ORIGINAL ARTICLE

Determination of "borderline resectable" pancreatic cancer – A global assessment of 30 shades of grey

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Abstract

Background: Pancreatic ductal adenocarcinoma (PDAC) is an aggressive cancer with a poor prognosis. Accurate preoperative assessment using computed tomography (CT) to determine resectability is crucial in ensuring patients are offered the most appropriate therapeutic strategy. Despite the use of classification guidelines, any interobserver variability between reviewing surgeons and radiologists may confound decisions influencing patient treatment pathways.

Methods: In this multicentre observational study, an international group of 96 clinicians (42 hepatopancreatobiliary surgeons and 54 radiologists) were surveyed and asked to report 30 pancreatic CT scans of pancreatic cancer deemed borderline at respective multidisciplinary meetings (MDM). The degree of interobserver agreement in resectability among radiologists and surgeons was assessed and subgroup regression analysis was performed.

Results: Interobserver variability between reviewers was high with no unanimous agreement. Overall interobserver agreement was fair with a kappa value of 0.32 with a higher rate of agreement among radiologists over surgeons.

Conclusion: Interobserver variability among radiologists and surgeons globally is high, calling into question the consistency of clinical decision making for patients with PDAC and suggesting that central review may be required for studies of neoadjuvant or adjuvant approaches in future as well as ongoing quality control initiatives, even amongst experts in the field.

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Introduction

The management of pancreatic ductal adenocarcinoma (PDAC) is challenging, largely due to its biological characteristics, complicated by anatomical location and generally late presentation due to minimal early symptoms.[1] Unfortunately, the rate of pancreatic cancer diagnosis and death continues to rise in the US and developed world and is predicted to become the second commonest cause of cancer death by the end of the decade.[2] PDAC now accounts for a disproportionate number of cancer-related deaths with a 1-year survival of 40% and a 5-year survival rate of 11%.[3] Surgical resection with negative margins plus neo/adjuvant chemotherapy remains the only potentially curative treatment option for localised disease characterised by favourable anatomical features.[1] In this regard, preoperative assessment is crucial to determine appropriate management.[1]

PDAC can be clinically categorised into resectable, borderline resectable and unresectable disease (locally advanced or metastatic).[1] Resectable disease carries a median survival 32 months while unresectable disease median survival is 12 months.[4,5]

Borderline resectable disease is determined based on a combination of primarily anatomical features plus biological and patient factors.

The anatomical extent of tumour is best assessed with computed tomography (CT) using a pancreatic protocol for local staging.[6] Surgical resectability is determined based on the tumour relationship with surrounding vascular structures and the presence of metastatic disease. Several slightly differing guidelines exist that define pancreatic cancer resectability (MD Anderson Centre Guidelines,[7] National Comprehensive Cancer Network (NCCN) Guidelines,[8] International Consensus,[9] Alliance A021101 guidelines[10]). Based on the International Consensus criteria (2017), the anatomical definition of borderline resectable PDAC describes a tumour that is at high risk for margin positive resection when surgery is used as the initial treatment strategy. Hence, neoadjuvant therapy is recommended to increase the chance of a R0 resection.[9]

Despite the use of clear and well-established guidelines for assessment of surgical resectability on CT, there remains subjectivity in the interpretation of CT scans among clinicians.[11,12] Achieving consensus and consistency in assessing resectability in pancreatic cancer is important. CT assessment of the resectability of PDAC has a direct influence on treatment pathways and therefore may influence patient outcomes including survival and treatment associated morbidity, making international comparisons difficult to interpret. Accurate consistent reproducible assessment is also important in the design of clinical trials comparing different interventions for patients with various stages of disease.

This study aimed to examine the strength of agreement and probability of diagnosis in the assessment of resectability in PDAC by radiologists and surgeons globally and whether these probabilities were influenced by factors such as experience, guidelines, and practice location.

Methods

This study was approved by the Monash Health Human Research Ethics Committee with site governance approval from seven large teaching hospitals. CT images of patients deemed to have borderline resectable pancreatic cancer at multidisciplinary meetings (MDM) were uploaded onto an image biobank. Eligible patients for this biobank were selected from the Upper Gastrointestinal Cancer Registry (UGICR)[13,1]. Being a low-risk retrospective study, waiver of consent was approved.

