The Surgeon xxx (xxxx) xxx

Contents lists available at ScienceDirect

The Surgeon

journal homepage: www.thesurgeon.net

Twenty years of pancreatoduodenectomy at a tertiary low-volume hospital: A nationwide Icelandic study☆

Karin Johansen [a,*], Gudjón Birgisson [b,c], Kristín Huld Haraldsdóttir [b,c]

[a] Department of Surgery in Linköping and Department of Biomedical and Clinical Sciences, Linköping University, Linköping, Sweden
[b] Department of Surgery, Landspitali—The National University Hospital of Iceland, Iceland
[c] Faculty of Medicine, University of Iceland, Iceland

ARTICLE INFO

Handling editor: D.G. Healy

Keywords:
Pancreatic surgery
Pancreaticoduodenectomy
Hospitals
Low-volume
Carcinoma
Pancreatic ductal
Treatment outcomes

ABSTRACT

Background: Due to its geographic isolation and limited population, Iceland inherently operates as a low-volume center for pancreatic surgery. To ensure high-quality health care, there is a long tradition of specialists training abroad. This retrospective cohort study aimed to evaluate pancreatic surgery outcomes in Iceland.
Methods: Patients who had undergone pancreatoduodenectomy in Iceland between 2003 and 2022 were included and compared between early (2003–2012) and late (2013–2022) periods.
Results: During the study period, 244 patients underwent a pancreatic procedure in Iceland, 122 of which were pancreatoduodenectomies. There was a notable increase in resection rates from the early to the late period, accompanied by significant reductions in the rates of pancreatic fistulas, postpancreatectomy hemorrhages, reoperations, length of hospital stay, and 30-day mortality. The rates of ideal outcome (54 %) and 90-day mortality (3 %) in the latter period were comparable to international rates. However, the total resection rates were low for the population size, and histopathological results revealed a high percentage of early-stage tumors.
Discussion: The findings of this retrospective study indicate a satisfactory standard of pancreatic surgery over the past decade, suggesting that the existing educational framework is effective. With continued careful preoperative evaluation, more patients could undergo pancreatic surgery in Iceland.

1. Introduction

Pancreatic operations are large and complex procedures, with reported rates of severe complications after pancreatoduodenectomy (PD) ranging between 20 % and 30 % in recent studies [1]. The question of volume in pancreatic surgery has been a growing topic over the last few decades, with many studies indicating an advantage in terms of the rate of resections, rate of radical resections, and short-term and overall mortality with increasing hospital volume [2–4]. Although a hospital volume of 20 PDs per year is often used as a cutoff for a high-volume center, it seems that outcomes improve further when the number of PDs exceeds 40 per year [5].

Before the discussion of hospital volume began and before the advent of enhanced recovery programs, prospects after PD were bleak. One study from the Netherlands evaluating the effects of early centralization reported a 24 % postoperative mortality rate after PD precentralization [2]. Other studies from the early 2000s reported better results but still had a postoperative mortality of 8–9 % [6,7].

Iceland is a small country, with a population of 380 000 inhabitants, and it is situated on the border of the North Atlantic and Arctic Oceans [8]. Landspitali, the National University Hospital of Iceland, is the only tertiary care hospital in Iceland and the nationwide referral center for malignant gastrointestinal surgery. As this is, by necessity, a low-volume hospital in terms of pancreatic surgery, there is a long tradition of specialist training overseas to gain sufficient experience and volumes to maintain a good standard of care despite the isolated conditions and limited number of surgeons performing these operations. However, until now, no formal evaluation of the outcomes of pancreatic surgery in Iceland has been published. The aim of this study was, therefore, to investigate the outcomes of pancreatoduodenectomy in Iceland over the last 20 years and to compare them between early and late periods. The primary hypothesis was that postoperative results would improve from the early to the late study period.

☆ This article is not based on previous communication to a society or a meeting.

