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ORIGINAL ARTICLE

Mortality after a cholecystectomy: a population-based study

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Abstract

Background: The trade-off between the benefits of surgery for gallstone disease for a large population and the risk of lethal outcome in a small minority requires knowledge of the overall mortality.

Methods: Between 2007 and 2010, 47 912 cholecystectomies for gallstone disease were registered in the Swedish Register for Cholecystectomy and endoscopic retrograde cholangiopancreatography (ERCP) (GallRiks). By linkage to the Swedish Death Register, the 30-day mortality after surgery was determined. The age- and sex-standardized mortality ratio (SMR) was estimated by dividing the observed mortality with the expected mortality rate in the Swedish general population 2007. The Charlson Comorbidity Index (CCI) was estimated by International Classification of Diseases (ICD) codes retrieved from the National Patient Register.

Results: Within 30 days after surgery, 72 (0.15%) patients died. The 30-day mortality was close [SMR = 2.58; 95% confidence interval (CI): 2.02–3.25] to that of the Swedish general population. In multivariable logistic regression analysis, predictors of 30-day mortality were age >70 years [odds ratio (OR) 7.04, CI: 2.23–22.26], CCI > 2 (OR 1.93, CI: 1.06–3.51), American Society of Anesthesiologists (ASA) > 2 (OR 13.28, CI: 4.64–38.02), acute surgery (OR 10.05, CI:2.41–41.95), open surgical approach (OR 2.20, CI: 1.55–4.69) and peri-operative complications (OR 3.27, CI: 1.74–6.15).

Discussion: Mortality after cholecystectomy is low. Co-morbidity and peri-operative complications may, however, increase mortality substantially. The increased mortality risk associated with open cholecystectomy could be explained by confounding factors influencing the decision to perform open surgery.

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Introduction

Background rationale

One of the most common procedures in routine surgical practice,[1] a cholecystectomy, for gallstone disease is generally associated with a low risk for major adverse events.[2,3] Nevertheless, post-operative mortality after surgery for a benign condition, although rare, is considered less acceptable than mortality after surgery for a potentially lethal disease. In population-based studies, the risk for post-operative mortality after a cholecystectomy for gallstone disease has been estimated to be between 0.1% and 0.7%.[4–8] Mortality rates were not substantially affected by the introduction of a laparoscopic cholecystectomy (LC).[7] Factors such as high age,[5,9] acute admission[10] and factors indicating underlying co-morbidity[10] are considered risk factors for post-operative mortality after a cholecystectomy.

Previous studies have largely been based on hospital-administration databases or national registers providing limited information on patient characteristics and factors related to the surgical technique.[4–7] Furthermore, many patients with gallstone disease undergo a cholecystectomy on an outpatient basis and may not be registered in national databases.[4–7] Finally, it is unclear how the mortality rates found in previous studies compare with mortality in a reference general population.[5–8]

Objectives

The aim of the present study was to evaluate the risk for post-operative mortality after a cholecystectomy using a nationwide

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prospective population-based biliary surgery register, and to compare this with the Swedish general population. We also aimed to clarify the role of patient- and surgically-related factors in predicting mortality after gallbladder surgery.

Material and methods

Study design

Established in 2005, the Swedish Register for Cholecystectomy and endoscopic retrograde cholangiopancreatography (ERCP) (GallRiks) has collected standardized data on the indications, complications and outcome of gallbladder surgery on a national basis.[11,12] Since 2007, more than 95% of all cholecystectomies performed in Sweden have been recorded in GallRiks. All cholecystectomies are registered online by the surgeon responsible for the procedure. Registered data include the unique national registration number (NRN)[13] which identifies each resident in Sweden, gender, medical history, American Society of Anesthesiologists (ASA) classification, surgical indication, type of procedure and peri-operative complications. Patient notes are reviewed by the local coordinator at each unit in order to register the occurrence of any post-operative adverse events within 30 days after surgery. The register is validated each year by blinded reassessment of a randomly selected sample of patient notes. The prevalence of errors so far has been lower than 2%.

Setting

Patients registered in GallRiks between 2007 and 2010 constituted the study population. The Charlson Co-morbidity Index (CCI) was estimated by obtaining International Classification of Diseases (ICD) codes from the National Patient Register.[14]

Participants

Between 2007 and 2010, 50 019 cholecystectomies were registered in GallRiks. After exclusion of patients with incorrect NRN, missing information on gender, age <18 years, those with malignancy in the biliary tract and individuals undergoing subtotal cholecystectomy, 47 912 patients who underwent a cholecystectomy because of gallstone disease remained for analyses. The study was approved by the Regional Ethics Committee in Stockholm, Sweden. All participants were informed about the registration.

Data sources and measurement

Using the NRN, linkage was made to the Swedish Death Register to identify all deaths that occurred within the first 30 days after surgery.

Bias

Multivariate logistic regression analysis was used to adjust for potential confounding from variables influencing post-operative mortality.

