IJIRIS: International Journal of Innovative Research in Information Security
Volume 11, Issue 09, November 2025
E-ISSN: 2349-7017
P-ISSN: 2349-7009
https://www.ijiris.com/archives
https://doi.org/10.26562/ijiris.2025.v1109.25

Pancreatic Cancer Detections Using Machine Learning Algorithms

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Publication History
Manuscript Reference No: IJIRIS/RS/Vol.11/Issue09/NVIS10104
Research Article Open Access| Double-Blind Peer-Reviewed| Article ID: IJIRIS/RS/Vol.11/Issue09/NVIS10104 Received: 28, October 2025, Revised: 05, November 2025, Accepted: 12, November 2025, Published Online: 21, November 2025.
https://www.ijiris.com/volumes/Vol11/iss-09/25.NVIS10104.pdf
Citation: Rizvana,Yeshawinir,UvinayKumar,Nanditham,Poorniman(2025)Pancreatic Cancer Detections Using Machine Learning Algorithms, IJIRIS: International Journal of Innovative Research in Information Security, Volume 11, Issue 09 of 2025 pages 603-608 **Doi:>** https://doi.org/10.26562/ijiris.2025.v1109.25
BibTeX Key:Rizvana@2025Pancreatic
IJIRIS papers should be cited as IJIRIS (International Journal of Innovative Research in Information Security, AM Publications, India 2025, ISSN 2349-7017, https://doi.org/10.26562/ijiris.2025.v1109.25 The journal's official abbreviation is IJIRIS. Orcid: https://orcid.org/0009-0004-9398-7488
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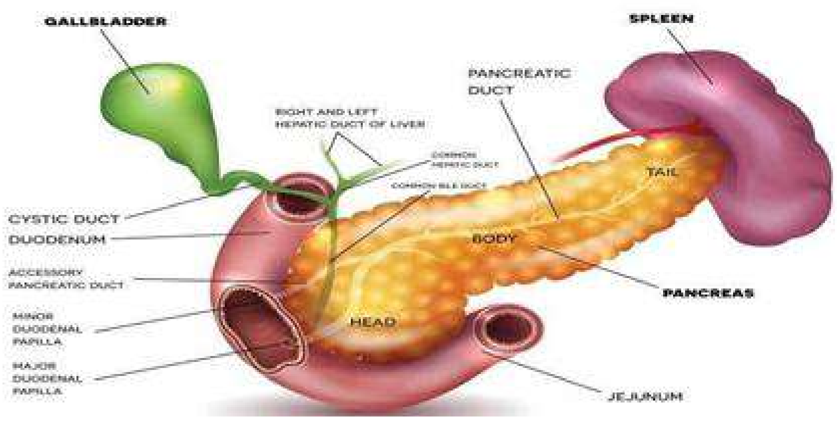
Abstract: Early detection of cancer improves survival chances. Pancreatic cancer has a poor prognosis but despite continuous challenges in medical research, efforts are still underway to identify strategies to diagnose the illness early and boost survival rates. Pancreatic cancer detection involves analysing various types of medical data such as imaging scans, blood biomarkers, patient history, and clinical notes to identify signsof malignancy in the pancreas. Genomic, protein, blood, and urine biomarkers of pancreatic cancer, as well as corresponding biosensors for diagnosis of pancreatic cancer, have been evaluated, each of these instance show that new biosensors are emerging asan incrediblyprominent substitute todefined processes. Pancreaticcancer which typically affects the exocrine part of the pancreatic, which produces digestive enzymes. The most common type is Pancreatic ductaladeno carcinoma cancer (PDCA) were it starts in the lining of the pancreatic ducts and makes upover 90% pfp ancreatic cancer cases and it become most common pancreatic cancer. Other rare pancreatic cancer like Acinarcell carcinoma that starts in the acinarcells of the pancreas. This cells are responsible for producing digestive enzymes like tryps in and lipase, helping in break down food in the small intestine. Pancreatic neuroendocrine tumors (PNETs) it is arise from hormone-producing cells. Advanced models, often using machine learning or deep learning the nassess this information to predict the likelihood of the cancer. The system provides risk scores or diagnosis suggestions to support physicians in early detection and decision- making, with ongoing refinement through feedback and updated data.
Keywords: Pancreatic Cancer, Biomarkers, Machine Learning, Early Detection of Cancer.

