Development and Validation of a Survival Prediction Model for Patients With Pancreatic Cancer

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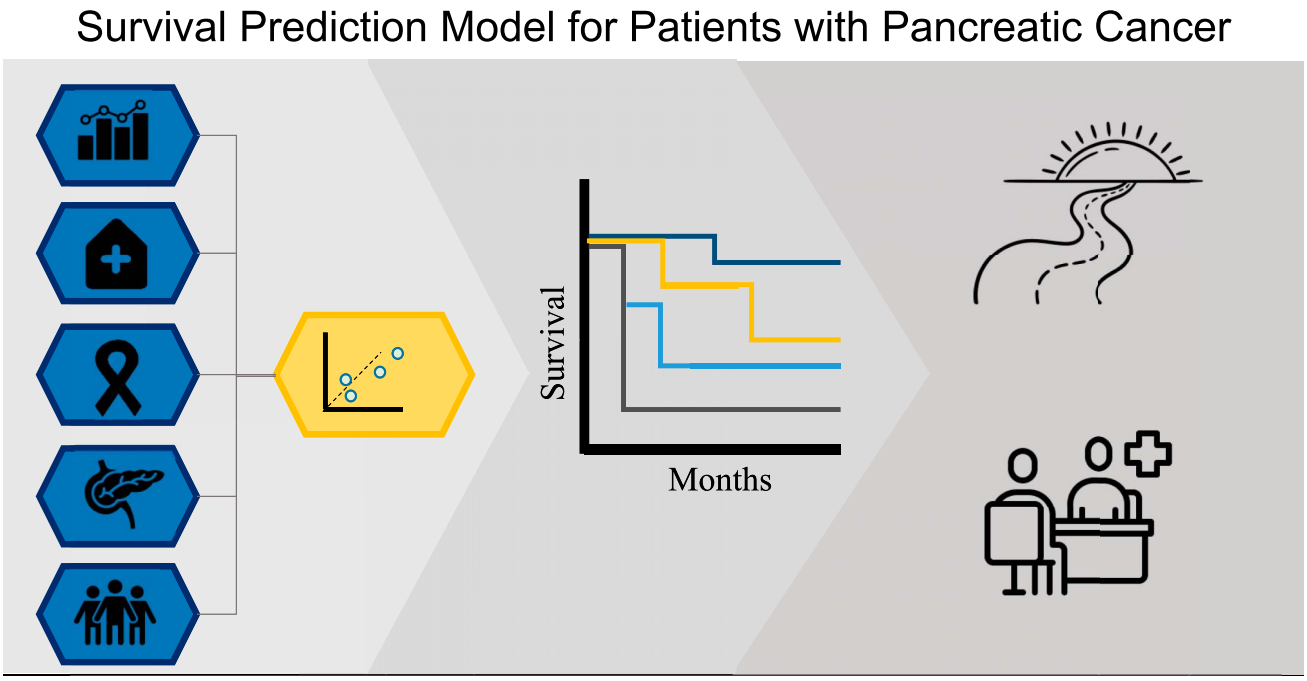
INTRODUCTION: **Patients with pancreatic ductal adenocarcinoma (PDAC) face challenging treatment decisions following their diagnosis. We developed and validated a survival prognostication model using routinely available clinical information, patient-reported symptoms, performance status, and initial cancer-directed treatment.**



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METHODS: **This retrospective cohort study included patients with PDAC from 2007 to 2020 using linked administrative databases in Ontario, Canada. Patients were randomly selected for model development (75%) and validation (25%). Using the development cohort, a multivariable Cox proportional hazards regression with backward stepwise variable selection was used to predict the probability of survival. Model performance was assessed on the validation cohort using the concordance index and calibration plots.**

RESULTS: **There were 17,450 patients (49% female) with a median age of 72 years (interquartile range 63–81) and a mean survival time of 9 months. In the derivation cohort, 1,469 patients (11%) had early stage, 4,202 (32%) had advanced stage disease, and 7,417 (57%) had unknown stage. The following factors were associated with an increased risk of death by more than 10%: tumor in the tail of the pancreas; advanced stage; hospitalization 3 months before diagnosis; congestive heart failure or dementia; low, moderate, or high pain score; moderate or high appetite score; high dyspnea and tiredness score; and a performance status score of 60–70 or lower. The calibration plot indicated good agreement with a C-index of 0.76.**