Study outcomes

The first aim of the current study was to assess the interobserver agreement between an international group of hepatopancreatobiliary (HPB) surgeons and abdominal radiologists who reviewed these images. The second aim was to determine whether the predicted probability of diagnosis, by resectability category, was influenced by reviewer specialty, years of experience, chosen resectability guidelines, or geographic location.

Patient selection

Patients participating in the UGICR who met the inclusion criteria and were treated or diagnosed at one of seven participating health services were included in the image biobank. Eligible patients must have been under 70 years of age at the time of the staging CT and recorded as having adequate functional status as demonstrated satisfying one of the following: undergone resection, received multi-agent chemotherapy or were either ECOG <2, Karnofsky Grade >80, or ASA score <4.

Diagnostic images files and identifiable metadata from the patient participants were obtained from the participating sites. Identifiable metadata was then removed from the image data and a unique study identification number was assigned to ensure re-identification with UGICR if required. Images from 118 participants were included in the image biobank.

Image biobank

XNAT, an open-source imaging informatics platform was selected to host the de-identified image biobank.[14] Patients classified as having borderline resectable disease in the UGICR database were selected, providing 50 eligible patients. The available scans for these patients were accessed from the respective institutions and reviewed by an experienced HPB surgeon (DC) and a radiologist with experience in pancreatic CT (JG) to determine suitability for the study. 20 individual patient studies were deemed unsuitable for review. Reasons included the lack of a portal venous phase, non-contrast imaging, post-operative CT scans or inadequate pancreatic visualisation. 30 CT scan image sets were included in the study. The study team agreed that this number of scans represented an acceptable number for clinicians (HPB surgeons and expert radiologists) to review, allowing for approximately 10 min per scan.

Reviewer recruitment

A group of Australian and international HPB surgeons and HPB radiologists were invited to review the 30 CT scan sets. Clinicians were identified through personal networks and professional groups and associations. Interested participants provided demographic, clinical training and clinical practice information through an on-line survey. This information included participation in multi-disciplinary meeting (MDM), clinical practice volume, training experience as well as preferred definition of resectability (the MD Anderson Centre Guidelines,[7] the National Comprehensive Cancer Network (NCCN) Guidelines,[8] the International Consensus[9] and the Alliance A021101 guidelines[10] of other unspecified guidelines).

[1] The UGICR is an Australian clinical quality registry established in 2016 that collects information about the diagnosis, treatment, and outcomes of individuals with an upper gastrointestinal cancer, developed as a mechanism to monitor and report on quality of care.

Image review

Clinician reviewers were granted image biobank access and asked to review each CT (examples provided in Appendix 2). These were presented to each reviewer in a random order to eliminate the risk of case order causing bias and to maximise the probability of an even distribution of reads per scan where reviewers failed to read all scans. No patient information was provided to reviewers. While all 30 scans were recorded as being borderline resectable, reviewers were unaware of this. Reviewers were asked a series of specific questions (see below) as well as their opinion on the diagnostic adequacy of CT scans (acceptable, borderline, unacceptable). There was no time limit for reviewers to assess the scans. Images were assessable in axial and multiplanar format and window level settings were freely adjustable.

Reviewers were asked specific questions based on the International Consensus Guidelines.[9] These included the anatomical associations with the superior mesenteric artery, coeliac artery, common hepatic artery and superior mesenteric vein and portal vein. Anatomical association options were 1) no contact, 2) contact <180° without deformity/stenosis, or 3) contact/invasion >180°. Participants were also asked whether they believed each vessel was eligible for resection or reconstruction. Reviewers then ultimately recorded their assessment of resectability as: i) resectable, ii) borderline resectable - arterial, iii) borderline resectable – venous, iv) locally advanced or v) metastatic.

Statistical analysis

All statistical analyses were performed using Stata/IC 17.0 (StataCorp LLC, College Station, TX, USA). A concordance statistic was used to assess reviewing clinician agreement with the UGICR assessment pf borderline resectable based on anatomic criteria. A reviewer's opinion was considered in agreement with the UGICR database if deemed either borderline resectable – arterial, or borderline resectable – venous.

