during 2008–18. Conversion to open cholecystectomy and emergency gallstone-related disease re-admissions were more frequent for these patients. Delayed cholecystectomy was more likely in low or medium surgical volume hospitals and for patients with other medical conditions.

The implications: Hospitals should be supported so that index cholecystectomy can be routinely provided to people over 50 with mild gallstone pancreatitis unless clinically contraindicated.

Acute pancreatitis is the most common type of pancreatic disease, and one of the most frequent gastrointestinal reasons for hospital admission.¹ About 40–70% of people with acute pancreatitis have gallstone disease, for which the definitive treatment is cholecystectomy.² For people with mild gallstone pancreatitis — that is, without organ failure or local or systemic complications — international guidelines recommend that laparoscopic cholecystectomy be performed during the index admission.^{3–5} Delaying cholecystectomy increases the risks of recurrent gallstone-related disease within 30 days of discharge, including those of pancreatitis, cholecystitis, and cholangitis.⁶ Re-admission with gallstone-related disease after delayed cholecystectomy also increases the costs of treatment.⁷

Although index cholecystectomy has been recommended for patients with mild gallstone pancreatitis since the early 2000s,^{8,9} population-based studies in the United States have found that adherence to this advice is especially poor when treating patients over 65 years of age.¹⁰

In our population-based, retrospective cohort study, we assessed the proportions of patients aged 50 years or more with mild gallstone pancreatitis who underwent index or interval cholecystectomy in New South Wales during 2008–18; compared the outcomes of index and interval cholecystectomy (mortality, emergency re-admissions, total hospital length of stay); and examined factors associated with people aged 50 years or more undergoing interval cholecystectomy.

Methods

We undertook a retrospective cohort study of all people aged 50 years or more with mild gallstone pancreatitis who underwent cholecystectomy in NSW within twelve months of their index admission during 2008–18. In Australia, people over 50 years of age comprise 33.6% of the population, and the

Abstract

Objectives: To estimate the proportions of people aged 50 years or more with mild gallstone pancreatitis who undergo index cholecystectomy (during their initial hospital admission) or interval cholecystectomy (during a subsequent admission); to compare outcomes following index and interval cholecystectomy; and to identify factors associated with undergoing interval cholecystectomy.

Design, setting, participants: Analysis of linked hospitalisation and deaths data for all people aged 50 years or more with mild gallstone pancreatitis who underwent cholecystectomy in New South Wales within twelve months of their index admission, 1 July 2008 – 30 June 2018.

Main outcome measures: Cholecystectomy classification (index or interval). Secondary outcomes: all-cause mortality (30–365 days), emergency re-admissions with gallstone-related disease (within 28 or 180 days of discharge); hospital lengths of stay (index admission, and all admissions with gallstone-related disease over six months).

Results: A total of 1836 patients underwent index cholecystectomy (37.9%) and 3003 interval cholecystectomy (62.1%). Mortality to twelve months was similar in the two groups. Larger proportions of people who underwent interval cholecystectomy were re-admitted within 28 days (246, 8.2% v 23, 1.3%) or 180 days (527, 17.6% v 59, 3.2%), or required open cholecystectomy (238, 7.9% v 69, 3.8%). Mean index admission length of stay was longer for index than interval cholecystectomy (7.7 [SD, 4.7] days v 5.3 [SD, 3.9] days), but six-month total length of stay was similar (8.2 [SD, 5.6] days v 7.9 [SD, 5.8] days). Interval cholecystectomy was more likely for patients with three or more comorbid conditions (adjusted odds ratio [aOR], 1.29; 95% CI, 1.08–1.55) or private health insurance (aOR, 1.31; 95% CI, 1.13–1.51), and for those admitted to low surgical volume hospitals (aOR, 1.84; 95% CI, 1.03–3.31).

