








Costs of elective vs emergency cholecystectomy in diabetic patients

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Abstract

Introduction: Hospitalization costs of diabetic patients are estimated to be higher than non-diabetic. Literature on the topic is however limited. The aim of this study was to compare the costs of elective and emergency cholecystectomy of diabetic and non-diabetic patients. **Material and methods:** A retrospective analysis involved diabetic versus non-diabetic age- and sex-matched patients who underwent emergency and elective cholecystectomy at a single center in Poland between 2016-2019. **Results:** The total costs of an elective cholecystectomy were 739.31 ± 423.07 USD for diabetic patients and 797.14 ± 772.24 USD for non-diabetic patients ($p = 0.51$). Whereas emergency cholecystectomy total costs were 3950.72 ± 2856.83 USD (diabetic patients) and 2464.31 ± 1718.21 USD (non-diabetic patients) ($p = 0.04$). The difference in total costs between elective cholecystectomy vs emergency cholecystectomy in both groups (diabetic vs non-diabetic patients) was statistically significant ($p < 0.01$ vs $p < 0.05$ respectively). **Conclusions:** In this study we demonstrated that emergency cholecystectomy is associated with a significant increase in hospitalization costs, particularly in diabetic patients. This suggests that early qualification of diabetic patients for an elective cholecystectomy could be beneficial for both diabetic patients and public health insurers.

Keywords: diabetes · elective cholecystectomy · emergency cholecystectomy · costs of hospitalization

Citation

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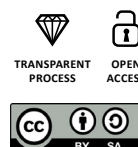
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Introduction

According to the latest World Health Organization data, the estimated number of people suffering from diabetes worldwide is 422 million and the incidence of diabetes is increasing rapidly [1]. Because of its many complications, diabetes mellitus is associated with significant costs in public healthcare systems around the globe [2,3]. Acute cholecystitis in diabetic patients is often complicated by gangrenous cholecystitis [1], peritonitis, preoperative perforation, impaired wound healing, infections, increased risk of cardiovascular events and renal failure [4–11]. For this reason, diabetic patients hospitalisation costs are estimated to be higher than non-diabetic. Literature on the topic is limited and mostly concludes that immediate intervention leads to a decrease in costs and shortens the length of hospital stay [12–16]. The aim of this study was to compare the costs of elective and emergency cholecystectomy of diabetic and non-diabetic patients.

Materials and methods

A retrospective analysis involved patients who underwent emergency and elective cholecystectomy at the Department of General, Endocrine and Transplant

Surgery of University Clinical Center in Gdańsk (Poland) between 2016 and 2019. Patients were assigned to diabetic group whenever diabetes mellitus of any type was identified in admission work-up. Using institutional registries we identified a total of 661 patients who underwent emergency cholecystectomy, of whom 70 patients had diabetes and 591 were non-diabetic. A random sample of 16 diabetic patients was included to the study depending on admission data criteria and was used to assign an age- and sex-adjusted control group.

A total of 1608 patients who underwent elective cholecystectomy were identified in institutional registries, of whom 135 had diabetes and 1473 were non-diabetic patients. A random sample of 20 diabetic patients were included to the study depending on admission data criteria. The control group of 80 patients was age- and sex-matched in a 4:1 ratio (Non-diabetic: Diabetic) (see Figure 1, Table 1).

The following were the criteria of inclusion into the study: unplanned or planned admission depending on group, cholecystectomy performed within 72 h of admission, and the availability of complete report of hospitalization costs in the electronic system. Patients were assigned to the diabetic group whenever diabetes mellitus of any type was identified in the admission work-up. The exclusion criteria included the lack of data on the costs of hospitalization, incomplete