Interobserver variability in clinician CT interpretation and clinician demographic and training characteristics were quantified using the Kappa statistic. Kappa interpretation was based on the Landis and Koch (1977) guidelines.[15] Values from 0.0 to 0.2 indicate slight agreement or no agreement, 0.21 to 0.40 indicate fair agreement, 0.41 to 0.60 indicate moderate agreement, 0.61 to 0.80 indicate substantial agreement, and 0.81 to 1.0 indicate near perfect or perfect agreement.[15]

An ordinal logistic regression analysis was conducted to estimate the odds of a reviewer selecting a more advanced resectability classification by use of the following predictor variables: the reviewers' practice location, preferred definition of resectability, specialty type, experience, and usual practice case-load volume. Substantial effects were observed for practice location, clinical specialty, and preferred definition of resectability. These predictor variables were fitted to a multivariable ordinal regression model, from which the predicted probabilities of a reviewer selecting a particular diagnosis were estimated. Unadjusted odds ratios for a reviewer choosing a one-unit increase in resectability were predicted from univariable ordinal regression models.

Results

Patient demographics

All 30 patients had borderline resectable disease as documented in the UGICR record of the MDM decision. There was a slightly higher proportion of female patients (n = 17, 56.7%). The median survival of the recruited patient population was 19 months. All patients were of good performance status. Patient characteristics are summarised in Appendix 1.

Reviewer recruitment and demographics

143 clinicians registered interest (see CONSORT diagram, Fig. 1), 96 commenced case reviews and 77 completed all 30 case reviews (n = 33 surgeons; n = 44 radiologists). The largest group of clinicians who completed case reviews were from Australian and New Zealand (n = 35, 46%) followed by Europe (n = 26; 33%) and North America (n = 12, 15%). 70 reviewers (73.4%) had at least six years of experience in specialist practice with the vast majority regularly participating in HPB MDMs (91%). Most case reviewers utilised the NCCN guidelines (58%) followed by the international consensus guidelines (36%). 3% used the MD Anderson guidelines (3%) with the remaining 3% using other guidelines.

CT scan quality

Included scans were overwhelmingly considered to be acceptable. One scan was considered unacceptable by most reviewers (72%). 80% of scans (n = 24) were considered acceptable by most reviewers (59%–92%) while the remaining 16.7% of scans (n = 5) were considered either borderline or acceptable.