Conclusions: Most NSW people over 50 with mild gallstone pancreatitis did not undergo index cholecystectomy, despite recommendations in international guidelines. Delayed cholecystectomy was associated with more frequent open cholecystectomy procedures and gallstone disease-related emergency re-admissions, as well as with low or medium hospital surgical volume, comorbidity, and having private insurance.

proportion is growing by about 0.2 percentage points each year.¹¹ The Surgical Care of Older People (SCOPE) dataset comprises linked hospital (Admitted Patient Data Collection) and deaths (Register of Births, Deaths, and Marriages) data for all people aged 50 years or more admitted to public or private hospitals in NSW for surgery during 1 January 2007 – 1 July 2019. The Admitted Patient Data Collection includes data for all inpatient services provided in NSW public, private, and day-stay services, including demographic characteristics and information on diagnosis and procedures, coded according to the International Classification of Diseases and Related Health Problems, tenth revision, Australian modification

(ICD-10-AM)¹² and the Australian Classification of Health Interventions (ACHI).¹³

Case inclusion

We initially included data for all people aged 50 years or more who were admitted to hospital with a primary diagnosis of acute gallstone pancreatitis during 1 July 2008 – 30 June 2018 and underwent cholecystectomy within twelve months of their index admission. Index admission for acute gallstone pancreatitis was identified by the primary diagnosis ICD-10-AM codes K85.1 (biliary acute pancreatitis) and K85.9 (acute pancreatitis, unspecified).¹² We applied an 18-month exclusion period (1 January 2007 – 30 June 2008) to ensure that only first presentations with acute gallstone pancreatitis were included. People admitted after 30 June 2018 were excluded to ensure that 12-month follow-up data were available for all included patients.

Cholecystectomy was identified by the ACHI procedure codes 30443-00, 30445-00, 30446-00, 30448-00, 30449-00, 30454-01, 30455, and 90343.¹³ Patients for whom indicators of severe biliary pancreatitis were recorded, such as major pancreatic dissection (ACHI code 30577-00), cholecystostomy (30375-05), or admission to intensive care, were excluded. Patients with records of more than one cholecystectomy were excluded because their gallstone pancreatitis was unlikely to have been mild, or coding errors were probable.

Patients were divided into two groups: those who underwent index cholecystectomy (ie, cholecystectomy was performed during their initial admission with gallstone pancreatitis), and those who underwent interval cholecystectomy (cholecystectomy was performed during a subsequent admission, but within twelve months of their initial presentation).

Outcome measures

The primary outcome was cholecystectomy classification (index or interval). Secondary health outcomes included all-cause mortality within 30, 90, 180, and 365 days of cholecystectomy; emergency re-admissions with gallstone-related disease within 28 or 180 days of discharge from the index admission; index admission length of stay; and total six-month length of stay linked to gallstone-related disease.

Gallstone-related disease referred to any pathology related to cholelithiasis, and was defined by the ICD-10-AM codes for cholelithiasis/choledocholithiasis (K80.2, K80.5, K80.8), cholecystitis (K80.0, K80.1, K80.4, K81.0, K81.8, K81.9), cholangitis (K80.3, K83.0), pancreatitis (K85.1, K85.8, K85.9), obstruction, perforation, or fistulisation of the biliary tract (K83.1, K83.2, K83.3), spasm of the sphincter of Oddi (K83.4), and unspecified disease of the gallbladder or biliary tract (K82, K83.9).¹²

Hospital length of stay was defined as the number of days from the date of admission to the discharge date for the index episode of care. Hospital admissions that included multiple contiguous episodes of care for an event, and for which the separation codes indicated transfer to another hospital or type change transfer, were treated as single hospital stays for the total length of stay calculation. Records with lengths of stay more than three standard deviations beyond the mean value were excluded as indicating atypical care practices, the effects of rare complications, or coding errors.¹⁴