1. INTRODUCTION:

The earliest records of pancreatic cancer attributed in 18th century by Italy scientist anatomist Giovanni Battista Morgagni in his 1761 publication, "The Seats and Causes of Diseases". It describe span creatic "scrirrhus", are considered the first recorded cases of the pancreatic ductal adenocarcinoma (PDAC).



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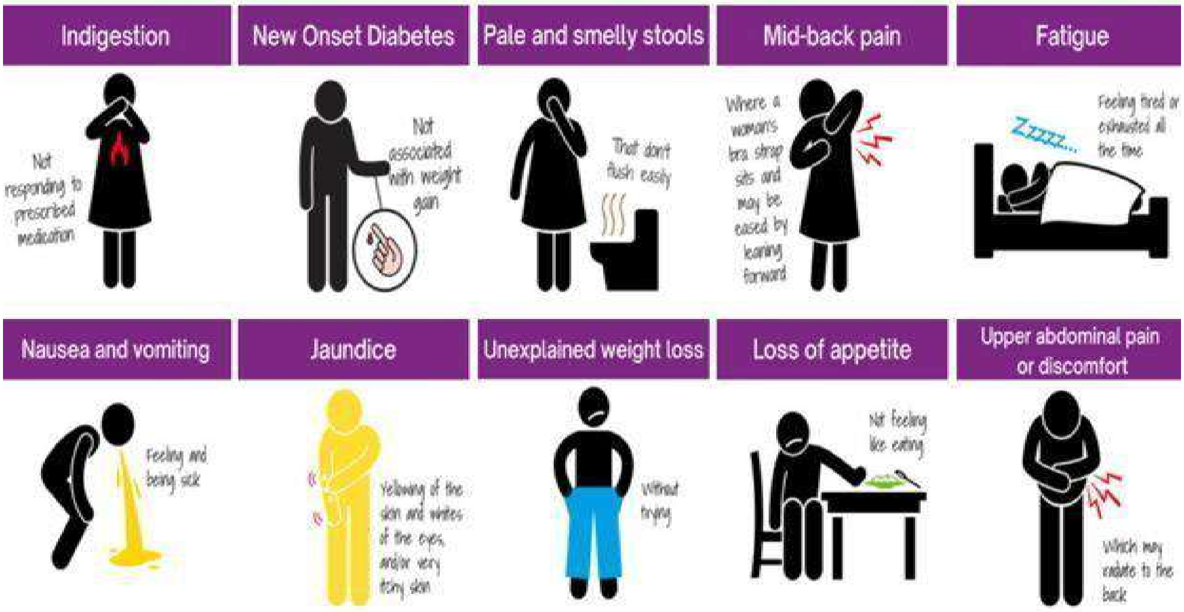
https://doi.org/10.26562/ijiris.2025.v1109.25

Fig1.1: Pancreatic cancer …[1]

The pancreatic cancer arises when cells in the pancreas, a glandular organ behind the stomach, begin to multiply out of control and form a mass. These cells have the ability to invade other parts of the body. Pancreatic adeno carcinoma is the most common cancer for about 90% of cases. It starts within the part of pancreas which produces digestive enzymes. The emergence of malignant cells within the pancreatic tissues indicates that cancer is developing. Jaundice and sudden weight loss are two of the distinguishing characteristics. The pancreas is the under the lower abdomen, which secretes enzymes aid in the digestion of proteins, crabs, and lipids. It also includes various roles like blood sugar regulation and the production of digestive enzymes. Pancreatic cancer is difficult to detect its cause's symptoms until that advanced early diagnosisis more challenging. According to authorized source of information reports provided by The American Cancer society describes that 3% of new diagnosis cases and 7% of cancer related fatalities in United States each year.

Pancreatic cancer is initialise when genetic mutation is occurs in the pancreatic cells like KRAS, TP53. Then mutation cells are multiplied or divided uncontrollably, and forms the bunch of cells called tumor. The tumor locally start spreading to nearby tissues and blood vessels. Then it spreads to distant organs like liver, lungs or peritoneum. Pancreatic Cancer doesn't causes symptoms in the early stages. Symptoms are jaundice, abdominal pain, weight loss, and digestive issue, the cancer is often advanced.