DISCUSSION: **This model accurately predicted one-year survival for PDAC using clinical factors, symptoms, and performance status. This model may foster shared decision making for patients and their providers.**

KEYWORDS: pancreatic cancer; prediction model; survival

SUPPLEMENTARY MATERIAL accompanies this paper at http://links.lww.com/CTG/B225

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PANCREAS

INTRODUCTION

Patients with pancreatic ductal adenocarcinoma (PDAC) face challenging treatment decisions immediately following their diagnosis (1). While there is available cancer-directed therapy including surgery, chemotherapy, and radiation alone or in combination, prognosis is dismal with an overall 5-year survival of $<$ 10% (2,3). Current guidelines emphasize treatment decisions based on cancer location (4,5). Patient age and comorbidities may also inform treatment choices due to the risk of non-cancer-related death and adverse outcomes with therapy (6,7). To provide patients with individualized prognostic information and help inform initial treatment decisions, a prediction model specific to PDAC is needed.

There are more than 40 published PDAC prognostic models (8). Only 3 models have been developed using the entire spectrum of PDAC, including patients with resectable, unresectable, and metastatic disease (9–11). These prior models have several limitations. One model did not report overall survival as an outcome (11). None of the 3 models incorporated patient comorbidities and functional status, 2 key factors involved in treatment decision making. Finally, no prior model provided prognostic information based on initial cancer-directed therapy.

Many patients with PDAC do not have specialized cancer consultations or receive cancer-directed therapy (12). This disparity in cancer-related care may indicate a gap on the care pathway. Patients who receive cancer-directed therapies have been shown to have higher survival, fewer healthcare visits and hospitalizations near the end of life, and lower odds of dying in a hospital compared with those who received no cancer-directed therapy when controlling for comorbidity, socioeconomic factors, and initial cancer location and stage (13). A lack of credible information regarding survival and quality-of-life (QOL) outcomes may lead to undertreatment, with patients declining treatments due to low chance of cure, or overtreatment and exposure to aggressive measures with minimal efficacy and harmful side effects (14).

To address these gaps, we developed and validated a survival prognostication model for PDAC incorporating routinely collected clinical information, patient-reported symptoms, and performance status. When combined with a second model under development that will aim to provide QOL data, this tool may be used by patients to learn about survival and quality-of-life estimates based on their clinical profile and initial treatment choices.

METHODS

We performed a population-based, retrospective study of data from adults diagnosed with PDAC using the provincial cancer registry in Ontario, Canada, from January 1, 2007, to December 31, 2020. All data sets were linked using unique encoded identifiers and analyzed at the Institute for Clinical Evaluative Sciences (ICES). Using deidentified secondary data, analysis for this project was authorized under section 45 of Ontario's *Personal Health Information Protection Act* (15). This study received ethical approval from the Ottawa Hospital Research Institute. This study followed the Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis or Diagnosis reporting guideline (16).

Data Sources

We used the following linked administrative databases: (i) Ontario Cancer Registry (cancer type, stage); (ii) Vital Statistics (age, sex, date of death); (iii) Statistics Canada (distance from cancer center); (iv) Activity Level Reporting (chemotherapy regime, radiation treatment); (v) Discharge Abstract Database (hospitalization dates, diagnoses, cancer surgery, comorbidity); (vi) National Acute Care Registry System (Emergency Department (ED) visits); (vii) physician billing (physician home visits for palliative care, rostered patient); (viii) Home care database (end of life home care service use); (ix) Ontario Drug Benefit (long-term care status); (x) Symptom Management Dataset (symptoms, performance status); and (xi) interRAI database (performance status, symptoms).

Symptoms and Performance Status

Since 2007, when routine systematic symptom screening of patients with cancer was mandated by Cancer Care Ontario, the Symptom Management database has included patient-completed data for symptoms and performance status using the Edmonton Symptom Assessment System (ESAS) (17) and Palliative Performance Scale (PPS) (18), respectively. The ESAS includes 9 symptoms (pain, depression, well-being, shortness of breath, anxiety, nausea, tiredness, drowsiness, and appetite) scored on a scale of 0 (symptom absent) to 10 (most severe) (17). The PPS is scored from 0 to 100 in 10-point increments: 0 indicating dead, 10–30 indicating end of life, 40–70 indicating transitional, and 80–100 indicating stable (18). Each patient undergoing consultation or treatment at a cancer center in Ontario is eligible to complete these assessments.