* Corresponding author. Department of Surgery, Linköping University Hospital, 58175, Linköping, Sweden.
E-mail address: karin.johansen@liu.se (K. Johansen).

https://doi.org/10.1016/j.surge.2025.04.051
Received 26 November 2024; Received in revised form 23 April 2025; Accepted 29 April 2025

2. Methods

2.1. Study design

This study was a national retrospective cohort analysis encompassing all patients who underwent pancreatoduodenectomy in Iceland from 2003 to 2022. The data were obtained from patients' medical records. No power calculation was performed, as this was a retrospective study, and all the available patients were included.

2.2. Variables

Postoperative pancreatic fistula (POPF), postpancreatectomy hemorrhage (PPH), delayed gastric emptying (DGE) and postpancreatectomy acute pancreatitis (PPAP) were defined according to the International Study Group of Pancreatic Surgery definitions and included only grade B/C complications [9–12]. Postoperative bile leakage was defined according to the International Study Group of Liver Surgery definition [13]. Severe complications were defined as Clavien–Dindo grade IIIa or higher [14]. Ideal outcome was defined according to Augustinus et al. as the absence of in-hospital mortality, complications of Clavien–Dindo IIIa or higher, POPF grade B or C, reoperation, readmission, and length of stay above the 75th percentile in this cohort [15]. The failure to rescue rate was computed as the percentage of patients with in-hospital or 30-day mortality among those with a complication of Clavien−Dindo IIIa or higher or POPF grade B or C [1]. The early period was defined as 2003–2012, and the late period was defined as 2013–2022.

2.3. Statistical analyses

Statistical analyses were performed via SPSS Statistics for Windows, version 28.0 (IBM, Armonk, NY, USA). Categorical variables were compared with the χ^2 test or Fisher's exact test, as appropriate, and numerical variables were compared with Student's *t*-test or the Mann−Whitney *U* test, as appropriate. For survival analysis among patients with periampullary malignancies, Kaplan−Meier survival curves with log rank tests were performed. A Cox regression analysis with backward selection was performed among patients with periampullary malignancies, where all variables deemed relevant were tested via univariable analysis, and those with a p value less than 0.05 were included in the multivariable regression analysis. A p value less than 0.05 was considered significant.

The protocol for this study was approved by the National Bioethics Committee in Iceland as well as by the Scientific Committee of Landspitali University Hospital.

3. Results

During the study period, 244 patients underwent a pancreatic procedure in Iceland, 122 of whom underwent a PD (Fig. 1).

A comparison of demographic data over time revealed that the patient population remained largely unchanged, with the exception of an increased body mass index (BMI) in the later period. The majority of patients were male (62 %). The most prevalent preoperative comorbidities were hypertension, cardiovascular comorbidities and diabetes, all of which slightly but not significantly increased in the late period (Table 1).

The usage rate of preoperative biliary drainage increased significantly from 43 to 64 % in the late period. The use of metal stents increased with time, although this could not be analyzed with a statistical test because of the small sample size. Only in two cases did the biliary procedures postpone the planned operation, both in the late period. The use of preoperative biopsies or brush cytologies increased significantly over time, as did the rate of neoadjuvant chemotherapy. The waiting time from treatment decision to operation was nonsignificantly longer in the late period (Supplementary data 1).

There were no minimally invasive procedures performed during the study period. All but one of the operations were performed as a classic PD, and all but one included a pancreatic anastomosis made to the jejunum. The operative time was unchanged, but there was a significant decrease in blood loss in the late period. No arterial resections were performed during the study period, but the rate of venous resections was nonsignificantly increased in the late period. More than 80 % of patients underwent surgery due to a periampullary tumor (Table 2).

Postoperatively, 45 % of patients had severe complications of Clavien−Dindo IIIa or higher, including 18 % who were treated with unplanned intensive care. The rates of clinically relevant pancreatic fistula, postpancreatectomy hemorrhage and reoperation all decreased significantly in the late period. The time before drain removal decreased significantly over time, as did the rate of wound infections and intra-abdominal abscesses. The length of stay decreased significantly from a median of 25 to 14 days. Ideal outcome increased nonsignificantly from 36 to 54 percent. The in-hospital, 30-day and 90-day mortality rates all decreased, with rates of 1 %, 0 % and 3 %, respectively, in the late period. Among these, only the decrease in 30-day mortality reached statistical significance (Table 3). The rate of failure to rescue among patients with severe complications or POPF B or C was 8.6 %.