F**ig1.2:** Symptoms of pancreatic cancer)…….. [2]

Stages of the Pancreatic cancer cell growth

Pancreatic Cancer is staged from 0 to IV based on tumor size, lymph node and spread to distant organs. Stage 0(Carcinoma in Situ)-Abnormal Cells are present in the pancreas but have not spread to nearby tissues. Stage I- Cancer is confined to the pancreas, mIA-Tumor is≤2cm, IB-Tumoris>2cm or≤4cm. StageII Cancer may have spread ton ear by lymph nodes, IIA-Tumoris≥4cm and has not spread tolymph nodes, IIB -Tumor of any size with spread to 1-3 nearby lymph nodes. Stage III – Cancer has spread to major blood vessels near the pancreas or to more then three nearby lymph nodes. Stage IV–Cancer had spread to distant organs, such as the liver or lungs. Early- stages cancers may treated with surgery, while advanced stages often require chemotherapy and other therapies.

2. RELATIVEWORK

Recent advancements in pancreatic cancer detection have leveraged a multidisciplinary approach, integrating imaging technologies, molecular biomarkers, and computational intelligence to enhance diagnostic accuracy, particularly at early stages. Conventional modalities such as computed tomography (CT), magnetic resonance imaging (MRI), and endoscopic ultrasound (EUS) have been significantly augmented by deep learning techniques, notably convolutional neural networks (CNNs), which enable automated tumor detection and characterization with improved sensitivity. Despite the clinical utility of carbohydrate antigen 19-9 (CA19-9), its limited specificity has driven exploration into novel circulating biomarkers, including exosomal RNA, micro RNAs, and circulating tumor DNA (ctDNA), which offer greater potential for early-stage detection.

In parallel, genomic and proteomic profiling through next-generation sequencing (NGS) and mass spectrometry has facilitated the identification of key oncogenic mutations (e.g., *KRAS*, *TP53*, *CDKN2A*) and aberrant protein signatures associated with tumorigenesis. Furthermore, machine learning and integrative multiomics analyses have enabled predictive modeling for risk stratification and early diagnosis by synthesizing data from clinical, genomic, and radiological sources.

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E-ISSN: 2349-7017
P-ISSN: 2349-7009
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https://doi.org/10.26562/ijiris.2025.v1109.25

National and international efforts, such as the Pancreatic Cancer Detection Consortium (PCDC), are actively developing and validating these integrative frameworks to translate research innovations into clinically actionable screening tools.

3. METHODOLOGY

Methodology for Pancreatic Cancer Detection Using Machine Learning and samples of biomarkers.

3.1. Data Collection and Preprocessing: The process begins with collecting heterogeneous data from sources such as medical imaging (CT, MRI, EUS), clinical records, genomic data (e.g., mutation profiles), and blood-based biomarkers. Preprocessing steps include: Normalization of clinical variables (age, CA19-9 levels, etc.)Image preprocessing, such as noise reduction, contrast enhancement, and tumor segmentation (often viaU-Net orsimilardeep learning models) Handling missing data and balancing datasets, especially since positive pancreatic cancer cases are often limited.

3.2. Feature Extraction and Selection: For non-image data, relevant features (e.g., CA19-9,mutationstatus,demographics)areselectedusingstatisticaltestsoralgorithms like Recursive Feature Elimination (RFE) or LASSO. For imaging data, CNNs can automatically learn hierarchical features, or features like texture, shape, and intensity can be extracted using radiomics**.**

3.3. Model Selection and Training Based on the datatype: Structured Data (clinical, biomarkers):Algorithms such as Random Forest(RF),Support Vector Machine(SVM), XGBoost, and Logistic Regression are commonly used. Image Data: Deep learning models, especially CNNs (e.g., ResNet, VGG, Inception), are employed. Multi-modal Fusion: Ensemble models or hybrid architectures combine clinical, genetic, and imaging data for improved prediction.

3.4. Model Evaluation Performance is evaluated using metrics like: Accuracy, Sensitivity (Recall), Specificity, Precision, AUC-ROC. Cross-validation (e.g., k-fold) ensures generalization and mitigates over fitting. Confusion Matrix analysis provides insights into false positives/negatives, which are critical in cancer diagnosis.