The interRAI database was initiated in 2002 in Ontario after the mandatory implementation of the Resident Assessment Instrument (19) for home care services. This is a standardized tool used for patients who are receiving publicly funded home care services for at least 60 days. The tool includes approximately 300 distinct items that assess various aspects of QOL including the presence of moderate-to-severe pain or depression, whether a caregiver lives in the patient's home, and the patient's performance status as determined by the health instability Changes in Health, End-Stage Disease and Signs and Symptoms (CHESS) scale (which considers changes in decision making, changes in activities of daily living, and the progression of end-stage disease) (20). The ESAS, PPS, and Resident Assessment Instrument have strong evidence of validity in clinical settings (21–23).

Cohort

Inclusion criteria included Ontario residents, with eligibility for the Ontario Health Insurance Plan coverage for at least 1-year preceding PDAC diagnosis; age 18–105 years at diagnosis; and availability of key data elements (age, sex, diagnosis date). We excluded patients with pancreatic neuroendocrine tumors and death date before or on the date of diagnosis. We also excluded patients who were not eligible for Ontario Health Insurance Plan at their PDAC diagnosis date or lost eligibility before their death or at the end of the study period. These patients would not have been captured in administrative databases, which are linked through health insurance numbers.

Outcome

The primary outcome was time to death (in days) from the date of diagnosis (index date). The date of death was available from the Vital Statistics database. We aimed to estimate the predicted probability of one-year survival.

Covariates

The following covariates were considered to build the prediction model: demographic characteristics (age at diagnosis, sex, caregiver living with patient [yes/no], lives within 50 km of a cancer center [yes/no]) (12); cancer location and stage; comorbidities (1 of 13 other chronic diseases as determined by validated algorithms) (24,25); cancer-directed therapy, including receipt of chemotherapy (yes/no), receipt of radiation treatment (yes/no) and/or cancer surgery (yes/no) in the past (from diagnosis up to 3 months previously), and ongoing (within the past 3 months) (13); patient-reported outcomes (performance status as reported by PPS and ESAS 9 symptom scores within 3 months of index date); and healthcare use within 3 months of index date (prior hospitalization, hospitalizations for palliative care including palliative care consultations, living in long-term care, receipt of end-of-life homecare services, having a regular family physician, and received physician home-visit).

Statistical Analysis

Development of Prediction Algorithm. We randomly selected 75% of eligible patients for model derivation and used the other 25% for model validation. We compared the distributions of baseline characteristics between the derivation and validation cohorts. Using the derivation cohort, we used a multivariable Cox proportional hazards regression model, incorporating the baseline characteristics listed above, to predict the 1-year probability of survival. Missing data from patient-reported categorical variables were handled by creating an additional missing category for that variable. For missing stage data, we elected to impute stage into early stage (stage I or II) or advance stage (stage III or IV) instead of removing these patients from the analysis entirely. This was done by single imputation by regression, after confirming a high level of model discrimination. Backward stepwise selection was used to select the characteristics into the final prediction model, with a liberal 2-sided $P < 0.10$ as the retention criteria (26,27) (see Appendix Table 1, http://links.lww.com/CTG/B225). Significant ($P < 0.10$) 2-way interactions between age, sex, treatment group, tumor location, comorbidity, and symptoms were incorporated into the model with the goal of achieving maximum discriminative ability within the derivation cohort as determined by the concordance index (C-index).

Validation of Prediction Algorithm. After the final regression model was established, the 1-year predicted probability of death was calculated for each patient in the validation cohort based on their specific covariate values, the estimates of the regression parameters, and the estimate of the baseline hazard function. Calibration (how close the model-estimated risk is to the observed risk) was examined by grouping patients into deciles of model-estimated 1-year risk of death. We then reviewed the plot of the observed against the predicted 1-year probabilities of death for patients across deciles to assess their distance from the ideal 45-degree line.

We measured the model's discriminative ability (ability to distinguish between patients who died from those who did not die) using the C-index (28). Concordance for survival data was calculated as the proportion of pairs in which the patient who died had a higher predicted probability than the patient who did not die. The C-index lies between 0.5 and 1, with a value of 0.5 implying that the prediction model is performing no better than random chance, and a value of 1 implying that the risk model discriminates for the outcome of interest 100% of the time (29,30). All analyses were conducted using the statistical SAS, version 9.3 (SAS Institute Inc).