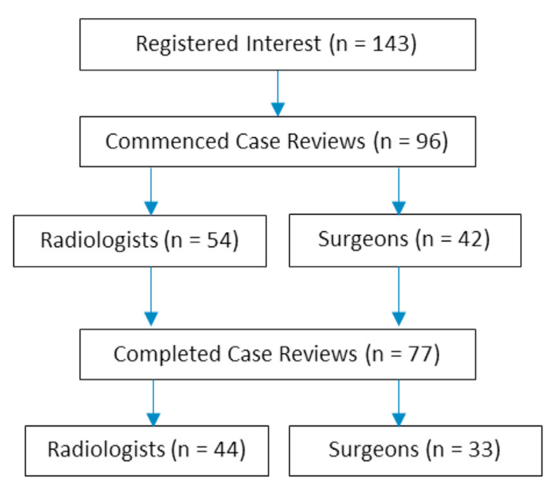

Figure 1 Clinician recruitment CONSORT diagram

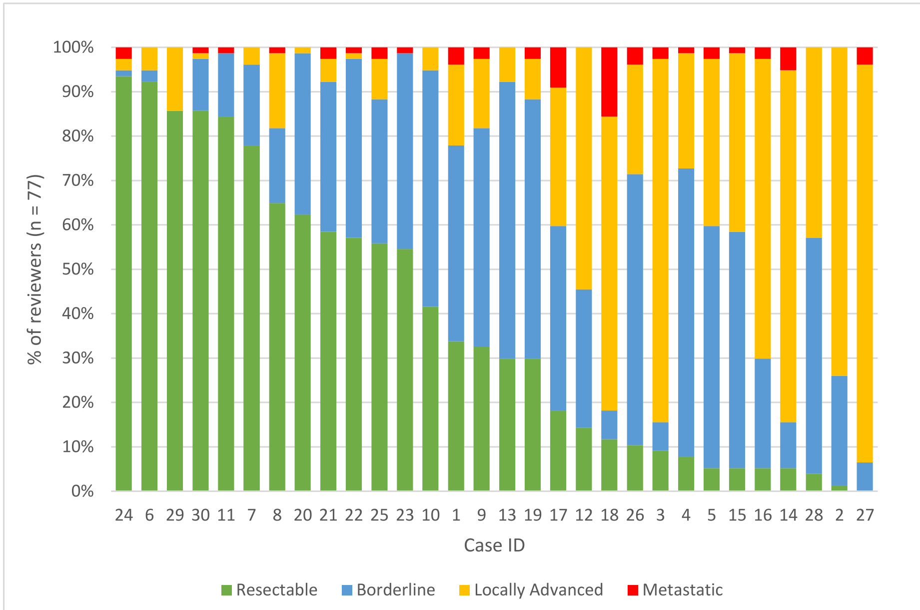

Figure 2 Reviewer determine anatomical resectability status of 30 included cases

Interobserver agreement between reviewers

a) Resectability status

Resectability classification data were categorised as 1) resectable (i), 2) borderline resectable (ii and iii) and 3) unresectable (iv and v). There was a high degree of variability in assessment of operability status between reviewers (Fig. 2). There were no cases where opinion on resectability was unanimous. Agreement of over 90% occurred in three cases and of these, two were deemed by 93.5% and 92.2% respectively to be resectable and one deemed by 89.6% to be locally advanced.

There was fair agreement among all reviewers (k = 0.32). Agreement was moderate in reviewers in North America (k = 0.41), and radiologists with 16–30 years' experience (k = 0.42). Agreement among surgeons and radiologists was similar (surgeons k = 0.31, radiologists k = 0.33).

b) Vessel involvement

Kappa values for radiologists interpreting tumour vessel contact were generally higher than that of surgeons with the highest degree of interobserver agreement being demonstrated among radiologists agreeing on the absence of tumour vessel contact. Tumour contact with the common hepatic artery (CHA) without invasion into the coeliac artery (CA) or proper hepatic artery (PHA) yielded the lowest degree of interobserver agreement. Interobserver agreement was poorest for BR-A patients and CHA contact/invasion without PHA/CA contact (Fig. 3).

c) Variation in reviewer characteristics

Most reviewer characteristics did not influence the degree of interobserver agreement (mostly "Fair"). North America-trained reviewers, and radiologists who reviewed 16–30 scans a month had higher interobserver agreement ("Moderate") (Table 1).

Based on the location of the reviewers' practice (Fig. 4) there was little difference in the odds of selecting a more advanced resectability classification for those based in Europe, North America, or Africa, when compared to Australia/Oceania (baseline). However, there was an observed increase in the odds of selecting a more advanced resectability classification for those based in Asia or South America (OR = 1.69 (95% CI: 1.03 to 2.79) and 1.70 (95% CI: 0.90 to 3.21) when compared to Australia/Oceania. The broad confidence intervals suggest that this difference in odds may range from no difference to a large difference. When comparing specialty, surgeons had lower odds (OR = 0.80 (95% CI: 0.68 to 0.93) of selecting more advanced disease, when compared to radiologists (Appendix 3).

Reviewers using the International Convention guidelines had similar odds of diagnosing a more advanced resectability classification to those using NCCN (baseline) guidelines (Fig. 5), whereas those using the MDACC guidelines had approximately 50% higher odds of selecting a more advanced resectability classification. Those using other guidelines had lower odds of selecting a more advanced resectability classification compared to the reference group. No differences in the predicted odds of a more advanced resectability classification were observed for the reviewers' experience (years of practice), number of scans per