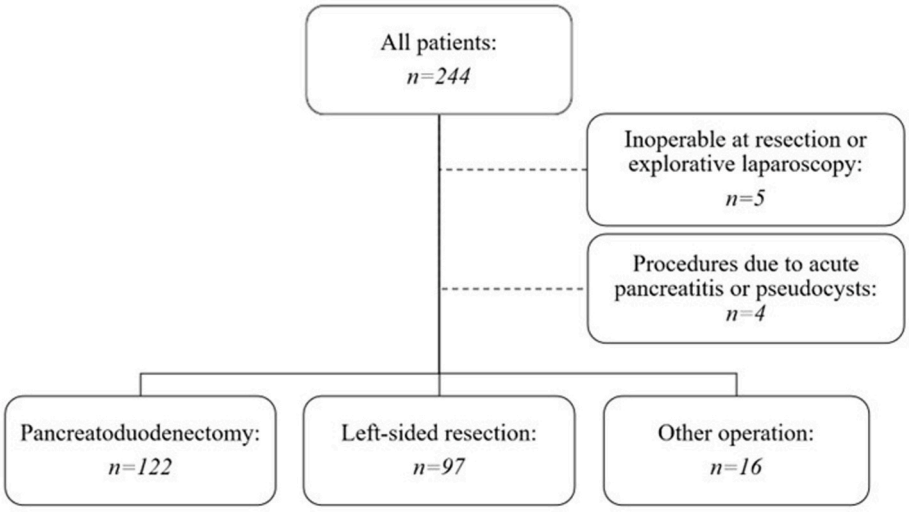

Fig. 1. Flow chart of patients who underwent pancreatic procedures in Iceland from 2003 to 2022.

Table 1
Demographic data and comorbidities.

	All patients $n = 122$	2003–2012 $n = 44$	2013–2022 $n = 78$	P value	Missing data (%)
Age (mean ± SD)	64 ± 10	65 ± 8	64 ± 11	0.716	0
Sex (%)				0.536	0
Male	76 (62.3)	29 (65.9)	47 (60.3)		
Female	46 (37.7)	15 (34.1)	31 (39.7)		
BMI (mean ± SD)	26 ± 5	25 ± 4	27 ± 5	0.005	3
ASA classification (%)				0.904	0
1-2	84 (68.9)	30 (68.2)	54 (69.2)		
3-4	38 (31.1)	14 (31.8)	24 (30.8)		
ECOG score (%)				0.908	5
0-1	100 (82.0)	36 (81.8)	64 (82.1)		
2-3	16 (13.1)	6 (13.6)	10 (12.8)		
Preoperative weight loss (%)	47 (38.5)	17 (38.6)	30 (38.5)	0.972	1
Smoking (%)	23 (18.9)	10 (22.7)	13 (16.7)	0.431	1
Cardiovascular comorbidities (%)	30 (24.6)	9 (20.5)	21 (26.9)	0.426	0
Hypertension (%)	47 (38.5)	15 (34.1)	32 (41.0)	0.450	0
Previous VTE (%)	3 (2.5)	1 (2.3)	2 (2.6)	1.000[a]	0
Diabetes (%)	20 (16.4)	6 (13.6)	14 (17.9)	0.537	0
Pulmonary comorbidities (%)	17 (13.9)	6 (13.6)	11 (14.1)	0.943	0
Kidney disease (%)	6 (4.9)	3 (6.8)	3 (3.8)	0.666[a]	0
Neurological comorbidities (%)	11 (9.0)	6 (13.6)	5 (6.4)	0.201[a]	0
Previous history of cancer (%)	10 (8.2)	3 (6.8)	7 (9.0)	1.000[a]	0

ASA, American Society of Anesthesiologists; BMI, body mass index; ECOG, Eastern Cooperative Oncology Group; SD, standard deviation; VTE, venous thromboembolism.