Sensitivity Analyses. We performed 2 sensitivity analyses. To determine whether our decision to impute cancer stage affected mortality predictions, we assessed model performance using nonimputed cancer stage instead of imputed stage (early stage and III/IV). Within this sensitivity analysis, we further assessed nonimputed stage compared with unknown stage as its own category. Second, we assessed whether model performance may have been affected by the introduction of FOLFIRINOX (oxaliplatin, irinotecan, fluorouracil, and leucovorin) therapy for PDAC by using a subset of patients with a diagnosis date from 2011 to 2019. FOLFIRINOX

Table 1. Distributions of baseline characteristics of the study cohort for the derivation and validation sets

Baseline characteristics[a]	Derivation set N = 13,088 (%)	Validation set N = 4,362
Sex		
Female	6,359 (48.6%)	2,143 (49.1%)
Tumor location		
Body of pancreas	2,025 (15.5%)	700 (16.1%)
Head of pancreas	5,750 (43.9%)	1,898 (43.5%)
Tail of pancreas	1,571 (12.0%)	508 (11.7%)
Cancer stage		
I	291 (2.2%)	84 (1.9%)
II	1,178 (9.0%)	432 (9.9%)
III	1,030 (7.9%)	339 (7.8%)
IV	3,172 (24.2%)	1,082 (24.8%)
Treatment type		
No cancer-directed therapy	7,175 (54.8%)	2,388 (54.8%)
Surgery alone	898 (6.9%)	303 (7.0%)
Chemotherapy alone	3,572 (27.3%)	1,180 (27.1%)
Radiation	493 (3.8%)	171 (3.9%)
Surgery followed by chemotherapy	950 (7.3%)	320 (7.3%)
Distance to nearest cancer centre <50 km	10,189 (77.9%)	3,396 (77.9%)
Hospitalization in the 3 months before diagnosis	7,694 (58.8%)	2,535 (58.1%)
Comorbidities		
Congestive heart failure	495 (3.8%)	181 (4.2%)
Dementia	474 (3.6%)	185 (4.2%)
Diabetes	3,722 (28.4%)	1,272 (29.2%)
Performance status[b]		
100 (stable)	501 (3.8%)	162 (3.7%)
80–90	1,591 (12.2%)	492 (11.3%)
60–70	1,122 (8.6%)	422 (9.7%)
40–50	839 (6.4%)	264 (6.1%)
10–30 (end of life)	93 (0.7%)	31 (0.7%)
Pain score		
None	834 (6.4%)	299 (6.9%)
Low	1,480 (11.3%)	492 (11.3%)
Moderate	1,425 (10.9%)	481 (11.0%)
High	1,217 (9.3%)	373 (8.6%)
Dyspnea score		
None	1,962 (15.0%)	661 (15.2%)
Low	1,381 (10.6%)	453 (10.4%)
Moderate	931 (7.1%)	328 (7.5%)
High	675 (5.2%)	200 (4.6%)
Tiredness score		
None	263 (2.0%)	93 (2.1%)
Low	913 (7.0%)	285 (6.5%)

Table 1. (*continued*)

Baseline characteristics[a]	Derivation set N = 13,088 (%)	Validation set N = 4,362
Moderate	1,575 (12.0%)	551 (12.6%)
High	2,207 (16.9%)	714 (16.4%)
Appetite score		
None	610 (4.7%)	207 (4.8%)
Low	835 (6.4%)	296 (6.8%)
Moderate	1,386 (10.6%)	458 (10.5%)
High	2,119 (16.2%)	681 (15.6%)
Anxiety score		
None	942 (7.2%)	305 (7.0%)
Low	1,404 (10.7%)	469 (10.8%)
Moderate	1,378 (10.5%)	482 (11.1%)
High	1,229 (9.4%)	387 (8.9%)

[a]Percentages do not total 100% because the missing category is not shown.
[b]Performance status ranges from 0 to 100 (in 10-point increments), with 80 to 100 indicating stable, 40 to 70 indicating transitional, 10 to 30 indicating end of life, and 0 indicating dead.

therapy was shown in 2011 to have a positive impact on overall survival in PDAC (31).

