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AI and Medical Information Databases: Transforming Pancreatic Cancer Patient Care

Houhong Wang and Shang Bian*
Department of General Surgery, The Affiliated Bozhou Hospital of Anhui Medical University, China

***Corresponding author:** Shang Bian, Department of General Surgery, The Affiliated Bozhou Hospital of Anhui Medical University, China
Email: whh6366@163.com

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Introduction

Background

Pancreatic cancer is one of the most lethal malignancies globally, with a 5 - year survival rate of less than 10% [1]. Its early - stage symptoms are often non - specific, leading to a high rate of late - stage diagnosis. Conventional treatment methods, including surgery, chemotherapy, and radiotherapy, have limited efficacy. However, the integration of artificial intelligence (AI) and medical information databases holds great promise for revolutionizing pancreatic cancer care. AI algorithms can analyze large - scale medical data, while medical information databases provide a wealth of clinical data, potentially enabling earlier detection, more personalized treatment, and better prognosis for patients.

Research Objectives

The aim of this retrospective study is to comprehensively analyze the impact of AI and medical information databases on pancreatic cancer patients. Specifically, we seek to determine how these technologies affect diagnosis accuracy, treatment planning, and patient outcomes, with the ultimate goal of providing evidence - based guidance for improving pancreatic cancer care.

Literature Review

Pancreatic Cancer: An Overview

Pancreatic cancer ranks as the seventh leading cause of cancer - related deaths worldwide [2]. The incidence has been steadily increasing in recent years. Symptoms such as abdominal pain, weight loss, and jaundice usually occur in the advanced stages. Diagnosis typically involves a combination of imaging techniques (e.g., computed tomography, magnetic resonance imaging) and biomarker tests (e.g., carbohydrate antigen 19 - 9). Current treatment options are often ineffective due to the aggressive nature of the cancer and its resistance to therapy.

AI in Healthcare

AI has made significant strides in healthcare. Machine learning algorithms, especially deep learning, have been applied in disease diagnosis, prediction, and treatment planning. For example, convolutional neural networks (CNNs) have shown high accuracy in diagnosing medical images, and recurrent neural networks (RNNs) can predict disease progression based on sequential patient data [3]. In cancer care, AI can assist in identifying high - risk patients, optimizing treatment strategies, and monitoring treatment responses.

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Medical Information Databases for Pancreatic Cancer

Medical information databases, such as the Surveillance, Epidemiology, and End Results (SEER) program in the United States and the Chinese Pancreatic Cancer Database (CPDC), play a crucial role in pancreatic cancer research. These databases collect detailed information on patient demographics, tumor characteristics, treatment modalities, and survival outcomes. They provide a valuable resource for researchers to analyze trends, evaluate treatment effectiveness, and develop new treatment strategies [4].

Previous Studies on AI and Databases in Pancreatic Cancer

Previous studies have explored the application of AI in pancreatic cancer diagnosis and prognosis prediction. Some studies have used machine learning algorithms to analyze medical images for early detection, while others have leveraged databases to develop prognostic models. However, most of these studies have focused on single - aspect applications, and the overall impact of integrating AI and medical information databases on patient care remains to be fully understood [5-10].

Methodology

Study Design

This is a retrospective study. We recruited 200 pancreatic cancer patients, randomly divided into an experimental group (n = 100) and a control group (n = 100). The experimental group received treatment with the assistance of AI - based diagnosis and medical information database - informed treatment planning, while the control group received conventional treatment.

Data Collection

Data were collected from multiple sources, including the SEER database, CPDC, and hospital medical records. The collected data included patient demographics (age, gender), tumor characteristics (tumor size, stage, grade), diagnostic data (imaging results, biomarker levels), treatment information (surgery type, chemotherapy regimen, radiotherapy dose), and follow - up data (survival time, recurrence status).

Data Preprocessing

The collected data were preprocessed to ensure data quality. Missing values were imputed using mean or median values for continuous variables and the most frequent category for categorical variables. Outliers were identified and treated using the interquartile range method. All data were then standardized to a common scale.

AI Models and Techniques Used

We employed several machines learning algorithms, including logistic regression, decision trees, and artificial neural networks. Logistic regression was used for predicting the probability of cancer recurrence, decision trees for classifying tumor stages, and neural networks for analyzing medical images. The models were trained and validated using a 70:30 split of the dataset.

Evaluation Metrics

We used multiple evaluation metrics to assess the performance of the AI models and the treatment outcomes. For diagnostic models, sensitivity, specificity, accuracy, and the area under the receiver - operating characteristic curve (AUC - ROC) were calculated. For treatment outcomes, overall survival (OS), disease - free survival (DFS), and recurrence rates were analyzed.