[a] Fisher's exact test.

Among the patients with a periampullary malignancy, there were no significant differences over time regarding the stage of the tumors or the rate of radical resection. Adjuvant chemotherapy was used significantly more often in the late period, and among those who received it, a greater proportion were treated with a combination regimen than with monotherapy. Sixty-five percent of patients experienced disease recurrence a median of 11 months after the operation (Supplementary data 2).

In the survival analysis, there were no significant differences in overall survival or disease-free survival over time among patients with periampullary tumors or, specifically, among patients with pancreatic cancers. The median overall survival for patients with periampullary malignancies was 2.1 years in the early period and 2.9 years in the late period, and the 5-year survival rates were 32 % and 36 %, respectively. For patients with pancreatic cancer, the median overall survival was 1.5 years in the early period and 2.5 years in the late period, and the 5-year survival rates were 27 % and 33 %, respectively (Fig. 2).

In the Cox regression analysis for overall survival among patients with periampullary malignancies, the significant variables were tumor stage and diagnosis (Supplementary data 3).

4. Discussion

In this comparison of pancreatoduodenectomies over 20 years in Iceland, considerable improvements were observed over time. In the latter half of the period, the rates of pancreatic fistulas, post-pancreatectomy hemorrhages, reoperations, abdominal infections, length of stay and 30-day mortality significantly improved. When the figures were compared with international data, the rate of ideal outcome in the later period was on par with that reported in a recent study from the GAPASURG collaborative of pancreatoduodenectomies in North America, the Netherlands, Germany and Sweden [16].

Impressively, the rates of 30- and 90-day mortality in the later period were similar to or even better than those reported in other Western countries with highly centralized pancreatic surgery. For example, the GAPASURG study mentioned above reported rates of 30-day mortality of between 2 % and 7 % among countries [16], and the recently published PORSCH trial from the Netherlands reported 90-day mortality rates of 3 % in the intervention arm and 5 % in the control arm of the trial [17]. Notably, the PORSCH trial also included a combination of PDs and pancreatic tail resections. The mortality in the earlier period of this study was considerably higher but still comparable to that reported in earlier studies [6,7].

One possible explanation for the good results in the late period could be the strict selection of patients. The mean ages were lower than those generally reported internationally [16], although the distributions of American Society of Anesthesiologists (ASA) scores and Eastern Cooperative Oncology Group (ECOG) performance statuses seem to be comparable to those reported in other Western countries [16–18]. As observed in other countries, patients who underwent surgery were predominantly male, although the incidence of pancreatic cancer is equally distributed between sexes [16,19].

The overall rate of Clavien–Dindo grade $\geq$ IIIa was considerably higher than that reported in other Western countries [16]. The reason for this is difficult to explain from the present data, as the rates of POPF, PPH and bile leakage, unplanned intensive care, reoperation and failure-to-rescue rates were, in fact, comparable to those reported elsewhere [1,16]. The only other variable that stands out among the post-operative complications was a very high rate of delayed gastric emptying and a long length of hospital stay, which, even in the recent period, was a median of 14 days. One potential explanation for this could be that complications were diagnosed and treated later than elsewhere or possibly a tendency of not draining small, subclinical leaks. The recently published PORSCH trial from the Netherlands is a clear example of the immense importance and clinical benefit of early detection and treatment of complications after pancreatic surgery [17].

Notably, the resection rates compared with those of the overall population of 380 000 inhabitants were surprisingly low. A recent report from Sweden described a PD resection rate of approximately 3.7 per 100 000 inhabitants nationwide [20], whereas the current study reported an overall resection rate of 1.6 per 100 000 inhabitants over the study period. The high rate of early cancer stages and relatively low rate of venous resections in the present study suggest that patients with more advanced tumors do not receive surgery in Iceland to the extent that is seen elsewhere in Europe [16,18,21]. This discrepancy may be explained in part by the fact that a few patients with advanced tumors requiring arterial resection were referred abroad for surgery during the study period and were not included in the study population.

