

# Impact of Operative Time on Outcomes after Pancreatic Resection: A Risk-Adjusted Analysis Using the American College of Surgeons NSQIP Database

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- BACKGROUND:** Longer operative time (OT) has been associated with negative outcomes in various surgical procedures, but its role in pancreatic resection, a complex, high-acuity endeavor, is not yet well defined. The aim of this study was to analyze the relationship between OT and pancreatectomy outcomes in a risk-adjusted fashion.
- STUDY DESIGN:** This retrospective cohort study analyzed patients undergoing pancreaticoduodenectomy (PD) or distal pancreatectomy (DP) between 2014 and 2015 using the procedure-targeted pancreatectomy database of the American College of Surgeons NSQIP. Univariable analyses and multiple backward stepwise conditional logistic regression models were used to assess the impact of OT on postoperative occurrences.
- RESULTS:** Among 10,157 patients, 6,844 PDs and 3,313 DPs were performed. Median operative time was 358 minutes (interquartile range 282 to 444 minutes) for PD and 213 minutes (interquartile range 157 to 285 minutes) for DP. Male sex, younger age, obesity, neoadjuvant treatment, minimally invasive approaches, and vascular/concurrent organ resections were associated with longer OT for both procedures. Morbidity increased in a stepwise manner with increasing OT. After risk adjustment, increasing OT was negatively associated with overall morbidity, major complications, pancreatectomy-specific complications, infectious complications, and prolonged hospital stay. These associations were independent from patients' preoperative characteristics, operative approach, vascular or concurrent organ resection, and postoperative diagnosis. These findings held true for both PD and DP. Conversely, the association between OT and mortality was mainly driven by the excessive operative durations for PDs, and was not significant for DPs.
- CONCLUSIONS:** Longer OT is independently associated with worse perioperative outcomes after pancreatic resection, and should be considered a relevant parameter in risk-adjustment processes for outcomes evaluation. These findings suggest possible areas of quality improvement through individual and system-level initiatives. (J Am Coll Surg 2018;■:1–14. © 2018 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Longer operative time (OT) has been negatively associated with outcomes across a wide spectrum of surgical procedures.<sup>1-5</sup> However, its impact on outcomes after

pancreatectomy is not yet well defined. Notably, operative duration results from complex interactions among patient factors, disease characteristics, surgeon's influence

**Disclosure Information:** Nothing to disclose.

Presented at the American College of Surgeons 103<sup>rd</sup> Annual Clinical Congress, San Diego, CA, October 2017.

Received December 13, 2017; Revised January 9, 2018; Accepted January 10, 2018.

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**Abbreviations and Acronyms**

ACS	= American College of Surgeons
CR	= clinically relevant
DP	= distal pancreatectomy
IQR	= interquartile range
MIPR	= minimally invasive pancreatic resection
OR	= odds ratio
OT	= operative time
PD	= pancreaticoduodenectomy
POPF	= postoperative pancreatic fistula
PUF	= Participant User Files

(experience, technical skills, and decision making), and system-level processes. This complexity is particularly true for pancreatic resections—high-acuity endeavors encompassing a wide spectrum of intraoperative decisions and technical challenges, which are still characterized by substantial postoperative morbidity.<sup>6,7</sup>

Unraveling the relationship between OT and outcomes after pancreatectomy is of great relevance. In particular, this analysis would provide evidence-based substantiation for the current widespread use of OT as a proficiency measure in learning curve analysis, for both open and minimally invasive pancreatic resection (MIPR).<sup>8-12</sup>

The aim of this study was to analyze the relationship between OT and outcomes of patients receiving pancreatic resection in a risk-adjusted fashion. To this end, the American College of Surgeons (ACS) NSQIP, an outcomes-based, risk-adjusted effort for the measurement and enhancement of the quality of surgical care<sup>13-17</sup> was used as the data substrate.

**METHODS****Data source**

The ACS NSQIP is a validated, prospectively maintained, multi-institutional clinical registry that provides participating hospitals with their risk-adjusted outcomes for quality-improvement purposes. Current details of the ACS NSQIP have been described elsewhere.<sup>13,16,18,19</sup> Data collected are also de-identified and made available for research purposes as Participant User Files (PUFs) containing detailed information on preoperative and operative variables and 30-day outcomes.<sup>20</sup> Additionally, pancreatectomy-specific data—included in the procedure-targeted pancreatectomy PUF<sup>21</sup>—provide the opportunity to refine risk adjustment and capture complications unique to these operations (eg postoperative pancreatic fistula [POPF]).

**Study design**

This article is compliant with STROBE (Strengthening the Reporting of Observational Studies in Epidemiology)

guidelines for the reporting of observational studies. In this retrospective cohort study, the 2014 to 2015 procedure-targeted pancreatectomy PUF was queried for all adult patients undergoing pancreatectomy. Current Procedural Terminology codes were used to extract pancreaticoduodenectomies (PDs) (CPTs: 48150, 48152, 48153, 48154) and distal pancreatectomies (DPs) (CPTs 48140, 48145, 48146). Pancreatectomy-specific variables were then merged to the information contained in the main NSQIP PUF using the unique “case id” variable.

Operative time, defined in the ACS NSQIP as minutes from procedure start to finish (ie skin incision to skin closure time), was available for all patients. Pancreaticoduodenectomies <120 minutes (n = 33), and DPs <30 minutes (n = 3) were excluded from the analysis to avoid possible data-entry errors. Operative time was categorized into 8 quantiles separately for PD and DP, such that an equal number of patients were in each quantile, and its association with various outcomes was examined.

**Outcomes measures**

Overall morbidity was derived as the aggregate sum of any surgical complication recorded in the ACS NSQIP PUF, including surgical site infections (superficial/deep/organ-space), wound disruption, pneumonia, unplanned reintubation, pulmonary embolism, ventilator dependency for longer than 48 hours, acute renal failure, progressive renal insufficiency, urinary infections, stroke, cardiac arrest, MI, deep vein thrombosis or thrombophlebitis, sepsis, or septic shock.<sup>22</sup> Complications were categorized as minor (superficial surgical site and urinary infections) or serious (all the others), as already established.<sup>23,24</sup> Infectious complications included surgical site infections, urinary infections, pneumonia, and sepsis or septic shock. All conditions already present at the time of operation were not considered as complications.<sup>25</sup> The administration of perioperative transfusions (ie RBC transfusions within 72 hours of the start of the operation) was also recorded. Mortality was defined as all-cause within 30 days of the operation. In accordance with previous literature,<sup>23,26</sup> a prolonged duration of hospital stay was indicated by discharge on or after postoperative day 14.

The definition of POPF was modeled after the International Study Group on Pancreatic Surgery recommendation<sup>27</sup> to the extent possible, given the constraints of the data available in the procedure-targeted pancreatectomy PUF.<sup>28</sup> Specifically, a POPF was defined as a drain amylase >300 U/L on postoperative day 3 or later, or a “yes” value in the “postoperative pancreatic fistula” column in the dataset. Clinically relevant (CR) POPF was further defined as the presence of a fistula in addition

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