Hypothetical Scenarios. To demonstrate how the model may support shared decision making, we considered 2 hypothetical clinical scenarios based on real-world cases and inputted the following baseline variables to generate 1-year survival estimates: (i) A 45-year-old woman with no comorbidities, stage I PDAC in the pancreatic head, Eastern Cooperative Oncology Group (ECOG) score of 0, good appetite, low anxiety level, and no pain and (ii) a 63-year old man with diabetes, stage III PDAC in the pancreatic head, ECOG score of 2, mild pain, moderately reduced appetite, and moderate tiredness.

RESULTS

We included 17,450 patients (49% female) diagnosed with pancreatic cancer from 2007 to 2020 with a median age of 72 years (interquartile range 63–81 years) and a mean survival time of 9 months. The derivation and validation cohorts have similar baseline characteristics (Table 1).

Cohort Characteristics

In the derivation cohort, 1,469 patients (11%) had stage I or II disease, 4,202 (32%) had stage III or IV disease, and 7,417 (57%) had unknown stage disease. Within the first four months of diagnosis, 7% of patients had surgery and chemotherapy, 7% had surgery alone, 27% had chemotherapy, 4% underwent radiation therapy, and 55% underwent no cancer-directed therapy. The majority of patients in the surgery and chemotherapy group underwent neoadjuvant chemotherapy before surgery. Of the ESAS assessments performed within 3 months of diagnosis, 13% of patients reported moderate-to-high pain and 6% reported no pain. In terms of performance status as measured by the PPS, 1,961 patients (15%) were in the transitional stage and 93 (0.7%) were in the end-of-life stage. Performance status data were missing for 68% of patients within 3 months of their diagnosis.

Development and Validation

After performing backward stepwise selection, the estimates of the main effects are presented in Table 2. The following factors were associated with an increased risk of death by more than 10%: location in the tail of the pancreas; advance stage disease; hospitalization for any reason in the 3 months before diagnosis; congestive heart failure or dementia; low, moderate, or high pain score; moderate or high appetite score; high dyspnea score; high tiredness score; and performance status score of 60–70 or below.

Receipt of any of the 4 types of cancer-directed therapy (surgery and chemotherapy, surgery alone, chemotherapy alone, radiation therapy alone) was associated with a decreased risk of death by more than 10% (Table 2). Multiple interactions were investigated and only those that were statistically significant and clinically relevant were included. Two-way interactions included in the model were as follows: age and sex; cancer stage and sex; appetite score and sex; dementia and sex; treatment group and age; treatment group and location of pancreatic tumor; treatment group and cancer stage; and treatment group and anxiety.

Figure 1 shows the calibration plot of the validation cohort, which indicates good agreement between the observed probabilities and predicted probabilities across deciles of risk. The model performed well within all deciles; however, model's performance was better within the lower predicted survival deciles. Model discrimination in the validation cohort was very good, with a C-index of 0.76.

Sensitivity Analysis

Limiting the model to cases with known cancer stage, the C-index of the validation cohort was 0.76. When we included all patients and included unknown as a stage, the C-index of the validation cohort was 0.76. When we limited the model to only include

Table 2. Estimates of main effects after backward selection (training data)

Variables	Hazard ratio (95% CI)
Mean age at diagnosis	1.008 (1.001–1.016)
Sex	
Female	0.88 (0.85–0.92)
Tumor location	
Head of pancreas	0.85 (0.80–0.90)
Tail of pancreas	1.23 (1.11–1.33)
Body of pancreas	1 [reference]
Cancer stage at diagnosis	
1 or 2	1 [reference]
3 or 4	1.42 (1.33–1.51)
Treatment type	
Chemotherapy alone occurring as the first treatment within 120 d of diagnosis	0.42 (0.40–0.45)
Radiation	0.72 (0.65–0.79)
Surgery	0.29 (0.26–0.32)
Surgery followed by chemotherapy	0.16 (0.14–0.19)
No cancer-directed therapy	1 [reference]
Distance to nearest cancer centre <50 km	0.94 (0.89–0.98)
Hospitalization in the 3 months before diagnosis	1.41 (1.35–1.47)
Comorbidities	
Congestive heart failure	1.13 (1.03–1.25)
Dementia	1.14 (1.03–1.25)
Diabetes	1.06 (1.01–1.11)
Performance status[a]	
100 (stable)	1 [reference]
80–90	1.13 (0.98–1.30)
60–70	1.34 (1.16–1.55)
40–50	1.51 (1.30–1.76)
10–30 (end of life)	1.72 (1.33–2.23)
Pain score	
None	1 [reference]
Low	1.145 (1.015–1.291)
Moderate	1.179 (1.042–1.334)
High	1.420 (1.246–1.618)
Dyspnea score	
None	1 [reference]
Low	1.09 (1.00–1.20)
Moderate	1.05 (0.95–1.16)
High	1.16 (1.04–1.29)
Tiredness score	
None	1 [reference]
Low	0.99 (0.81–1.21)
Moderate	1.16 (0.95–1.41)
High	1.31 (1.07–1.60)
Appetite score	
None, best appetite	1 [reference]
Low	1.08 (0.93–1.26)
Moderate	1.21 (1.05–1.40)
High, worst appetite	1.48 (1.28–1.71)
Anxiety score	
None	1 [reference]
Low	0.87 (0.78–0.96)
Moderate	0.88 (0.79–0.98)
High	0.81 (0.72–0.90)

