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PANCREATIC CANCER: RISK FACTORS, CHALLENGES IN EARLY DETECTION AND PREVENTION STRATEGIES

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Abastract: Pancreatic cancer has increased globally, especially in developed countries, and is a major public health concern. This increase is associated with an ageing population, changes in lifestyle, advances in diagnosis and greater longevity. Despite advances in diagnosis, the majority of cases are still discovered in advanced stages, which reduces survival rates, which remain below 10% at five years. Older age, smoking, obesity, unhealthy diets and exposure to toxic substances are the main risk factors. Pancreatic cancer is predominantly pancreatic ductal adenocarcinoma (PDAC), which accounts for 90% of cases and has a high mortality rate. Pancreatic neuroendocrine tumors (PNETs) and cystic neoplasms, which account for 5% of cases, have a better prognosis when diagnosed early. The incidence of pancreatic cancer is expected to continue rising, necessitating effective prevention and screening strategies. Traditional risk factors include smoking, obesity, type 2 diabetes, chronic pancreatitis and genetic factors such as mutations in the BRCA2, PALB2 and STK11 genes. In addition, epigenetic alterations, such as DNA methylation and regulation by microRNAs, are also associated with pancreatic cancer. The use of risk scores based on artificial intelligence could improve risk prediction and early detection, allowing for more effective screening in high-risk populations. Early detection is challenging due to the difficulty in identifying tumors at early stages. Imaging tests such as computed tomography (CT) and magnetic resonance imaging (MRI) are fundamental, but with limitations for detecting small tumors. Tumor biomarkers, such as CA 19-9, have limited utility, and research is focused on new biomarkers to improve diagnostic accuracy. Screening programs for high-risk individuals, such as those with genetic mutations, can increase the chances of early diagnosis and improve survival. Preventing pancreatic cancer involves adopting

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healthy habits, such as a balanced diet, regular physical activity and smoking cessation. Controlling obesity and type 2 diabetes is also essential. Research is investigating the use of chemopreventive agents, such as metformin and aspirin, to reduce the risk, with promising results, but more studies are needed. Prevention and early detection are crucial to improving the prognosis and reducing the mortality associated with pancreatic cancer.

Keywords: "Pancreatic Cancer", "Early Detection", "Biomarkers", "Screening Strategies" and "Imaging Techniques".

INTRODUCTION

Pancreatic cancer is one of the most aggressive and lethal tumors, with an extremely high mortality rate [1,2,3]. Most cases are diagnosed late, when the disease is already in advanced stages and therapeutic options are limited [1,2,3]. This characteristic means that pancreatic cancer represents one of the greatest challenges in oncology, as the absence of specific symptoms in the early stages hinders its early detection and compromises the chances of curative treatment [2,3].

Pancreatic cancer comprises different histological types, with pancreatic ductal adenocarcinoma (PDAC) being the most prevalent, accounting for around 90% of cases [2,3]. This aggressive tumor originates in the cells lining the pancreatic ducts and has a high capacity for metastatic spread, making treatment difficult and reducing the chances of survival [2,3]. In addition to PDAC, pancreatic neuroendocrine tumors (PNETs) account for approximately 5% of cases and originate from the cells responsible for producing hormones, and can be functional or non-functional [2,3,4].

In general, PNETs have a less aggressive clinical course and a better prognosis than ductal adenocarcinoma [2,3,4]. Another relevant group are cystic neoplasms, which account for around 5% of cases and develop from pancreatic cysts, and can be serous (usually benign) or mucinous (with greater potential for malignancy) [2,3,4]. In addition to these, there are rare types of pancreatic cancer, such as acinar cell carcinomas, undifferentiated carcinomas and sarcomas, which show different degrees of aggressiveness and response to treatment [3,4]. Faced with this diversity of presentations, early diagnosis and individualization of the therapeutic approach are essential for improving patients' clinical outcomes [3,4].

Five-year overall survival for patients with pancreatic cancer is less than 10%, making it one of the cancers with the worst prognosis [3,4]. Compared to other types of neoplasms, such as breast and prostate cancer, which have significantly higher survival rates due to early detection and better therapeutic options, pancreatic cancer continues to have limited progress in terms of increasing the life expectancy of patients [3,4]. This reinforces the need for more effective screening and early diagnosis strategies [3,4,5].

One of the main difficulties in managing pancreatic cancer is its silent evolution in the early stages [4,5]. Many patients remain asymptomatic or present with non-specific symptoms such as fatigue, abdominal discomfort and weight loss, which are often attributed to other clinical conditions [4,5]. As a result, most diagnoses occur when the tumor has already spread locally or generated metastases, drastically reducing the chances of curative treatment [4,5,6].