When examining long-term survival among patients with periampullary and pancreatic tumors, the rates continue to be comparable with those reported internationally. In the international ESPAC-4 trial,

Table 2
Operation and diagnosis.

	All patients $n = 122$	2003–2012 $n = 44$	2013–2022 $n = 78$	P value	Missing data (%)
Operation type (%)				1.000[a]	0
PD	121 (99.2)	44 (100.0)	77 (98.7)		
PPPD	1 (0.8)	0.(0.0)	1 (1.3)		
Pancreatic anastomosis to (%)				0.361[a]	0
Jejunum	121 (99.2)	43 (97.7)	78 (100.0)		
Stomach	1 (0.8)	1.(2.3)	0 (0.0)		
Operative time, min, median (IQR)	330 (285–390)	335 (260–415)	328 (303–375)	0.726	16
Blood loss, ml, median (IQR)	500 (300–900)	600 (500–1000)	400 (300–725)	0.003	3
Venous resection (%)	10 (8.2)	1 (2.3)	9 (11.5)	0.093[a]	0
Periampullary tumors (%)	103 (84.4)	38 (86.4)	65 (83.3)	0.658[b]	0
PDAC	42 (34.4)	15 (34.1)	27 (34.6)		
Distal bile duct	18 (14.8)	6 (13.6)	12 (15.4)		
Ampulla Vateri	32 (26.2)	12 (27.3)	20 (25.6)		
Duodenal	11 (9.0)	5 (11.4)	6 (7.7)		
Other lesions	19 (15.6)	6 (13.6)	13 (16.7)		
NET	8 (6.6)	2 (4.5)	6 (7.7)		
Cysts	5 (4.1)	2 (4.5)	3 (3.8)		
Metastases	2 (1.6)	1 (2.3)	1 (1.3)		
Chronic pancreatitis	1 (0.8)	1 (2.3)	0 (0.0)		
Others and benign	3 (2.5)	0 (0.0)	3 (3.8)		

IQR, interquartile range; NET, neuroendocrine tumor; PD, pancreatoduodenectomy; PDAC, pancreatic ductal adenocarcinoma; PPPD, pylorus-preserving pancreatoduodenectomy.

[a] Fisher's exact test.

[b] Comparison between the two main groups of periampullary tumors and other lesions.

Table 3
Postoperative course.

	All patients $n = 122$	2003–2012 $n = 44$	2013–2022 $n = 78$	P value	Missing data (%)
Clavien–Dindo (%)				0.231	0
0-II	67 (54.9)	21.(47.7)	46 (59.0)		
IIIa-V	55 (45.1)	23.(52.3)	32 (41.0)		
POPF grade B-C (%)	21 (17.2)	12 (27.3)	9 (11.5)	0.027	0
Bile leak grade B-C (%)	8 (6.6)	3 (6.8)	5 (6.4)	1.000[a]	0
DGE grade B-C (%)	55 (45.1)	24 (54.5)	31 (39.7)	0.115	0
PPH grade B-C (%)	14 (11.5)	9 (20.5)	5 (6.4)	0.019	0
PPAP grade B-C (%)	3 (2.5)	0 (0.0)	3 (3.8)	0.552[a]	0
Unplanned intensive care (%)	22 (18.0)	11 (25.0)	11 (14.1)	0.133	0
Days of unplanned intensive care, median (IQR)	2 (1–12)	7 (2–26)	2 (1–2)	0.056	0
Reoperation (%)	15 (12.3)	10 (22.7)	5 (6.4)	0.008	0
Days with original drain, median (IQR)	5 (4–7)	9 (7–12)	4 (3–5)	<0.001	14
Radiologic drain placement (%)	29 (23.8)	10 (22.7)	19 (24.4)	0.839	0
Wound disruption (%)	8 (6.6)	3 (6.8)	5 (6.4)	1.000[a]	0
Wound infection or intraabdominal abscess (%)	46 (37.7)	23 (52.3)	23 (29.5)	0.013	0
Medical complications (%)	20 (16.4)	10 (22.7)	10 (12.8)	0.156	0
Pneumonia	12 (9.8)	6 (13.6)	6 (7.7)		
Thromboembolism	4 (3.3)	3 (6.8)	1 (1.3)		
Cardiovascular	6 (4.9)	2 (4.5)	4 (5.1)		
Neurological	2 (1.6)	1 (2.3)	1 (1.3)		
Length of stay, median (IQR)	17 (12–32)	25 (14–32)	14 (10–30)	0.028	2
Ideal outcome (%)	58 (47.5)	16 (36.4)	42 (53.8)	0.063	0
In-hospital mortality (%)	5 (4.1)	4 (9.1)	1 (1.3)	0.056[a]	0
30-day mortality (%)	3 (2.5)	3 (6.8)	0 (0.0)	0.045[a]	0
90-day mortality (%)	6 (4.9)	4 (9.1)	2 (2.6)	0.187[a]	0