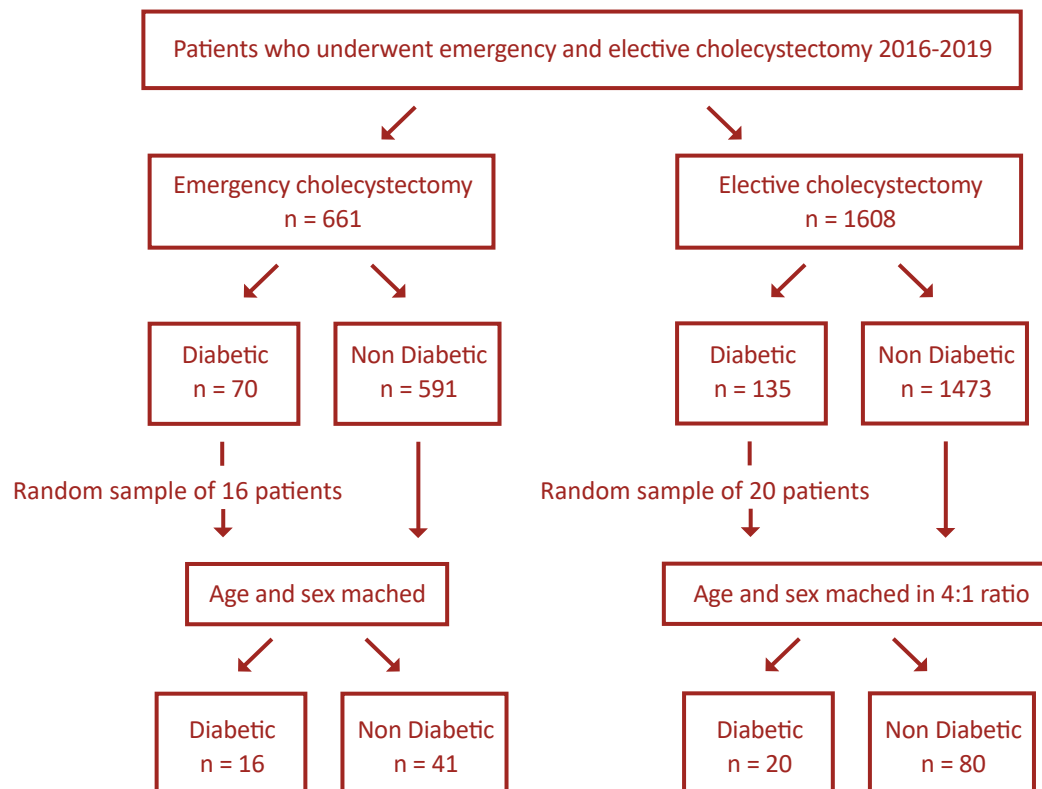


Figure 1. Flowchart illustrating patient selection

Table 1. Age distribution of patients in the emergency vs elective cholecystectomy group

Age	Diabetic	Non-diabetic	Diabetic	Non-diabetic
> 40	1	5	1	6
41-60	7	16	11	44
61-80	7	15	8	30
> 80	1	5	0	0

data on time or course of hospitalization, more than one surgery performed that was not related to cholecystectomy and its complications during the same hospitalization, cholecystectomy performed during hospitalization for a different reason.

Calculation of the direct costs of the Emergency Department included: medical imaging, medicines, consultations, laboratory tests, procedures performed and equipment. Whereas the General Surgery Department costs taken into account (in emergency and elective cholecystectomy) were: medical imaging, medicines, consultations, histopathology, laboratory works, procedures performed, equipment, operating room cost, cost of stay. Total costs of emergency cholecystectomy were a sum of costs incurred at the Emergency and General Surgery Departments. Total hospitalization costs taken into account for elective cholecystectomy were all generated at the General Surgery Department. Costs were converted from Polish Złoty (PLN) to US Dollars (USD) using the National Bank of Poland exchange rates from 11 September 2019. Descriptive analysis included medians, means and standard deviations. In comparative analysis U Mann-Whitney test, Student's t-test and the X^2 test were used. Distribution was tested using Shapiro-Wilk test. Statistical significance was accepted at $p < 0.05$. Statistical analyses were performed using Statistica 13.3 (TIBCO Software, Palo Alto, United States).

Results

A group of 57 patients (16 with diabetes and 41 non-diabetic) who underwent emergency cholecystectomy was analyzed. A total of 100 patients who underwent elective cholecystectomy were included to the study, 20 patients with diabetes and 80 patients without. Patients were matched in the group by age and sex. In the emergency group the access

to viable data from the point of admission was limited, and therefore group size was limited as well. The downgrading of data quality was ruled out by the mean group size.