Results

Patient Characteristics

Table 1 shows the baseline characteristics of the two groups. There were no significant differences in age, gender, tumor stage, and other characteristics between the experimental group and the control group ($p > 0.05$), indicating that the two groups were comparable [11-14].

AI - Assisted Diagnosis Results

Table 2 presents the diagnostic performance of the AI models compared with conventional diagnostic methods. The AI - based diagnostic models showed significantly higher sensitivity (85.6% vs. 72.3%, $p < 0.01$) and specificity (82.4% vs. 70.1%, $p < 0.01$) than the conventional methods.

Treatment Planning and Outcomes

Table 3 shows the treatment - related outcomes of the two groups. The experimental group had a higher surgical resection rate (65% vs. 45%, $p < 0.01$), lower postoperative complication rate (12% vs. 25%, $p < 0.01$), and better 1 - year overall survival rate (75% vs. 60%, $p < 0.01$) compared with the control group.

Survival Analysis

The median overall survival of the experimental group was 22.5 months, significantly longer than that of the control group (18.2 months, $p < 0.01$). The hazard ratio for death in the experimental group compared with the control group was 0.68 (95% CI: 0.52 - 0.89), indicating a 32% reduction in the risk of death [15-18].

Table 1: Baseline characteristics of the two groups.

Characteristics	Experimental Group (n = 100)	Control Group (n = 100)	p - value
Age (mean ± SD)	62.5 ± 8.3	61.8 ± 7.9	0.45
Gender (Male/Female)	58/42	60/40	0.78
Tumor Stage (I/II/III/IV)	12/25/35/28	10/23/37/30	0.82
Tumor Size (mean ± SD, cm)	3.8 ± 1.2	3.6 ± 1.1	0.23
CA19 - 9 Level (mean ± SD, U/mL)	520.3 ± 150.5	515.6 ± 145.8	0.67

Table 2: Diagnostic performance of the AI models compared with conventional diagnostic methods.

Diagnostic Method	Sensitivity	Specificity	Accuracy	AUC - ROC
AI - based Model	85.6%	82.4%	84.1%	0.88
Conventional Method	72.3%	70.1%	71.2%	0.75

Table 3: Treatment - related outcomes of the two groups.

Treatment Outcomes	Experimental Group	Control Group	p - value
Surgical Resection Rate	65%	45%	<0.01
Postoperative Complication Rate	12%	25%	<0.01
1 - Year Overall Survival Rate	75%	60%	<0.01
1 - Year Disease - Free Survival Rate	60%	45%	<0.01
Recurrence Rate within 1 Year	20%	35%	<0.01

Discussion

The results of this study demonstrate that the integration of AI and medical information databases can significantly improve the diagnosis and treatment of pancreatic cancer. The higher diagnostic accuracy of AI models enables earlier detection of the disease, which is crucial for improving treatment outcomes. The personalized treatment planning based on medical information databases helps optimize treatment strategies, resulting in better surgical resection rates, lower complication rates, and improved survival outcomes.

Compared with previous studies, our research provides a more comprehensive evaluation of the impact of AI and medical information databases on pancreatic cancer patient care. While some previous studies focused only on diagnosis or prognosis, our study covers the entire process from diagnosis to treatment and long - term outcomes. The results are consistent with previous findings that AI can enhance diagnostic accuracy, but our study further validates its positive impact on treatment and survival. This study has several limitations. First, the sample size is relatively small, which may limit the generalizability of the results. Second, the study is retrospective, and there may be potential biases in data collection and selection. Third, the AI models used in this study may not be applicable to all clinical scenarios, and further validation in larger and more diverse populations is needed.

Future research should focus on expanding the sample size and conducting prospective studies to confirm the findings. Additionally, efforts should be made to develop more advanced AI models that can integrate multiple types of data, such as genomics and proteomics data, to provide more personalized treatment recommendations. Collaborative research between different institutions and countries is also essential to build more comprehensive medical information databases. In conclusion, this study shows that AI and medical information databases have a positive impact on pancreatic cancer patient care. They can improve diagnosis accuracy, optimize treatment planning, and enhance patient survival. These findings highlight the potential of these technologies in transforming pancreatic cancer treatment. The results of this study have important implications for clinical practice. Clinicians should consider incorporating AI - based diagnostic tools and medical information database - informed treatment strategies into their practice. This can help improve the quality of care and patient outcomes for pancreatic cancer patients.

The integration of AI and medical information databases represents a new frontier in pancreatic cancer care. Continued research and development in this area are expected to bring more breakthroughs and benefits to patients in the future.

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