		All Observers	Radiologists	Surgeons	≤2 resections/mo†	≥3 resections/mo†
		Agreement on resectability status				
Resectability	Overall	0.301	0.315	0.287	0.340	0.301
	Resectable	0.412	0.445	0.378	0.412	0.375
	BR-A	0.124	0.119	0.120	0.169	0.154
	BR-V	0.178	0.181	0.177	0.185	0.227
	LA	0.389	0.409	0.366	0.458	0.361
		Agreement on vessels involved				
Vessel	SMV/PV	0.472	0.551	0.389	0.442	0.376
	SMA	0.504	0.587	0.400	0.473	0.413
	CA	0.441	0.500	0.384	0.423	0.407
	CHA	0.347	0.438	0.226	0.316	0.201
		Agreement on contact circumferential degrees				
No contact	SMV/PV	0.542	0.662	0.425	0.480	0.412
	SMA	0.588	0.680	0.473	0.541	0.484
	CA	0.503	0.589	0.410	0.440	0.421
	CHA	0.454	0.564	0.307	0.442	0.270
< 180°	SMV/PV	0.523	0.460	0.267	0.341	0.253
	SMA	0.327	0.387	0.252	0.305	0.257
	CA	0.211	0.242	0.168	0.220	0.168
	CHA*	0.124	0.133	0.105	0.111	0.120
> 180°	SMV/PV	0.370	0.553	0.497	0.515	0.481
	SMA	0.558	0.638	0.451	0.534	0.495
	CA	0.535	0.575	0.532	0.560	0.590
	CHA**	0.330	0.434	0.184	0.248	0.153

Poor	Fair	Moderate	Substantial	Almost Perfect
0 - 0.2	0.2 - 0.4	0.4 - 0.6	0.6 - 0.8	0.8 - 1

Figure 3 Heatmap demonstrating kappa values of resectability status and tumour vascular contact[15] * Common hepatic artery (CHA) contact/invasion WITHOUT proper hepatic artery (PHA)/coeliac artery contact (CA) ** CHA contact/invasion WITH PHA/CA contact † Surgeons only

month, or number of surgeries performed per month. The exception to this was those surgeons performing >5 surgeries per month had lower odds of choosing a more advanced resectability classification, when compared to baseline (OR = 0.72 (95% CI: 0.53 to 0.98).

As odds ratios are difficult to interpret, the predicted probability of a reviewer selecting a particular outcome was determined from a multivariable ordinal regression model, in which the reviewers' location, clinical specialty and diagnosis method were included as predictor variables. The results of this regression model are presented in Table 2. The unadjusted and adjusted odds ratios were of similar proportions, and so only the adjusted model coefficients are presented here.

After adjusting for other predictor variables, the results of the multivariable ordinal regression provide similar information to the unadjusted models. For example, after adjusting for location and preferred definition of resectability, a surgeon has a higher predicted probability of selection a less advanced resectability classification (40%) than the most advanced classification (28% probability).

Discussion

The finding of interobserver variability in PDAC resectability assessment on CT is demonstrated elsewhere in the literature albeit that these studies have been restricted to relatively small groups from discrete geographical areas or given specialty with study participants using the same sets of guidelines.[11,12,16,17] In contrast, our study surveys a global population of expert radiologists and HPB surgeons using various guidelines in their usual practice. This finding is important as the accurate assessment of operability is critical in determining a patient's treatment. Surgical resection with tumour free margins (± neoadjuvant or adjuvant chemotherapy) offers the only prospect of curative treatment for patients with PDAC. Failure to accurately classify a resectable PDAC may lead to patients missing an opportunity for curative treatment. Conversely, failure to recognise unresectable disease may lead to patients undergoing unnecessarily aggressive and/or futile therapy with attendant increased morbidity and a subsequent impact on patients' quality of life. In one retrospective cohort study of 371 patients that underwent surgery, negative

Table 1 Inter-reviewer agreement by reviewer characteristics (for reviewers who completed all cases, n = 77)