Total hospitalization cost

In a group of patients who underwent elective cholecystectomy, the total costs for diabetic patients were 739.31 ± 423.07 USD [median: 536.15 USD; range: 287.20 USD – 1606.67 USD] and for non-diabetic was 797.14 ± 772.24 USD ($p = 0.51$)

[median: 651.47 USD; range: 281.75 – 6089.41 USD]. In a group of patients who underwent emergency cholecystectomy total costs for diabetic patients were 3950.72 ± 2856.83 USD [median: 3188.67 USD; range: 753.23 – 10760.15 USD] and 2464.31 ± 1718.21 USD ($p = 0.04$) [median: 2087.56 USD; range: 689.26 USD – 10950.16 USD] for non-diabetic patients. The difference in total costs between elective cholecystectomy and emergency cholecystectomy in both groups (diabetic and non-diabetic patients) was statistically significant ($p < 0.01$, $p < 0.05$ respectively) (see Table 2 and Table 3).

Table 2. Mean emergency ward costs in emergency cholecystectomy group

	Diabetic	Non-diabetic	p-value
Medical imaging	79.52 USD	50.29 USD	0.495
Consultations	31.13 USD	23.55 USD	0.356
Procedures	32.64 USD	35.33 USD	0.670
Laboratory tests	23.24 USD	20.91 USD	0.477
Medicines	3.47 USD	4.88 USD	0.279
Equipment	8.35 USD	6.12 USD	0.657
Other	0 USD	0 USD	0.000
Total*	178.48 USD	141.20 USD	0.505

*Due to the applied approximations, individual costs cannot be summed up to a total cost.

Table 3. Mean general surgery ward costs in emergency vs planned cholecystectomy group

	Diabetic	Non-diabetic	p-value	Diabetic	Non-diabetic	p-value
Cost of stay	1416.86 USD	758.01 USD	0.015	329.19 USD	424.29 USD	0.829
Operation room	628.81 USD	577.49 USD	0.676	605.53 USD	566.15 USD	0.113
Histopathology	31.56 USD	11.24 USD	0.901	9.40 USD	11.05 USD	0.595
Laboratory tests	73.86 USD	29.13 USD	0.012	11.96 USD	15.14 USD	0.510
Medicines	371.23 USD	178.93 USD	0.083	17.42 USD	34.10 USD	0.561
Medical imaging	87.28 USD	34.47 USD	0.066	0 USD	0 USD	0.000
Equipment	252.53 USD	98.09 USD	0.001	61.44 USD	63.59 USD	0.638
Consultations	26.36 USD	12.02 USD	0.050	0 USD	0 USD	0.000
Other	68.02 USD	18.50 USD	0.038	0 USD	0 USD	0.000
Total hospitalization*	3950.72 USD	2464.31 USD	0.040	739.31 USD	797.14 USD	0.515

*Due to the applied approximations, individual costs cannot be summed up to a total cost.

Procedure-related costs

Procedure-related costs included General Surgery Department procedures plus costs of operating theatre (Table 3). Procedure costs in the emergency group were 724.60 ± 416.92 USD for diabetic patients and 625.26 ± 304.78 USD for non-diabetic patients ($p = 0.613$). Elective cholecystectomy group costs were 605.53 ± 246.04 USD for diabetic patients and 566.15 ± 325.37 USD for non-diabetic patients, $p = 0.113$. Differences in procedural costs between patients in diabetic and non-diabetic groups undergoing emergency cholecystectomy and those who underwent planned cholecystectomy were not statistically-significant, $p = 0.824$ and $p = 0.992$ respectively.

Other costs

Medical imaging costs were only applicable to the emergency cholecystectomy group and at the General Surgery Department they were 87.28 ± 152.21 USD for diabetic patients and 34.47 ± 70.87 USD for non-diabetic patients, $p = 0.066$. Whereas at the Emergency Department they were 79.52 ± 103.90 USD for diabetic patients and 50.29 ± 75.10 USD for non-diabetic,

$p = 0.495$. Other types of costs were not statistically significant with all p-values greater than 0.05 (see Table 2 and Table 3).

Length of stay

Mean length of stay counted in days for patients undergoing elective surgery was: 3.12 ± 2.96 for diabetic patients and 2.35 ± 0.87 for non-diabetic patients, ($p = 0.555$). Difference between elective and emergency cholecystectomy was statistically significant both for diabetic $p < 0.001$ and for non-diabetic patients $p < 0.001$. For emergency cholecystectomy mean length of stay was 10.62 ± 8.15 for diabetics and 5.49 ± 3.96 for non-diabetic patients $p = 0.017$.