DGE, delayed gastric emptying; IQR, interquartile range; POPF, postoperative pancreatic fistula; PPAP, postpancreatectomy acute pancreatitis; PPH, post-pancreatectomy hemorrhage.

[a] Fisher's exact test.

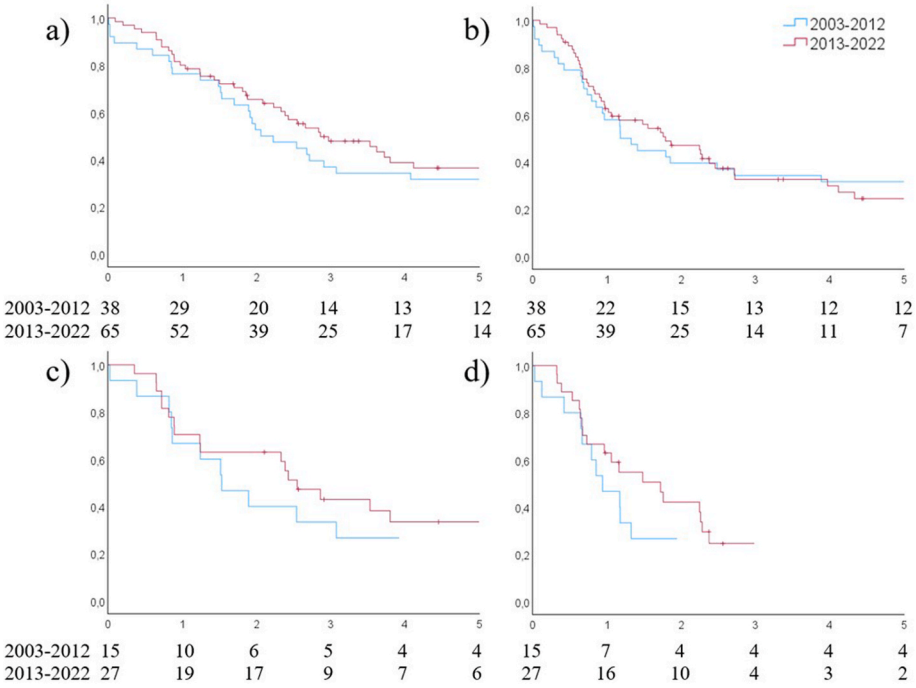

Fig. 2. Kaplan–Meier survival curves: a) overall survival among patients with periampullary malignancies; b) disease-free survival among patients with periampullary malignancies; c) overall survival among patients with pancreatic cancer; d) disease-free survival among patients with pancreatic cancer. Years are shown on the x axis. The number at risk is denoted below each curve.