Reviewer Characteristic	N	Percentage (%)	Kappa	Agreement
All	77	–	0.319	Fair
Current Location				
Australia & New Zealand	35	46.2	0.326	Fair
Europe	26	33.3	0.32	Fair
North America	12	15.4	0.338	Fair
Other[a]	4	5.1	0.159	Slight
Clinical Specialty				
Surgery	33	42.9	0.308	Fair
Radiology	44	57.1	0.331	Fair
Years of Specialist Practice				
0–5	19	24.7	0.335	Fair
6–10	32	41.6	0.3	Fair
>10	25	32.5	0.348	Fair
Unknown[b]	1	1.3	–	–
Clinical Training Location				
Australia & New Zealand	21	27.3	0.357	Fair
Europe	38	49.4	0.286	Fair
North America	12	15.6	0.41	Moderate
Other[a]	6	7.8	0.243	Fair
Reviewer Preferred Definition of Resectability				
International Consensus	25	32.5	0.339	Fair
NCCN	42	54.5	0.32	Fair
Other definition	4	5.2	0.487	Moderate
Unknown[b]	6	7.8	0.115	Slight
Clinical Practice – Surgeons: Operations per month				
1–2	13	16.9	0.36	Fair
3–5	8	10.4	0.344	Fair
>5	7	9.1	0.246	Fair
Unknown	4	5.2	0.234	Fair
Clinical Practice - Radiologists: Reviews per month				
1–9	11	14.3	0.32	Fair
10–15	12	15.6	0.349	Fair
16–30	13	16.9	0.423	Moderate
>30	6	7.8	0.251	Fair
Unknown	3	3.9	–	–
MDM Participation				
Yes	66	85.7	0.342	Fair
No	6	7.8	0.299	Fair
Unknown	5	6.5	0.085	Slight
MDM Cases per month				
1–9	13	16.9	0.326	Fair
10–15	18	23.3	0.36	Fair
16–30	18	23.3	0.393	Fair
>30	16	20.8	0.273	Fair
Unknown	1	1.3	–	–

[a] South America, Africa and Asia.
[b] Unknown characteristic if not declared by a clinician in demographic survey.

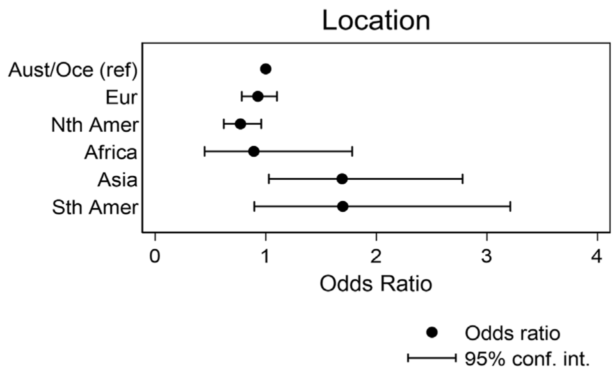

Figure 4 Location of reviewers' practice

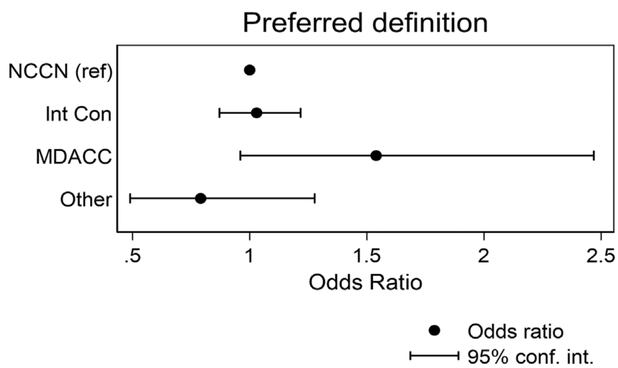

Figure 5 Preferred definition of resectability

resection margin (R0) rates for resectable, borderline and locally advanced tumours were 73%, 55% and 16% respectively highlighting the significance of accurate preoperative assessment.[18]

The pattern of interobserver variability, as demonstrated in the heat map in Fig. 3 broadly reflects the findings of Giannone et al. (2021).[11] Agreement was lowest in situations where tumour contact <180° for any vessel in both data sets with highest agreement where contact >180°.[11] Interobserver variability in staging discrepancies between specialist and sub-specialist radiologists has also been demonstrated.[19]