Discussion

To our knowledge, this is the first report of specific hospitalization costs of diabetic and non-diabetic patients undergoing elective and emergency cholecystectomy. Our results suggest that emergent intervention in diabetic and non-diabetic group of patients leads to greater total costs of hospitalization,

costs of stay and procedure-related costs compared to planned cholecystectomy ($p < 0.05$). Furthermore, a significant difference between emergency hospitalization costs of diabetic and non-diabetic patients was found ($p = 0.04$), while there was no significant difference in cost between diabetic and non-diabetic patients in elective hospitalisation (see Table 3). This suggests that acute cholecystitis is not only burdened with higher risk of complications but also with a much higher cost. This may be another important factor underlining the need for diabetes patients to undergo elective surgery. However according to EASL guidelines, routine surgical treatment is not recommended for patients with asymptomatic gallbladder stones [17]. In our analysis the costs of hospitalisation were greater in emergency intervention both in diabetic and non-diabetic patients. It was reported numerous times, that elective surgery carries lower risk of complications [12,15,18,19]. Perhaps this is due to the fact that patients undergoing elective surgery not only do not have a fast progressing emergency condition but also are better prepared for surgery i.e. intentional weight loss, adequate glycemic control, appropriate treatment of possible arrhythmias and hypertension. [20]

Treatment of complications significantly prolong the hospital stay directly leading to increased costs of hospitalization. Costs of emergency surgery in diabetic patients are significantly higher ($p = 0.015$) than in non-diabetic. This is due to increased levels of complications intraoperatively and in postoperative period in diabetic patients with acute cholecystitis in comparison to non-diabetics [11,19,21–24].

Increase of procedure-related costs could be explained by frequently more advanced disease at admission of diabetic patients with acute cholecystitis. As reported previously, diabetics more often present with gangrenous cholecystitis, gall bladder perforation or emphysematous cholecystitis [1,7,25–28]. This leads to extended duration of surgery and increased use of materials during surgical interventions resulting in increased costs of surgery [29]. Increased rate of complications such as wound infections or impaired wound healing requires additional instrumental interventions during post-operative stay and thus generates further costs [30,31].

Imaging costs were a significant part of increased costs in emergency patients because in our study patients undergoing elective cholecystectomy obtained imaging prior to their admission. Furthermore, medical imaging during hospital stay was required due to emerging complications. It can be considered one of

the major cost-generating factors along with procedures and the length of stay.

In our study, the length of hospitalization is a measure of effectiveness. There is a statistically significant difference between the length of hospitalization of elective and emergency patients in both groups diabetic and non-diabetic ($p < 0.001$) and the emergency patients' length of stay was longer.

There is no significant difference between the length of stay of diabetic and non-diabetic patients undergoing elective surgery. This is in contrast to emergency procedures. The length of stay of patients with diabetes operated urgently was statistically significantly longer than in non-diabetic patients (10.62 ± 8.15 vs 5.49 ± 3.96 , $p = 0.017$). This may be due to a more locally advanced disease and more common complications. Regardless of the reason above, our study clearly shows that diabetic patients may benefit from elective cholecystectomy.

Study limitations

First of all, this study is limited due to its retrospective nature. We performed a univariate analysis and did not involve potential cofactors such as glycaemia control, comorbidities and medications. Furthermore, the calculated costs might differ in other health care systems and crude values might vary substantially. However, we believe that the differences shown seem universal due to common cost-generating factors.

Conclusion

In this study we demonstrated that an emergency cholecystectomy in a diabetic patient is associated with greater costs when compared to a planned cholecystectomy. While there are no differences in the costs of elective hospitalizations, there is a statistically significant difference in the costs of emergency surgery between diabetic and non-diabetic patients. As cholelithiasis in diabetic patients can often be diagnosed at its asymptomatic stage, we suggest that qualifying these patients to an elective cholecystectomy early on may lead to fewer serious complications and a decrease in total costs of hospitalization. Although elective cholecystectomy is not supported in current guidelines, it seems that such approach could be beneficial for both diabetic patients and public health insurers. (European Association for the Study of the Liver (EASL), 2016)

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