Study size

The study size was determined by the number of procedures registered in GallRiks. The size was expected to be sufficient to identify the most important factors influencing post-operative mortality and to calculate standardized mortality ratio.

Criteria for cause of death

As all analyses were based on anonymized files, we were not able to determine the cause of death from the death certificates. However, we had access to the ICD codes from the death certificates, which served as a base for defining cause of death. If the death certificate stated ICD codes related to gallstone disease (K80-K87) or liver failure (K72) as cause of death, the cause of death was classified as related to the gallstone disease. The same categorization was applied if the death certificate stated a non-specific cause of death (R68.8, R09.2, I16.9, I97 and J96.9) and gallstone disease (K80-K87) as a contributing factor. If septicaemia (A41.9) without any other surgery-related diagnosis as contributing factor was defined as cause of death, the cause of death was classified as related to complications to the gallstone disease. If the death certificate stated chronic ischaemic heart disease (I25), myocardial infarct (I21), cerebral bleeding (I61) or pulmonary oedema (J81) as the cause of death, the main cause of death was defined as cardiovascular. If septicaemia (A41.9) without any gallstone-related code was stated and no direct relation to the gallstone disease or surgical procedure was indicated, the cause of death was defined as infectious. If bleeding (R58.9), disease in the circulatory system after surgery (I97), post-operative bleeding (T81.0) or post-operative infection (T81.4) was stated as cause of death in the death certificate, the cause of death was defined as a post-operative complication. The cause of death was only attributed to the procedure per se if the death certificate stated a complication as the main cause of death or as contributing factor. If the death certificate stated a non-specific cause of death (R68.8) and gallstone disease (K80-K87) as contributing factor, the cause of death was classified as related to complications to the gallstone disease. If there was only a non-specific code, the cause of death was unclear. Where the cause was obvious from the death certificate (malignant disease, pulmonary embolism, infectious disease, chronic obstructive pulmonary disease, or bleeding duodenal ulcer or trauma), the main diagnosis was considered the cause of death.

Statistical analysis

All analyses were performed with an anonymized data file. Poisson regression was used to calculate the 30-day age- and sex-standardized mortality ratio (SMR) with the corresponding 95% confidence interval (CI) using the expected mortality rate extrapolated from the Swedish general population in 2007 as a reference.

Multivariable logistic regression was used to calculate the odds ratios (OR) and the corresponding 95% CI for the impact of each predictor on the risk for death after a cholecystectomy. The predefined model included gender, age (<50 years, 50–70 years and >70 years), American Society of Anesthesiologists (ASA) classification (1–2, 3–5), indication for surgery (uncomplicated gallstone

Table 1 Baseline characteristics of 47 912 patients who underwent a cholecystectomy because of gallstone disease 2006–2010 in Sweden

	Mortality within 30 days	*N*
Gender		
Women	32 (0.099%)	32 429
Men	40 (0.258%)	15 482
Data missing	0 (0%)	1
Age		
<50	4 (0.017%)	23 123
50–70	16 (0.084%)	19 122
>70	52 (0.918%)	5 665
Data missing	0 (0%)	2
Charlson co-morbidity Index		
0–2	56 (0.112%)	46 776
>2	16 (1.408%)	1 136
ASA		
1	5 (0.018%)	27 031
2	17 (0.096%)	17 706
3–5	50 (1.588%)	3 149
Data missing	0 (0%)	26
Indication		
Gallstone pain	12 (0.041%)	29 279
Pancreatitis, cholecystitis or jaundice	60 (0.322%)	18 633
Acute/planned surgery		
Planned	14 (0.038%)	36 721
Acute	58 (0.518%)	11 191
Surgical approach		
Laparoscopic (including conversion)	25 (0.059%)	42 366
Open	47 (0.847%)	5 546
Per-operative complications		
No	59 (0.128%)	46 022
Yes	13 (0.688%)	1 890

ASA, American Society of Anesthesiologists.

disease, gallstone disease with complication (cholecystitis, gallstone-related pancreatitis or common bile duct stone), mode of admission (planned/acute), surgical approach (laparoscopic, open, conversion), operation time (<90, ≥90 min), CCI and peri-operative complications. Acute surgery was defined as a procedure performed during an ongoing episode of acute cholecystitis, acute pancreatitis or obstructive jaundice.

Results

Participants

Between 2006 and 2010, 50 019 cholecystectomies were registered in the Swedish Register for Cholecystectomy and ERCP (GallRiks), of which 47 912 met the inclusion criteria (Table 1).

Table 2 Causes of death (patients who died within 30 days after surgery)

	N	%
Deaths due to gallstone disease	36	50.0
Cardiovascular diseases	15 (0.099%)	20.8
Postoperative complications	7	9.7
Malignant diseases	4	5.6
Pulmonary embolism	2	2.8
Duodenal ulcer bleeding	1	1.4
Infectious disease	1	1.4
Chronic Obstructive Pulmonary disease	1	1.4
Pneumonia	1	1.4
Trauma	1	1.4
Unclear	3	4.2
Total	72	100

Descriptive data

In total, 72 (0.15%) patients died within the first 30 days after surgery. Causes of death are presented in Table 2. Of those who died within 30 days, 35 patients (48.6%) were re-admitted at least once after the surgical procedure.