The wide differences of opinion of operability amongst reviewers highlights the complexity of assessment of operability in PDAC. Operability is determined by a complex interplay of factors that may not be captured by existing guidelines. The wide difference of opinion demonstrated in this study are likely resolved in MDT discussion in day-to-day clinical practice. This raises the question of whether resectability assessment and treatment decision would be across different MDTs for the same patient. Even with the use of the same set of guidelines, difference of opinion may still be present. This difference may be minimised using a standard synoptic reporting method, like that achieved with synoptic pathology reporting.[20,21] Furthermore, with the evolution of surgical techniques and development of neoadjuvant therapies, locally advanced tumours that would once have been considered inoperable can be resected with R0 margins.[22,23] This may explain our data showing a higher portion of cases being deemed resectable by surgeons (0.4) over radiologists (0.36). Furthermore, in addition to differences in adoption of guidelines, eligibility for resectability of vessels is dependent on the surgeon experience. This may explain the result that surgeons performing more than five surgeries per

Table 2 Predicted probabilities of diagnosis outcome, with 95% confidence intervals and p-values

	Diagnosis (resectability)		
	Resectable	Borderline	Unresectable
	Pr (95%CI); p-value	Pr (95%CI); p-value	Pr (95%CI); p-value
Clinical specialty			
Radiologist	0.36 (0.33, 0.38); <0.001	0.32 (0.30, 0.34); <0.001	0.32 (0.29, 0.34); <0.001
Surgeon	0.40 (0.37, 0.43); <0.001	0.32 (0.30, 0.34); <0.001	0.28 (0.25, 0.30); <0.001
Preferred definition			
NCCN	0.37 (0.35, 0.40); <0.001	0.32 (0.30, 0.34); <0.001	0.30 (0.12, 0.37); <0.001
Int Con	0.38 (0.34, 0.41); <0.001	0.32 (0.30, 0.34); <0.001	0.30 (0.27, 0.33); <0.001
MDACC	0.28 (0.19, 0.38); <0.001	0.32 (0.29, 0.35); <0.001	0.40 (0.29, 0.51); <0.001
Other	0.44 (0.28, 0.61); <0.001	0.31 (0.27, 0.36); <0.001	0.25 (0.12, 0.37); <0.001
Location			
Aust/Ocean	0.36 (0.34, 0.39); <0.001	0.32 (0.308, 0.34); <0.001	0.31 (0.28, 0.34); <0.001
Europe	0.38 (0.35, 0.42); <0.001	0.32 (0.30, 0.34); <0.001	0.29 (0.27, 0.32); <0.001
Nth America	0.42 (0.37, 0.48); <0.001	0.31 (0.29, 0.34); <0.001	0.26 (0.22, 0.30); <0.001
Africa	0.35 (0.13, 0.56); 0.002	0.32 (0.30, 0.34); <0.001	0.33 (0.12, 0.53): 0.002
Asia	0.27 (0.17, 0.37); <0.01	0.32 (0.29, 0.35); <0.001	0.41 (0.29, 0.53); <0.001
Sth America	0.27 (0.15, 0.40); <0.001	0.32 (0.29,0.35); <0.001	0.41 (0.26,0.56); <0.001

month had lower odds of choosing a more advanced resectability classification when compared to baseline.

This degree of interobserver ability also highlights the difficulties in establishing a 'ground truth' or the objective assessment of a test for the purposes of future clinical research. This has relevance in artificial intelligence (AI) research. The development of AI algorithms for use in CT interpretation require large datasets of labelled image data. Determining 'ground truth' or the correct interpretation of a scan while minimising bias is crucial to achieving accurate algorithms. It also suggests that some degree of central review may be required in future studies of neoadjuvant therapy.

There are limitations to this study. The interobserver agreement demonstrated may have been inflated by the inclusion of borderline resectable pancreatic cancer only at the time of MDM assessment. The highest degree of variability amongst reviewers in our study was in those patients who reviewers felt had truly borderline resectable PDAC (Fig. 3). Had more patients with clearly resectable or clearly locally advanced disease been included, the overall rate of agreement may have been higher.