[a]Performance status ranges from 0 to 100 (in 10-point increments), with 80 to 100 indicating stable, 40 to 70 indicating transitional, 10 to 30 indicating end of life, and 0 indicating dead.

patients diagnosed with PDAC from 2011 to 2019, the C-statistic from the validation cohort was 0.77.

Hypothetical Scenarios

In the first scenario, the 45-year-old woman with no comorbidities with stage I pancreatic head PDAC, ECOG of 0, and mild symptoms had a one-year survival of 85% with surgery and chemotherapy treatment. With the same baseline characteristics, the other treatment pathways of chemotherapy alone, surgery alone, radiation alone, and no treatment predict one-year survival rates of 83%, 84%, 65%, and 78% respectively.

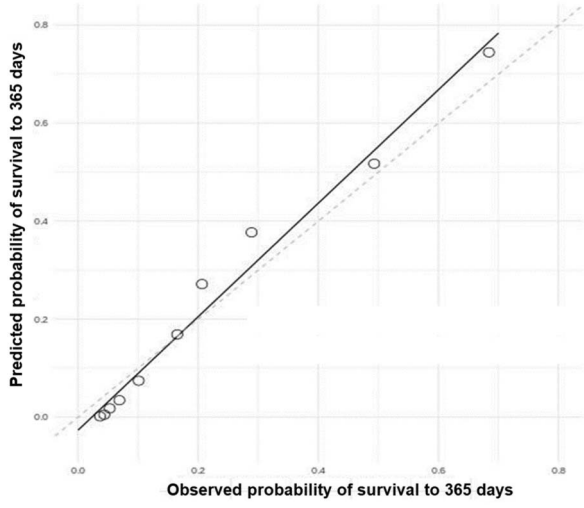

Figure 1. Calibration plot from validation set. Dots represent the deciles of patients' observed 1-year probability of death plotted against their predicted 1-year probability of death. The dashed line is the ideal 45-degree line.

In the second scenario, a 63-year old man with diabetes and stage III pancreatic head PDAC with an ECOG score of 2 and mild-to-moderate symptoms had a one-year survival of 56% with surgery and chemotherapy or surgery alone. With the same baseline characteristics, the other treatment pathways of chemotherapy alone, radiation alone, and no treatment predict one-year survival rates of 48%, 31%, and 24% respectively.

DISCUSSION

In this study, we developed and validated a predictive survival model that can be used to support shared decision making for patients with PDAC and clinicians. Our results were based on a large population-based cohort that included patients with various cancer stages and tumor locations, baseline demographics and comorbidities, initial symptom severity and performance status, and initial cancer-directed treatment. Our model had good calibration and strong discriminative ability to distinguish patients who died compared with those who did not die, with a C-index of 0.76 that remained robust through a series of sensitivity analyses.

In a 2022 systematic review (8), Ioannou et al identified 49 prognostic models to predict survival for patients with PDAC. Five models showed strong discriminative ability in a validation cohort with C-index above 0.70 (11,32–35), of which 2 had robust sample sizes $>$ 500 (11,33). In one study, Song et al used a large validation cohort of 26,455 patients using the Surveillance Epidemiology and End Results program to develop their model (11). The model was limited by a lack of incorporation of patient comorbidities and using a dichotomous treatment variable (surgery versus no surgery). In the other model developed using a large cohort, Dasari et al (33) reported prognosis after pancreaticoduodenectomy for patients with PDAC, distal cholangiocarcinoma, ampullary carcinoma, or duodenal carcinoma. This study lacked generalizability to the broader PDAC population as it only included patients who underwent surgery.