which included patients from Great Britain, Germany, France and Sweden, the 5-year survival rate among pancreatic cancer patients receiving combination therapy with gemcitabine and capecitabine was 29 %, whereas it was 33 % in the latter period of the present study [21]. The explanation for this finding likely lies again in the histopathological data, where 20 % of patients with periampullary carcinoma had a tumor stage of 0 (in situ) and I. In the cox regression analysis among patients with a periampullary malignancy, both tumor stage and diagnosis were significant, with increasing hazard ratios for increasing tumor stages as expected. In terms of diagnosis, the duodenal and ampullary tumors both had significantly lower hazard ratios than PDAC, which is in line with other studies [5,22]. Apart from this, a relatively high percentage of patients in the late period received adjuvant chemotherapy.

Several limitations were identified in this study. First, among patients with periampullary malignancies, only patients who had undergone surgery were included, and we do not know the total number of patients diagnosed with periampullary malignancies during the same period. Second, some patients who were referred abroad for surgery because of advanced tumors were not included, which may have led to survival estimates being deceptively positive. Third, because of the small sample size, the study was underpowered for some of the statistical analyses performed. Fourth, radicality was mostly specified in the older definition of a tumor in the resection margin, which makes it unreliable with respect to today's standards [23]. Finally, the data were collected retrospectively, which makes some variables, such as the relatively newly defined complication of PPAP, difficult to confirm and probably underdiagnosed. However, this was a nationwide study with comprehensive data over 20 years, reflecting the actual situation of pancreatic surgery in Iceland.

5. Conclusion

This national study, which analyzed 20 years of pancreatoduodenectomies in Iceland, demonstrated significant improvements over time. Although patients had a high rate of severe complications postoperatively, the rates of pancreatic fistulas, postpancreatectomy hemorrhages, bile leaks, unplanned intensive care, reoperations and ideal outcome in the latter half of the study period were in fact all comparable with those reported in other Western countries, and the rates of short-term mortality were on par with or even better than those reported in North America, Sweden, the Netherlands and Germany. These results suggest that the current system of training surgeons overseas is effective and valuable for ensuring the quality of pancreatic surgery in Iceland. Outside of the Icelandic setting, this teaching model may also be relevant for other hospitals that are low volume by necessity, for example due to geographic isolation. The current study also suggests that resection rates are low in Iceland and that, with continued careful preoperative evaluation of patients, more patients could likely undergo pancreatic surgery in the country.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.surge.2025.04.051.

References

[1] Gleeson EM, Pitt HA, Mackay TM, Wellner UF, Williamsson C, Busch OR, et al. Failure to rescue after pancreatoduodenectomy: a transatlantic analysis. Ann Surg 2021;274:459–66.
[2] Lemmens VE, Bosscha K, van der Schelling G, Brenninkmeijer S, Coebergh JW, de Hingh IH. Improving outcome for patients with pancreatic cancer through centralization. Br J Surg 2011;98:1455–62.
[3] Gooiker GA, Lemmens VE, Besselink MG, Busch OR, Bonsing BA, Molenaar IQ, et al. Impact of centralization of pancreatic cancer surgery on resection rates and survival. Br J Surg 2014;101:1000–5.
[4] Onete VG, Besselink MG, Salsbach CM, Van Eijck CH, Busch OR, Gouma DJ, et al. Impact of centralization of pancreatoduodenectomy on reported radical resections rates in a nationwide pathology database. HPB (Oxford) 2015;17:736–42.