Covariates

Patient demographic characteristics included in our analysis were sex, age (50–64, 65–74, 75–84, 85 or more years), Charlson

comorbidity index score (zero, one or two, three or more comorbid conditions; identified using an ICD-10-AM coding algorithm¹⁵ with a one-year lookback period¹⁶), private health insurance status at time of admission, Socio-Economic Indexes for Areas Index of Relative Socio-economic Disadvantage (IRSD) quintile,¹⁷ and geographic classification (Accessibility/Remoteness Index of Australia [ARIA+]: major city, inner regional, outer regional, remote, very remote).¹⁸

Hospitalisation covariates were urgency of admission (planned, emergency), cholecystectomy type (laparoscopic, laparoscopic with bile duct exploration, open, open with choledochotomy, laparoscopic converted to open cholecystectomy), associated procedures or complications (cholangiogram [ACHI code 30439], endoscopic retrograde cholangiopancreatography with sphincterotomy [30485], biliary bypass [31472], repair of bile duct injury [30472]), surgical centre volume (annual number of cholecystectomies: low, fewer than 52; medium, 52–156; high, more than 156), and hospital types for index and surgery admissions (public tertiary, public non-tertiary, private).

Statistical analysis

We summarise demographic characteristics as descriptive statistics (means with standard deviations [SDs], medians with interquartile ranges [IQRs]), and assessed differences between the index and interval cholecystectomy groups in χ^2 tests (categorical variables), *t* tests (continuous variables), or Wilcoxon rank sum tests (non-parametric data). We assessed the influence of patient-level factors (age group, sex, comorbidity, insurance status, geographic classification) and hospital-level factors (surgical volume, hospital type) on the likelihood of interval cholecystectomy in multilevel multivariable logistic regression models, and report adjusted odds ratios (aORs) with 95% confidence intervals (CIs). We did not include socio-economic status in the model because it is linked with geographic location and private insurance status; hospitals were included as a random effect to account for clustering within hospitals. Model discrimination and fit were respectively assessed by calculating area under the receiver operating characteristic curve (AUC; values greater than 0.7 deemed acceptable discrimination) and the Akaike information criterion. Analyses were conducted in SAS Enterprise Guide 7.1.

Ethics approval

The NSW Population and Health Services Research Ethics Committee approved the study (2018HRE0201).

Results

Of 4839 patients who underwent cholecystectomy in 158 NSW hospitals, 1836 underwent index cholecystectomy (37.9%) and 3003 interval cholecystectomy (62.1%). The proportion of patients who underwent index cholecystectomy increased from 119 of 384 (31.0%) in 2008–09 to 233 of 585 (39.8%) in 2017–18 (mean annual change, 5.3%; 95% CI, 3.2–7.5%). The median time from index admission to cholecystectomy was three days (IQR, 0–6 days) for index cholecystectomy, and 56 days (IQR, 27–107 days) for interval cholecystectomy.

Patient, hospital, and clinical characteristics

Compared with patients who underwent index cholecystectomy, larger proportions of those who underwent interval cholecystectomy were men (52.1% *v* 48.9%), had other medical

conditions (one or two: 37.2% *v* 35.1%; three or more: 24.9% *v* 23.1%), and had private health insurance (35.7% *v* 32.5%). Age group, socio-economic status, and geographic location distributions were similar in the two groups (Box 1).

Compared with patients who underwent index cholecystectomy, larger proportions of people who underwent interval cholecystectomy were admitted to public non-tertiary (60.6% *v* 49.2%), low surgical volume (14.1% *v* 11.1%), and medium surgical volume hospitals (52.7% *v* 42.1%). Ninety-three patients who underwent index cholecystectomy (5.1%) and 54 who underwent interval cholecystectomy (1.8%) initially presented to private hospitals; 214 (11.7%) and 974 (32.4%) respectively underwent cholecystectomy at private hospitals (Box 2).