3.5. Interpretability and Validation To ensure clinical acceptance: Techniques like SHAP (shapley Additive explanations) or LIME explain model predictions. External validation on independent datasets or prospective cohorts is essential to verify real- world performance. Integration with clinical decision systems is tested through pilot studies or trials.

4. RESULTS

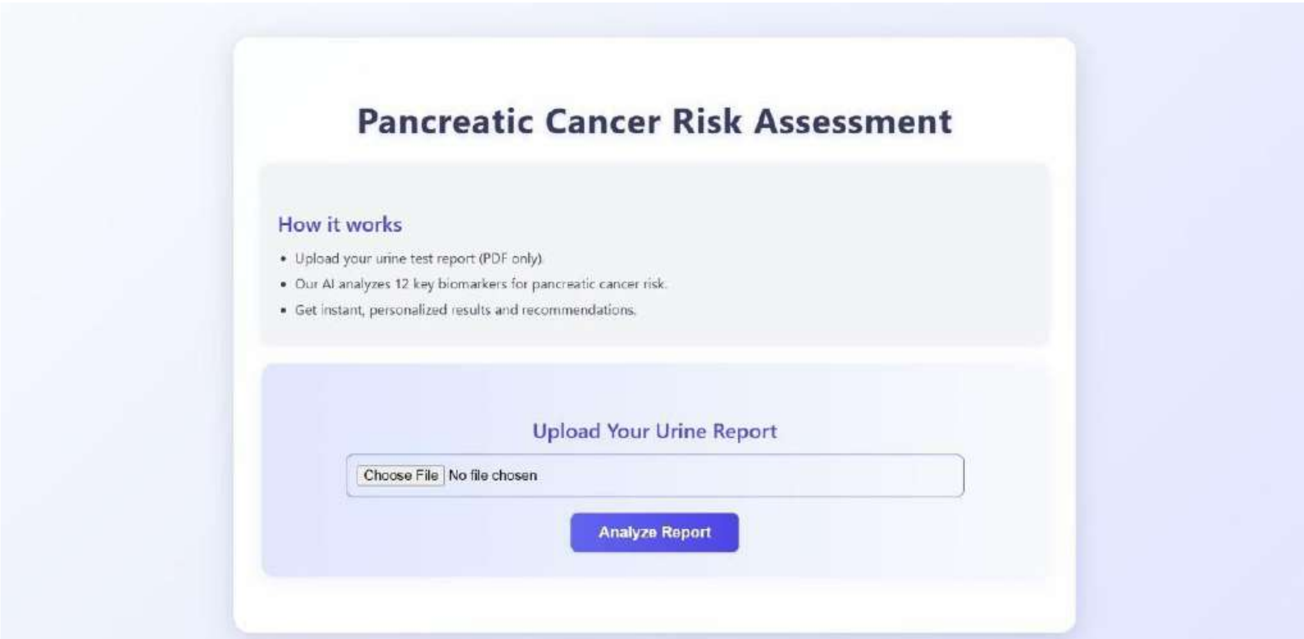

Fig1.3: Urine Sample Report Document

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P-ISSN: 2349-7009
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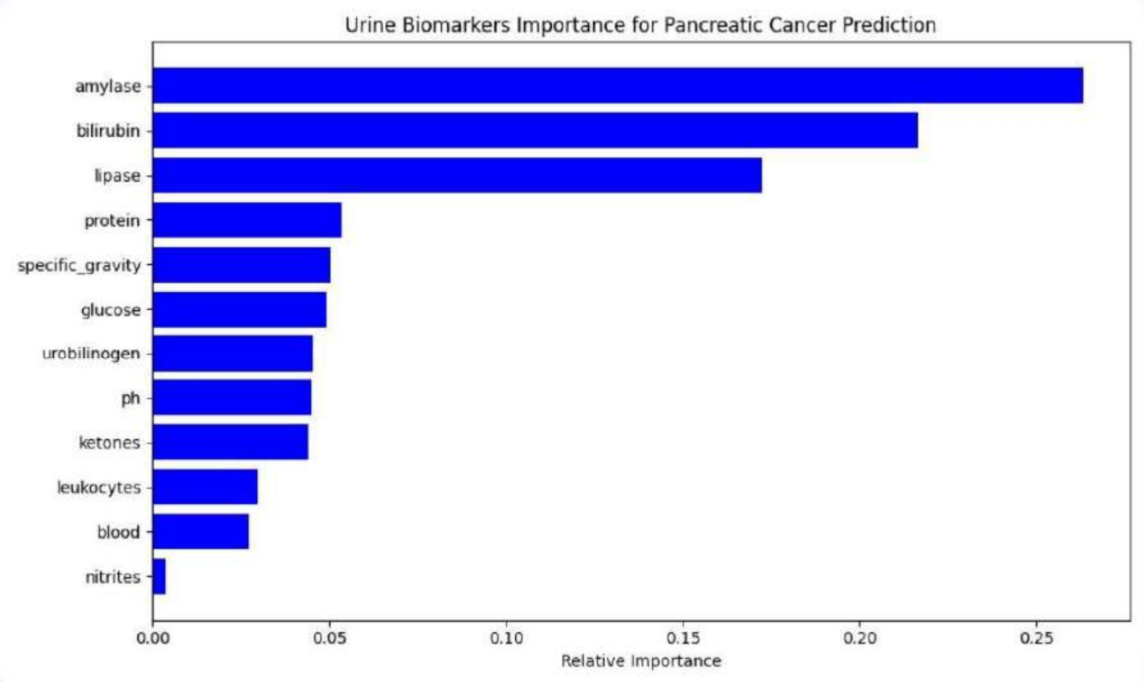
Biomarker Values

Biomarker	Your Value	Normal Range
Glucose	0	0-15 mg/dL