Outcome data

The 30-day mortality was slightly elevated in comparison with the age- and gender-matched background population (SMR = 2.58; 95% CI: 2.02–3.25].

Main results

The effect of different predictors on post-operative mortality was analysed in a multivariable logistic regression model (Table 3). Mortality was higher in patients aged >70 years (OR 7.04, CI: 2.23–22.26), patients with CCI 3 or higher (OR 1.93, CI: 1.06–3.51), ASA III or higher (OR 13.28, CI: 4.64–38.02), patients undergoing acute surgery (OR 10.05, CI: 2.41–41.95), open surgery (OR 2.20, CI: 1.55–4.69) and those suffering peri-operative complications (OR 3.27, CI: 1.74–6.15).

Discussion

Key results

In this nationwide population-based cohort study, 30-day mortality after a cholecystectomy due to gallstone disease was low. This mortality rate was no different to that of the age- and gender-matched Swedish general population. Some risk factors, however, were seen in these patients.

Limitations

Some methodological aspects deserve attention. The prospective collection of data on clinically relevant factors, the nationwide and population-based design with almost complete coverage of all patients undergoing cholecystectomy in Sweden and the validation of data strengthen the outcome of the present study. The

Table 3 Odds ratios and 95% confidence intervals of the association between predictors and 30-day mortality after a cholecystectomy

	OR	95% CI
Gender		
Woman	1	Ref
Man	1.20	0.74–1.96
Age		
<50	1	Ref
50–70	2.12	0.67–6.74
>70	7.04	2.23–22.26
Charlson co-morbidity Index		
0–2	1	Ref
>2	1.93	1.06–3.51
ASA		
1	1	Ref
2	1.98	0.658–5.77
3–5	13.28	4.64–38.02
Indication		
Gallstone pain	1	Ref
Pancreatitis, cholecystitis or jaundice	0.28	0.06–1.26
Acute/planned surgery		
Planned	1	Ref
Acute	10.05	2.41–41.95
Surgical approach		
Laparoscopic (including conversion)	1	Ref
Open	2.20	1.55–4.69
Peri-operative complications		
No	1	Ref
Yes	3.27	1.74–6.15

ASA, American Society of Anesthesiologists.

completeness of follow-up was assured by linkage to the Swedish Death Register which secured identification of all deaths occurring within 30-day after a cholecystectomy. However, this study has some limitations. We could not fully assess the exact circumstances behind the surgery and subsequent care in patients who died post-operatively, and consequently some of the deaths might not have been directly associated with surgery itself. The causes of death were determined from the ICD codes of the death certificates. Even if the exact cause of death was uncertain in some cases, the ICD codes of the death certificates have a higher validity than the discharge notes.[15] For patients who died from the gallstone disease or surgery-related complications, the specific cause could not be determined.

In agreement with the results of Rosenmüller *et al.*,[4] there were large discrepancies in SMR as regards the surgical approach; the mortality being higher than expected among patients undergoing OC and lower than expected in patients undergoing LC. Although adjusting for age, ASA classification and surgical indication, we did not have information on some important factors such as body mass index, previous abdominal surgery and liver cirrhosis that might have affected the decision on surgical approach and the subsequent outcome of surgery. The underlying cause of death has commonly been described to be factors related to patient co-morbidity rather than post-operative complications. In the present study, 11% of deaths within 30 days of surgery were as a result of post=-operative complications. Scollay *et al.* reported[5] that post-operative medical complications such as cardiac failure, respiratory and renal failure were more common causes of death than surgical complications such as bleeding or septicaemia. These results suggest more careful selection when choosing patients for surgery.

Interpretation

High age, underlying co-morbidity, acute surgery and peri-operative complications were risk factors for post-operative mortality after a cholecystectomy. Even if the absolute mortality risk was low, there is a mortality rate that should not be neglected. The benefit from surgery for benign conditions should be considered in relation to the risk of rare but severe complications.

Previous studies[2,3,8,9] have concluded that there is an increased mortality risk for patients with acute disease and urgent surgery. The results in our study are in line with these studies although not achieving statistical significance. These parameters, however, are generally assumed to be risk factors for post-operative mortality.

Generalizability

In conclusion, in this nationwide population-based cohort study, post-operative mortality after a cholecystectomy as a result of gallstone disease was low. The low mortality rate might be explained by careful selection of patients for surgery. Nevertheless, attention should be given to risk factors, such as high ASA score, high age and post-operative complications. Improved medical management and attention to patient care processes may reduce mortality after gallbladder surgery.

Conflict of interest

None declared.

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