Laparoscopic cholecystectomy was performed in 4347 of 4839 cases (89.8%), including 1681 index (91.2%) and 2666 interval cholecystectomies (88.8%); bile duct exploration was more

frequently undertaken during index cholecystectomies (88, 4.7% *v* 99, 3.3%). Open cholecystectomy (129, 4.3% *v* 32, 1.7%) and conversion from laparoscopic to open cholecystectomy (109, 3.6% *v* 37, 2.0%) were more frequent for interval cholecystectomies. The proportion of completed open cholecystectomy procedures was larger for patients who underwent interval cholecystectomy (238, 7.9% *v* 69, 3.8%) (Box 2).

Clinical outcomes

Mortality at 30, 90, 180, and 365 days was similar for the index and interval cholecystectomy groups. The proportions of emergency re-admissions linked to gallstone disease were higher for patients who underwent interval cholecystectomy (28 days: 8.2% *v* 1.3%; 180 days: 17.6% *v* 3.2%). Mean index admission length of stay was longer for index than interval cholecystectomy (7.7 days; SD, 4.7 days *v* 5.3; SD, 3.9 days), but mean 6-month emergency re-admission (3.0 days; SD, 3.9 days *v* 3.2; SD, 4.1 days) and total

1 Index admission characteristics of people aged 50 years or more admitted to New South Wales hospitals with mild gallstone pancreatitis during 2008–18, who underwent cholecystectomy within twelve months of index admission

Characteristic	All patients	Index cholecystectomy	Interval cholecystectomy	P
Patients	4839	1836 [37.9%]	3003 [62.1%]	
Sex				0.029
Men	2464 (50.9%)	898 (48.9%)	1566 (52.1%)	
Women	2375 (49.1%)	938 (51.1%)	1437(47.9%)	
Age group (years)				0.11
50–64	1959 (40.5%)	735 (40.0%)	1224 (40.8%)	
65–74	1439 (29.7%)	523 (28.5%)	916 (30.5%)	
75–84	1127 (23.3%)	443 (24.1%)	684 (22.8%)	
85 or more	314 (6.5%)	135 (7.4%)	179 (6.0%)	
Charlson comorbidity index				0.028
0	1906 (39.4%)	767 (41.8%)	1139 (37.9%)	
1 or 2	1761(36.4%)	645 (35.1%)	1116 (37.2%)	
3 or more	1172 (24.2%)	424 (23.1%)	748 (24.9%)	
Private health insurance				0.003
Yes	1668 (34.5%)	596 (32.5%)	1072 (35.7%)	
No	2798 (57.8%)	1124 (61.2%)	1674 (55.7%)	
Missing data	373 (7.7%)	116 (6.3%)	257 (8.6%)	
Index of Relative Socio-economic Disadvantage ¹⁷ (quintiles)				0.75
1 (most disadvantaged)	1334 (28.2%)	500 (28.2%)	834 (28.3%)	
2	1221 (25.8%)	455 (25.6%)	766 (26.0%)	
3	906 (19.2%)	347 (19.5%)	559 (18.9%)	
4	630 (13.3%)	247 (13.9%)	383 (13.0%)	
5 (least disadvantaged)	636 (13.5%)	227 (12.8%)	409 (13.9%)	
Missing data	112 (2.3%)	60 (3.3%)	52 (1.7%)	
Geographic location ¹⁸				0.06
Major city	3257 (69.0%)	1254 (70.6%)	2003 (67.8%)	
Inner regional	1147 (24.5%)	417 (23.5%)	730 (24.7%)	
Outer regional/remote/very remote	325 (6.9%)	105 (5.9%)	220 (7.5%)	
Missing data	110 (2.3%)	60 (3.3%)	50 (1.7%)	

2 Admission, procedure, and hospital characteristics for people aged 50 years or more admitted to New South Wales hospitals with mild gallstone pancreatitis during 2008–18, who underwent cholecystectomy within twelve months of index admission