By contrast, our model captures a broad range of patient presentations across the spectrum of patient and disease-specific characteristics. We included patient-reported measures of performance status and symptom severity captured in population-based databases using validated tools (17,18,21,22). In addition, we incorporated initial cancer-directed therapy (surgery and chemotherapy, surgery alone, chemotherapy alone, radiation alone, no cancer-directed therapy), a factor associated with mortality and QOL outcomes (13).

Numerous prior PDAC prognosis models have incorporated factors that are only available to healthcare professionals, such as biomarkers and primary tumor size and histology (8). By contrast, the covariates inputted into our model are self-reportable by patients. This feature can allow our model to be incorporated into a patient-facing tool to support shared decision making. In considering the substantial variability in response to cancer-directed therapies, this tool may help patients examine survival estimates based on information available at the time of their diagnosis. Discussions based on information presented in the hypothetical scenarios above may inform discussions around incorporating palliative care and proactive symptom management early into treatment plans. The poor survival among patients with PDAC deepens the potential value of treatment approaches aimed at improving of QOL (36,37).

This study has notable limitations. First, primary stage data were missing for a large portion of included patients. We addressed this issue by applying a highly discriminatory prediction model to impute cancer stage based on prediction variables within the cohort. Based on sensitivity analyses, the inclusion of patients with imputed stage data did not significantly change the observed trends. Second, we lacked biomarker data which may affect prognosis (38). Third, symptom and performance status data were missing for more than 60% of patients. Fourth, imaging and laboratory data were unavailable and therefore could not be included in the model, which may affect prognosis. Fifth, some treatment options could not be captured in our model. For instance, neoadjuvant chemotherapy followed by surgical resection could not be included in the prediction model. Finally, we examined ESAS scores within 3 months of diagnosis and as such, some scores might have been obtained after selection of treatment, introducing a potential time bias.

This study has several strengths. It is an accessible and pragmatic predictive model using readily available data that may be built into patient-facing and provider-facing tools. Our use of high-quality population level databases adds generalizability to our findings. In addition, we used clinically relevant variables and characterized demographic, clinical, and patient-reported variables using previously validated codes through administrative databases. Our model is also unique in contrast to prior prognosis models as we provide survival estimates based on index cancer treatment (or lack thereof).

In conclusion, we developed and validated a one-year survival risk model for patients with PDAC using routinely available administrative healthcare data including clinical factors and patient-reported symptoms and performance stays. Future work will focus on integrating symptom, QOL, and performance status as outcomes into this model, building a patient-facing tool, and testing and refining the tool with patients and families. These steps would further support this model's utility for patient-centered care in PDAC, support patients' engagement with their healthcare providers, and help foster shared decision making.

CONFLICTS OF INTEREST

Guarantor of the article: Paul D. James, MD, MSc.

Specific author contributions: P.D.J., F.A., M.S., and R.K. played roles in planning and conducting the study, collecting and interpreting data, and drafting the manuscript. B.A. critically reviewed the manuscript and led the revisions in response to the reviewers' comments. R.T. and A.G. contributed significantly to the analysis and interpretation of data, and drafting of the manuscript. C.W. and H.S., P.T., A.T.H., N.C., and R.S. were involved in data collection, study planning, and manuscript drafting. C.W. participated in data interpretation and manuscript drafting. All authors, as per the ICMJE guidelines, have reviewed and approved the final draft submitted for publication.

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Potential competing interests: None to report.

IRB approval: This study was reviewed and approved for research by local REB.

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Study Highlights

WHAT IS KNOWN

- ✓ Patients with pancreatic ductal adenocarcinoma face challenging treatment decisions immediately following their diagnosis.
- ✓ Current guidelines emphasize treatment decisions based on cancer location only.
- ✓ Patient age and comorbidities may also inform treatment choices due to the risk of non-cancer-related death and adverse outcomes with therapy.

WHAT IS NEW HERE

- ✓ A model designed to provide patients with individualized prognostic information and help inform initial treatment decisions.
- ✓ Model incorporates routinely collected clinical and demographic information, patient-reported symptoms, and performance status.
- ✓ Our validated model has strong discriminative ability to accurately predict survival among patients with pancreatic ductal adenocarcinoma.

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