[5] van der Geest LG, van Rijssen LB, Molenaar IQ, de Hingh IH, Groot Koerkamp B, Busch OR, et al. Volume-outcome relationships in pancreatoduodenectomy for cancer. HPB (Oxford) 2016;18:317–24.
[6] Muscari F, Suc B, Kirzin S, Hay JM, Fourtanier G, Fingerhut A, et al. Risk factors for mortality and intra-abdominal complications after pancreatoduodenectomy: multivariate analysis in 300 patients. Surgery 2006;139:591–8.
[7] Lin PW, Shan YS, Lin YJ, Hung CJ. Pancreaticoduodenectomy for pancreatic head cancer: PPPD versus Whipple procedure. Hepatogastroenterology 2005;52:1601–4.
[8] Icelandic population statistics, overview. Statistics Iceland. 2023 [Available from: https://www.statice.is/.
[9] Bassi C, Marchegiani G, Dervenis C, Sarr M, Abu Hilal M, Adham M, et al. The 2016 update of the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 Years after. Surgery 2017;161:584–91.
[10] Wente MN, Veit JA, Bassi C, Dervenis C, Fingerhut A, Gouma DJ, et al. Postpancreatectomy hemorrhage (PPH): an international study group of pancreatic surgery (ISGPS) definition. Surgery 2007;142:20–5.
[11] Wente MN, Bassi C, Dervenis C, Fingerhut A, Gouma DJ, Izbicki JR, et al. Delayed gastric emptying (DGE) after pancreatic surgery: a suggested definition by the International Study Group of Pancreatic Surgery (ISGPS). Surgery 2007;142:761–8.
[12] Marchegiani G, Barreto SG, Bannone E, Sarr M, Vollmer CM, Connor S, et al. Postpancreatectomy acute pancreatitis (PPAP): definition and grading from the international study group for pancreatic surgery (ISGPS). Ann Surg 2022;275:663–72.
[13] Koch M, Garden OJ, Padbury R, Rahbari NN, Adam R, Capussotti L, et al. Bile leakage after hepatobiliary and pancreatic surgery: a definition and grading of severity by the International Study Group of Liver Surgery. Surgery 2011;149:680–8.
[14] Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205–13.
[15] Augustinus S, Mackay TM, Andersson B, Beane JD, Busch OR, Gleeson EM, et al. Ideal outcome after pancreatoduodenectomy: a transatlantic evaluation of a harmonized composite outcome measure. Ann Surg 2023;278:740–7.
[16] de Graaf N, Augustinus S, Wellner UF, Johansen K, Andersson B, Beane JD, et al. Transatlantic differences in the use and outcome of minimally invasive pancreatoduodenectomy: an international multi-registry analysis. Surg Endosc 2024;38:7099–111.
[17] Smits FJ, Henry AC, Besselink MG, Busch OR, van Eijck CH, Arntz M, et al. Algorithm-based care versus usual care for the early recognition and management of complications after pancreatic resection in The Netherlands: an open-label, nationwide, stepped-wedge cluster-randomised trial. Lancet 2022;399:1867–75.
[18] Johansen KU, Lundgren LM, Gasslander TR, Sandström P, Björnsson B. There is No increase in perioperative mortality after pancreaticoduodenectomy in octogenarians: results from the Swedish national registry for tumors in the pancreatic and periampullary region. Annals of Surgery Open 2020;1:e015.
[19] Gaddam S, Abboud Y, Oh J, Samaan JS, Nissen NN, Lu SC, et al. Incidence of pancreatic cancer by age and sex in the US, 2000-2018. JAMA 2021;326:2075–7.
[20] RCC. National registry for tumors in the pancreatic and periampullary region. Yearly Report 2021 (in Swedish). Regionala cancercentrum i samverkan 2021. 2021.
[21] Neoptolemos JP, Palmer DH, Ghaneh P, Psarelli EE, Valle JW, Halloran CM, et al. Comparison of adjuvant gemcitabine and capecitabine with gemcitabine monotherapy in patients with resected pancreatic cancer (ESPAC-4): a multicentre, open-label, randomised, phase 3 trial. Lancet 2017;389:1011–24.
[22] Uijterwijk BA, Lemmers DH, Ghidini M, Wilmink H, Zaniboni A, Salvia R, et al. The five periampullary cancers, not just different siblings but different families: an international multicenter cohort study. Ann Surg Oncol 2024;31:6157–69.
[23] Verbeke CS, Leitch D, Menon KV, McMahon MJ, Guillou PJ, Anthoney A. Redefining the R1 resection in pancreatic cancer. Br J Surg 2006;93:1232–7.