Characteristic	All patients	Index cholecystectomy	Interval cholecystectomy	P
Patients	4839	1836 [37.9%]	3003 [62.1%]	
Urgency of admission				< 0.001
Emergency	4586 (95.4%)	1658 (90.8%)	2928 (98.2%)	
Planned	222 (4.6%)	169 (9.3%)	53 (1.8%)	
Missing data	31	9 (0.5%)	22 (0.7%)	
Surgery type				< 0.001
Laparoscopic cholecystectomy	4347 (89.8%)	1681 (91.2%)	2666 (88.8%)	
Laparoscopic cholecystectomy with bile duct exploration	185 (3.8%)	86 (4.7%)	99 (3.3%)	
Open cholecystectomy	137 (2.8%)	19 (1.0%)	118 (3.9%)	
Open cholecystectomy with choledochotomy	24 (0.5%)	13 (0.7%)	11 (0.4%)	
Laparoscopic converted to open cholecystectomy	146 (3.0%)	37 (2.0%)	109 (3.6%)	
Other procedures				
Cholangiogram (any use)	4145 (85.6%)	1666 (90.7%)	2479 (82.6%)	< 0.001
ERCP sphincterotomy (any use)	822 (17.0%)	303 (16.5%)	519 (17.3%)	0.48
ERCP sphincterotomy (index admission only)	595 (12.3%)	277 (15.1%)	318 (10.6%)	< 0.001
Biliary bypass	6 (0.1%)	< 5	< 5	
Repair of bile duct injury	6 (0.1%)	< 5	< 5	
Surgical volume (number per year)				< 0.001
Low (fewer than 52)	627 (13.0%)	204 (11.1%)	423 (14.1%)	
Medium (52–156)	2353 (48.6%)	772 (42.1%)	1581 (52.7%)	
High (more than 156)	1859 (38.4%)	860 (46.8%)	999 (33.3%)	
Admission hospital type				< 0.001
Public, tertiary referral	1967 (40.6%)	839 (45.7%)	1128 (37.6%)	
Public, non-tertiary	2725 (56.3%)	904 (49.2%)	1821 (60.6%)	
Private	147 (3.0%)	93 (5.1%)	54 (1.8%)	
Surgery hospital type				< 0.001
Public, tertiary referral	1677 (34.7%)	836 (45.5%)	841 (28.0%)	
Public, non-tertiary	1974 (40.8%)	786 (42.8%)	1188 (39.6%)	
Private	1188 (24.6%)	214 (11.7%)	974 (32.4%)	

ERCP = endoscopic retrograde cholangiopancreatography. ♦

6-month hospital lengths of stay (8.2 days; SD, 5.6 days *v* 7.9; SD, 5.8 days) were each similar for the two groups (Box 3).

Multilevel multivariable logistic regression analysis

After adjusting for clustering by admission hospital, having private health insurance (aOR, 1.31; 95% CI, 1.13–1.51) or three or more comorbid conditions (aOR, 1.29; 95% CI, 1.08–1.55) were associated with undergoing interval cholecystectomy. The likelihood of interval cholecystectomy was also higher for people with one or two comorbid conditions (aOR, 1.20; 95% CI, 1.03–1.40) and men (aOR, 1.16; 95% CI, 1.02–1.33). Conversely, the likelihood of interval cholecystectomy declined with age group (85 years or more *v* 50–64 years: aOR, 0.62; 95% CI, 0.47–0.83) (Box 4).

Interval cholecystectomy was more likely for people whose index admissions were to medium (aOR, 2.41; 95% CI, 1.24–4.66) or low volume hospitals (aOR, 1.84; 95% CI, 1.03–3.31), but less

likely if the index admission was to a private hospital (aOR, 0.19; 95% CI, 0.09–0.39). Geographic classification of residence did not influence the likelihood of interval cholecystectomy (Box 4), but was retained in the model as it enhanced model fit. The fully adjusted model provided adequate statistical discrimination (AUC, 0.71).