While anatomic operability on imaging is the main determinant of tumour resectability, we acknowledge that the final decision on resectability made by the multidisciplinary team in clinical practice accounts for additional factors including the patient expectations and willingness to undergo major surgery, age, CA19.9 or other biomarkers, additional scans and comorbidities, although all patients whose CT scans were circulated for review subsequently had doublet chemotherapy and/or a major resection or had good performance status scores. Selection of scans was further refined to include only those that were felt to be of sufficient quality to assess operability, although not all scans were necessarily dedicated "pancreatic protocol scans". Nevertheless, it is notable that only 3.3% of scans were considered by reviewers to be of insufficient quality to allow assessment of operability with an additional 13.4% being considered borderline. The small minority of scans deemed borderline or unacceptable further highlights a difference of opinion on scan adequacy. The included set was a real-world sample hence the presence of a small proportion of these being considered borderline or unacceptable might be reflective of real world clinical scenarios. These limitations could be addressed by a prospective study mandating pancreatic protocol CT scans and including consecutive patients diagnosed with non-metastatic pancreatic cancer to ensure that the cohort accurately reflects the distribution of cases within the population.

A further limitation to the current study is that data was collected at the national or continental level, only. These data did not allow for further investigation at the regional level, and thus we were unable to determine whether clinical settings that might affect case load and availability of services affected the decision-making processes of the specialists within the current study. Further investigation determining whether factors influencing clinical settings, such as rurality, should be conducted.

The findings of this study warrant further investigation. Considering the above limitations, the variation in determination of anatomical resectability among a large cross section of expert surgeons and radiologists may still impact real-world treatment and outcomes. Future work is required to better understand the precise mechanisms and factors influencing resectability assessment variability. This work may allow the development of new protocols or techniques that can lead to a reduction in variability of clinician opinion. If successful, this work can lead to an improvement in the consistency of patient treatment pathways and provide confidence to clinicians and patients that the most appropriate care is being consistently provided.

Conclusion

This study demonstrates a low level of agreement among experienced surgeons and radiologists in the assessment of PDAC resectability, plus a lack of consistency in the use of reporting guidelines. While the root cause of this is likely multifactorial, further research is warranted into addressing these findings as improvements in consistency of reporting will lead to optimised clinical decision making and reproducibility of clinical trials results.

Author contributions

Conceptualisation: JZ, DC, JG, JS; Data curation: BD, TM, CP; Formal analysis: CP, TM, HB; Funding Acquisition: JZ, TM; Investigation: JS, JG, AB, AB, AD, AG, AH, AR, AW, BD, BL, BR, CB, CB, CC, CH, CH, CL, CP, CT, DB, DB, DW, DD, DN, EA, EB, EH, FA, FC, FL, FU, FV, GC, GG, GH, GM, GS, HH, HK, IA, JD, JD, JH, JK, JN, JT, KK, LB, LW, MD, MG, MN, MS, MS, MZ, NB, NC, NK, NM, PK, PT, RB, RB, RC, RH, RT, SA, SC, SC, SS, ST, TC, VM, VW, WC, WT; Methodology: DC, JZ, JG, TM, BD, JS; Project administration: TM, BD; Supervision: JZ, DC; Visualisation: TM, HB, CP; Writing – original draft: HB, TM; Writing – review and editing: HB, JZ, DC, TM, CP, JS, JG, BD, AB, AB, AD, AG, AH, AR, AW, BD, BL, BR, CB, CB, CC, CH, CH, CL, CP, CT, DB, DB, DW, DD, DN, EA, EB, EH, FA, FC, FL, FU, FV, GC, GG, GH, GM, GS, HH, HK, IA, JD, JD, JH, JK, JN, JT, KK, LB, LW, MD, MG, MN, MS, MS, MZ, NB, NC, NK, NM, PK, PT, RB, RB, RC, RH, RT, SA, SC, SC, SS, ST, TC, VM, VW, WC, WT.

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Data availability statement

Raw data were generated at Monash Health. The CT biobank is deidentified and stored on the XNAT platform and is available to all authors. Derived data supporting the findings of this study as well as the original CT biobank used for the study are available from the corresponding author HB and research coordinator B D'Souza on request.

Conflict of interest

None to declare.

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Appendix A. Supplementary data

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