Bilirubin	0	0-0.2 mg/dL
Urobilinogen	0	0.2-1.0 mg/dL
Protein	0	0-15 mg/dL
Ph	0	4.5-8.0
Blood	0	0-3 RBC/μL
Specific Gravity	0	1.005-1.030
Ketones	0	0-0.5 mg/dL
Leukocytes	0	0-5 WBC/μL
Nitrites	0	Negative
Amylase	0	30-110 U/L
Lipase	0	0-160 U/L

- Schedule an appointment with your primary care physician
- Monitor for symptoms like jaundice, abdominal pain, or unexplained weight loss
- This assessment is not a diagnosis - always consult with a healthcare professional

Key Risk Factors



← Back to Assessment Tool

Fig1.3.1: Risk Assessment in Urine Report (Medium Risk

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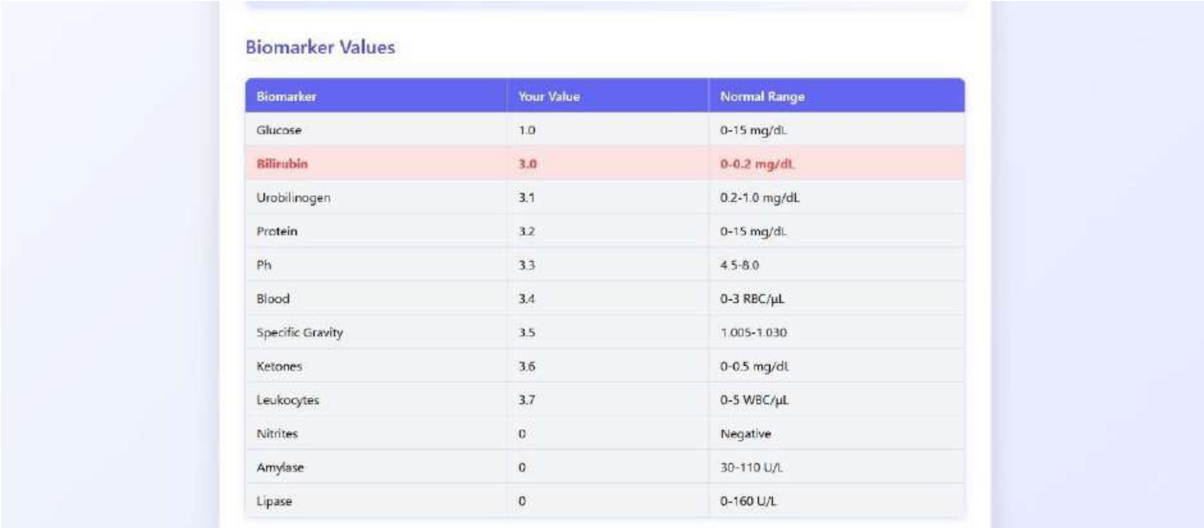
Biomarker Values