Discussion

We have reported the first population-based retrospective cohort study to examine index and interval cholecystectomy for people aged 50 years or more with mild gallstone pancreatitis in Australia. The proportion of patients who underwent index cholecystectomy increased from 31.0% in 2008–09 to 39.8% in 2017–18. Interval cholecystectomy was performed with considerable delay, the median time from index admission to surgery being 56

3 Outcomes for people aged 50 years or more admitted to New South Wales hospitals with mild gallstone pancreatitis during 2008–18, who underwent cholecystectomy within twelve months of their index admission

Characteristic	All patients	Index cholecystectomy	Interval cholecystectomy	P
Patients	4839	1836	3003	
Deaths				
30 days	< 5	< 5	< 5	
90 days	16 (0.3%)	6 (0.3%)	10 (0.3%)	0.97
180 days	39 (0.8%)	13 (0.7%)	26 (0.9%)	0.55
365 days	87 (1.8%)	34 (1.8%)	53 (1.8%)	0.82
Emergency re-admissions (gallstone-related)				
Within 28 days	269 (5.6%)	23 (1.3%)	246 (8.2%)	< 0.001
1 admission	254 (5.3%)	23 (1.3%)	231 (7.7%)	
2 admissions	14 (0.3%)	< 5	14 (0.5%)	
3 admissions	< 5	< 5	< 5	
Within 180 days	586 (12.1%)	59 (3.2%)	527 (17.6%)	< 0.001
1 admission	504 (10.4%)	53 (2.9%)	451 (15.0%)	
2 admissions	71 (1.5%)	5 (0.3%)	66 (2.2%)	
3 or more admissions	11 (0.3%)	< 5	10 (0.3%)	
Length of stay (days), mean (SD)				
Index admission*	6.2 (4.3)	7.7 (4.7)	5.3 (3.9)	< 0.001
Six-month total (excluding index admission)†	3.2 (4.1)	3.0 (3.9)	3.2 (4.1)	0.61
Six-month total (including index admission)‡	8.0 (5.7)	8.2 (5.6)	7.9 (5.8)	0.08
Length of stay (days), median (IQR)				
Index admission	5 (3–8)	7 (4–10)	4 (3–7)	< 0.001
Six-month total (excluding index admission)	2 (1–4)	2 (0–4)	1 (1–4)	0.07
Six-month total (including index admission)	7 (4–10)	7 (5–10)	6 (4–10)	< 0.001

IQR = interquartile range; SD = standard deviation. * Excludes 73 patients (1.5%; index, 48 [2.6%]; interval, 25 [0.8%]) for whom length of stay was more than three standard deviations above the mean. † Excludes 41 patients (0.8%; index, five [0.3%]; interval, 36 [1.2%]) for whom length of stay was more than three standard deviations above the mean. ‡ Excludes 81 patients (1.7%; index, 27 [1.5%]; interval, 54 [1.8%]) for whom length of stay was more than three standard deviations above the mean. ◆

days (three days for index cholecystectomy). Although mortality and cumulative six-month length of hospital stay after index and interval cholecystectomy were similar, the proportions of patients with emergency gallstone-related re-admissions and for whom conversion to an open procedure was required were each higher for people who underwent delayed cholecystectomy.

Delayed cholecystectomy is a deferral of definitive management of gallstones and increases the risk of recurrent biliary events that require re-admission.^{19–21} Two-year re-admission rates as high as 44% have been reported for people aged 65 years or more.¹⁰

Earlier studies found that rates of operative complications, open conversion, and mortality were similar following index and delayed cholecystectomy for mild gallstone pancreatitis.^{21–23} We found that, for people aged 50 years or more, open cholecystectomy and laparoscopic conversion to open cholecystectomy were each more common when cholecystectomy was delayed. This may be partially attributable to recurrent episodes of gallstone-related disease and delays in definitive management. Chronic inflammation and subsequent complicated biliary disease and intra-abdominal adhesions may make the laparoscopic approach more difficult. The risk of open cholecystectomy is particularly relevant in older people, for whom recovery from

an open procedure is more challenging, given the increased risk of post-operative complications and the longer recovery time.²⁴

We identified several service and patient factors that influence the likelihood of interval cholecystectomy. The association between low and medium surgical volume and interval cholecystectomy probably reflects lower surgeon availability and lack of access to dedicated emergency surgery operating time in public hospitals, particularly in lower volume centres. This situation does not conform with the key principle that emergency surgery capacity be matched to predicted local emergency case load.²⁵ This model, employed by many metropolitan acute surgical units, has been validated in Australian rural centres,²⁶ and our findings possibly indicate systemic problems with the delivery of regional emergency general surgery.

