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Pneumonia is associated with a high risk of mortality after pancreaticoduodenectomy

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Background. *Pancreatectomy is associated with a high complication rate that varies between 40–60%. Although many specific complications have been extensively studied, postoperative pneumonia has received little attention.*
Methods. *Patients undergoing pancreaticoduodenectomy (n = 1,090) and distal pancreatectomy (n = 436) from 2002 to 2014 at Thomas Jefferson University Hospital were retrospectively assessed for postoperative pneumonia. Incidence, predictive factors, and outcomes were determined.*
Results. *Pneumonia was diagnosed in 4.3% of patients after pancreaticoduodenectomy and 2.5% after distal pancreatectomy. The majority of the pneumonias were attributed to aspiration (87.2% and 81.8%, respectively). Pneumonias were more frequently severe (Clavien-Dindo grades 4 or 5) in the pancreaticoduodenectomy group compared to the distal pancreatectomy group (55.3% vs 9.1%, P = .006). Post-pancreaticoduodenectomy pneumonia predictors included delayed gastric emptying (odds ratio 8.2, P < .001), oxygen requirement on postoperative day 3 (odds ratio 3.2, P = .005), and chronic obstructive pulmonary disease (odds ratio 3.1, P = .049). In the post-pancreaticoduodenectomy group, pneumonia was associated with a very high 90-day mortality compared with those who did not have pneumonia (29.8% vs 2.1%, P < .001) and had the largest effect on mortality after pancreaticoduodenectomy (odds ratio 9.6, P < .001). A preoperative risk score model for pneumonia post-pancreaticoduodenectomy was developed.*
Conclusion. *Pneumonia after pancreaticoduodenectomy is an uncommon but highly morbid event and is associated with a substantially increased risk of perioperative death. (Surgery 2017;161:959-67.)*

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Mortality rates after pancreatic resection have decreased to 1–3% at high-volume centers, yet morbidity rates have remained relatively high at 40–60%.[1,2] Specific postoperative complications have been analyzed extensively in the surgical

literature, including common problems such as pancreatic fistula and delayed gastric emptying (both have an incidence of around 20%).[3-7] In fact, the International Study Group of Pancreatic Surgery (ISGPS) has provided expert guidelines on severity grading for many complication types.[8-10] In contrast to many of these complications, postoperative pneumonia after pancreatic resection has not been the subject of a focused study to our knowledge, despite its serious potential consequences.

Pneumonia has been reported to occur after pancreatic resection in 1–6% of cases and has been associated with both pancreatic fistula and delayed gastric emptying (DGE).[1,2,7,11] In 2 studies on hospital readmission after pancreatic resection,

pneumonia was found to be the third most common cause of early readmission (4–5% of the total readmissions).[11,12] Pneumonia was also identified as the second most common nonoperative complication after pancreatic resection, trailing behind urinary tract infections, which is consistent with studies of nosocomial infections in the general medical literature.[7,13]

We present the recent experience with pneumonia after pancreatic resection at a single, high-volume pancreatic surgery center. We investigated the incidence, risk factors, and impact associated with pneumonia after pancreatic resection. Furthermore, we developed a novel risk scoring system to predict the likelihood of developing pneumonia after pancreaticoduodenectomy (PD), with the goal of identifying patients who may benefit from interventions aimed at reducing pneumonia risk.

METHODS

This study was approved by the Institutional Review Board of Thomas Jefferson University. A total of 1,526 patients underwent PD or distal pancreatectomy (DP) at the Thomas Jefferson University Hospital between May 2002 and December 2014 by 10 surgeons. Patient data were retrospectively collected using electronic records and entered into a pancreatectomy database. Patients were assessed specifically for evidence of postoperative pneumonia (within 90 days of operation) in the electronic records, and cases were classified based on the apparent cause: aspiration, ventilator-associated, or community-acquired.

There is no consensus regarding the definition of pneumonia in the literature, so for the purposes of this study, *pneumonia* was defined as radiographic evidence of pulmonary consolidation or an infiltrate within 90 days of the index operation, followed by antibiotic therapy administered to treat the pneumonia.[14] Each case of pneumonia was then further confirmed according to National Surgical Quality Improvement Program criteria.[15] For the purposes of this study, we defined *aspiration pneumonia* as a diagnosis of pneumonia within 5 days of a witnessed aspiration event, nasogastric intubation, or emesis.[16] *Ventilator-associated pneumonia* was defined as a diagnosis of pneumonia during the course of endotracheal intubation without any apparent aspiration. *Community-acquired pneumonia* was assigned when pneumonia developed after discharge and in the absence of another attributable cause. Tobacco use was initially detailed as active, quit, and number of pack years. Detailed smoking history proved to be no more informative in this cohort than stratifying

patients according to any tobacco history (versus none at all). Therefore, the latter categorization is reported herein.

Definitions of common complications after pancreatic resection, such as DGE, pancreatic leak, and duodenal jejunostomy/gastrojejunostomy leak have been described elsewhere.[5,8,10] The severity of each case of pneumonia was generally categorized using the Clavien-Dindo classification system.[17] DGE was specifically graded using the accepted ISGPS criteria.[8] Surgical mortality was assigned for any death that occurred within 90 days of the index operation, and pneumonia-specific mortality referred to those deaths in which postoperative pneumonia was thought to be a principal cause of death based on a close review of electronic records.

Statistical analysis. Statistical comparisons were principally performed between patients with and without a diagnosis of pneumonia. Other groups were also compared, including pneumonia-related outcomes after PD and DP. Continuous variables were summarized using medians and ranges, and categorical variables were summarized using frequencies and percentages. Continuous outcome variables were analyzed using a Wilcoxon rank-sum test, and categorical outcome variables were analyzed using the χ^2 test or logistic regression.

Stepwise backward selection was used to determine significant predictors of 90-day mortality with a $P < .1$. Multivariable logistic regression was used to determine odds ratios (ORs) for significant predictors of 90-day mortality and pneumonia. Given percentages were calculated using the total number of patients with available data for a given data field. Completeness of each data field in the data set varied, in which case different denominators were used to calculate percentages.

Developing the postoperative pneumonia risk score. To create the postoperative pneumonia risk score, the PD study population ($n = 1,090$) was randomly divided into a development cohort ($n = 872$) and a validation cohort ($n = 218$) comprising 80% and 20% of the study population, respectively. Similarity of the 2 cohorts was confirmed by comparing the demographics, preoperative variables, postoperative outcomes, and incidence of pneumonia between the 2 groups. Preoperative clinical variables were analyzed in univariate analyses to determine significance for the development of pneumonia. Predictors of pneumonia were combined into a multivariable logistic regression model, and stepwise backward selection with a $P < .20$ was used to identify the resulting significant predictors.