Biomarker	Your Value	Normal Range
Glucose	1.0	0-15 mg/dL
Bilirubin	3.0	0-0.2 mg/dL
Urobilinogen	3.1	0.2-1.0 mg/dL
Protein	3.2	0-15 mg/dL
Ph	3.3	4.5-8.0
Blood	3.4	0-3 RBC/μL
Specific Gravity	3.5	1.005-1.030
Ketones	3.6	0-0.5 mg/dL
Leukocytes	3.7	0-5 WBC/μL
Nitrites	0	Negative
Amylase	0	30-110 U/L
Lipase	0	0-160 U/L

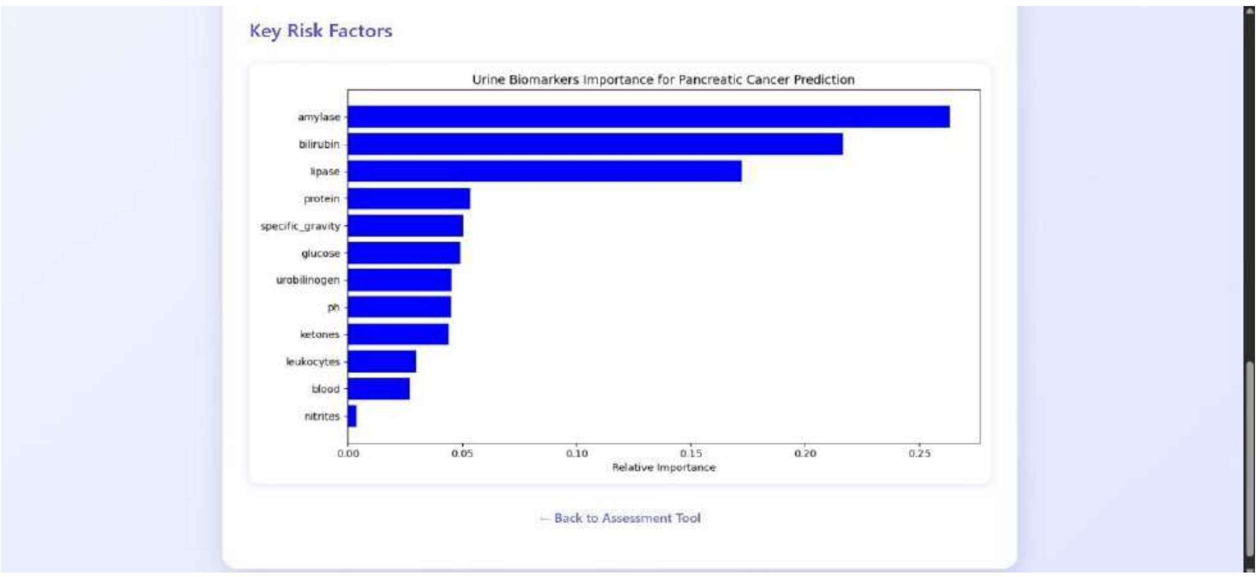

Fig1.3.2: Risk Assessment in Urine Report (High Risk

E-ISSN: 2349-7017
P-ISSN: 2349-7009
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5. CONCLUSION

In conclusion, machine learning offers a powerful and promising approach to improving the early detection and diagnosis of pancreatic cancer, a disease often identified at an advanced stage due to its subtle early symptoms. By leveraging diverse data sources such as medical imaging, clinical biomarkers, and genomic information, ML algorithms can uncover complex patterns and predictive features that may not be evident through traditional diagnostic methods. Techniques such as deep learning, ensemble models, and multi-modal data fusion have demonstrated high potential in enhancing diagnostic accuracy and sensitivity. Furthermore, the integration of explainable AI tools ensures that these models can provide transparent and clinically interpretable results, fostering trust and adoption in medical settings. As research advances and more high-quality data becomes available, machine learning is expected to play an increasingly critical rolein the early, accurate, and non-invasive detection of pancreatic cancer, ultimately contributing to better outcomes and survival rates.

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