While most people with gallstone pancreatitis in NSW present to public hospitals, those with private health insurance can choose private surgery, which may be available earlier and reduce demand on the public health system. But for people without private health insurance, it is essential that the public health system be able to deliver high quality care. The association of comorbidity with interval cholecystectomy reflects the fact that surgeons must balance immediate peri-operative risk against

4 Likelihood of people aged 50 years or more admitted to New South Wales hospitals with mild gallstone pancreatitis during 2008–18 undergoing interval cholecystectomy: multilevel multivariable logistic regression analysis

Characteristic	Adjusted odds ratio* (95% CI)
Age group (years)	
50–64	1
65–74	0.98 (0.83–1.15)
75–84	0.83 (0.69–0.99)
85 or more	0.62 (0.47–0.83)
Sex (men)	1.16 (1.02–1.33)
Charlson Comorbidity Index	
0	1
1 or 2	1.20 (1.03–1.40)
3 or more (multimorbidity)	1.29 (1.08–1.55)
Private health insurance	1.31 (1.13–1.51)
Geographic location	
Major city	1
Inner regional	0.97 (0.74–1.27)
Outer regional/remote/very remote	0.94 (0.64–1.38)
Hospital referral status	
Public, tertiary referral	1
Public, non-tertiary	0.93 (0.53–1.61)
Private	0.19 (0.09–0.39)
Surgical volume (number per year)	
Low (less than 52)	1.84 (1.03–3.31)
Medium (52–156)	2.41 (1.24–4.66)
High (more than 156)	1

CI = confidence interval. * Adjusted for clustering by admission hospital (random effect). ◆

the risks of future re-admission and operative complications. Delaying cholecystectomy would only be warranted clinically if improvement of comorbid conditions was considered possible.

Limitations

Several limitations are inherent to analyses of administrative data, including the assumption that the databases are complete and accurate, particularly with respect to coding of diagnoses and

procedures. Private health insurance, socio-economic position, geographic location, and urgency of admission data were not recorded for some patients, who were therefore not included in the corresponding analyses. Further, as direct measures of acute pancreatitis severity according to the revised Atlanta Classification,²⁷ such as organ failure and local or systemic complications, were not available, we used other indicators of severe gallstone pancreatitis (major pancreatic resection, cholecystostomy, intensive care unit admission) to define severe cases for exclusion. Some mild cases of gallstone pancreatitis may have thereby been excluded, or moderately severe to severe cases included; patients with complications that sometimes necessitate intensive care, such as bile duct injury and biliary bypass surgery, may also have been excluded. We did not compare the characteristics and outcomes for people who did and did not undergo cholecystectomy.

Conclusion

During 2008–18, fewer than 40% of people in NSW aged 50 years or more with mild gallstone pancreatitis underwent cholecystectomy during their index admissions, despite international guidelines recommending this strategy. The proportion undergoing index cholecystectomy has increased in recent years, but is still below 50%. Patients who underwent delayed cholecystectomy were at greater risk of requiring open cholecystectomy and emergency re-admissions during the following six months. Despite the generally higher risk associated with surgery in people aged 50 or more,²⁸ cholecystectomy for mild gallstone pancreatitis should be performed, when possible, during the index admission. Accordingly, patient-, service-, and surgeon-related factors implicated in delaying cholecystectomy should be further investigated, ideally using a standardised quality improvement approach.²⁵

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