The lack of highly specific and sensitive biomarkers for early diagnosis is one of the major challenges faced in pancreatic oncology [4,5,6]. The CA 19-9 tumor marker, currently used in clinical practice, has low specificity and is usually only elevated in more advanced stages of the disease [4,5,6]. Thus, there is an urgent need for new biomarkers and diagnostic tools that can detect pancreatic cancer in the early stages, enabling more effective treatment and a positive impact on patient survival [5,6,7].

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In recent decades, the epidemiology of pancreatic cancer has undergone significant changes, with an increase in the overall incidence of the disease [6,7,8]. This increase can be attributed to several factors, including the ageing of the population, changes in dietary patterns, an increase in obesity and a higher prevalence of type 2 diabetes [6,7,8]. These metabolic risk factors have been associated with the development of pancreatic cancer, reinforcing the importance of preventive and lifestyle modification strategies [7,8].

Advances in genetics have made it possible to identify hereditary mutations that significantly increase the individual risk of developing pancreatic cancer [7,8]. Genes such as BRCA2, PALB2 and STK11 have been associated with the disease, making it possible to implement screening strategies in high-risk populations [7,8,9]. The use of genetics in risk stratification can be a crucial advance in targeting screening tests to individuals who are more likely to develop the disease, increasing the chances of an early and potentially curative diagnosis [7,8,9].

Given this challenging scenario, it is essential to invest in new strategies for the early detection and prevention of pancreatic cancer [7,8,9]. Recent research has explored the use of artificial intelligence in analyzing clinical data to identify patterns that may indicate the presence of the disease before obvious symptoms appear [7,8,9]. Furthermore, research into promising molecular biomarkers could revolutionize the way pancreatic cancer is diagnosed [7,8,9]. In the field of prevention, interventions such as the control of metabolic factors and the use of chemopreventive agents, such as metformin and aspirin, show potential in reducing the incidence of the disease, although more studies are needed to validate these approaches [8,9].

An integrative review on pancreatic cancer is essential to gather and critically analyze the latest evidence on the epidemiology, risk factors, early detection strategies and preventive approaches of this highly lethal disease [8,9]. Given the complexity of the diagnosis and the limitations of the available therapeutic options, a comprehensive review makes it possible to identify gaps in knowledge, assess the effectiveness of new screening technologies and highlight potential clinical and behavioral interventions that could improve patient prognosis [8,9]. Furthermore, by synthesizing data from multiple studies, this approach contributes to guiding more effective clinical practices and stimulating new research aimed at the prevention and treatment of pancreatic cancer [8,9,10].

OBJECTIVES

This review aims to analyze the main challenges and advances in the early detection of pancreatic cancer, an aggressive neoplasm whose identification in the early stages can significantly impact the prognosis of patients [10]. Given the absence of specific symptoms in the early stages of the disease, early diagnosis is still a major obstacle in clinical practice [10,11]. Therefore, the role of emerging strategies will be explored, such as the development of more sensitive and specific biomarkers, the use of new imaging techniques and the implementation of personalized risk scores, which can contribute to more effective screening, especially in high-risk populations [10,11].

In addition, the review seeks to discuss future prospects in prevention and early detection, addressing the impact of behavioral interventions, the potential use of chemopreventive agents and the application of personalized medicine for targeted screening [11]. The limitations of current diagnostic approaches and the opportunities for improving these strategies will be assessed, considering the progress of research in the area and the need for clinical validation of new techno-

logies [11]. In this way, this analysis aims to help identify promising directions that could improve survival and quality of life for pancreatic cancer patients [11].

METHODS

This integrative review was conducted with the aim of analyzing the best available evidence on the challenges and advances in the early detection of pancreatic cancer [11]. To do this, the PUBMED, VHL and MEDLINE databases were consulted, covering publications between 2019 and 2024. The search was carried out using keywords such as *"Pancreatic Cancer"*, *"Early Detection"*, *"Biomarkers"*, *"Screening Strategies"* and *"Imaging Techniques"*, combined with Boolean operators (AND, OR) to maximize the relevance of the results [11].

Additional filters were applied to limit the selection of studies to English and Portuguese, excluding narrative review articles and non-peer-reviewed studies [11,12]. The inclusion of articles followed strict criteria, including studies that addressed new diagnostic technologies, the efficacy of biomarkers, the impact of screening programs, preventive strategies and clinical outcomes associated with early detection [11,12]. Articles that dealt with other rare pancreatic neoplasms or that did not detail specific diagnostic and therapeutic methods for pancreatic cancer were excluded [11,12].

The article selection process was carried out in two stages. In the first phase, 250 titles and abstracts were analyzed to identify relevant studies within the initial set of retrieved articles [11,12]. In the second phase, 41 full texts of the selected articles were evaluated in detail, extracting data on patient characteristics, diagnostic methods, types of biomarkers, the effectiveness of imaging tests and the impact of early detection on prognosis [11,12,13].

The data was organized in a systematic way, allowing a comparison between different methods of early detection and their respective advantages and limitations [12,13]. The final analysis was conducted based on the criteria of sensitivity and specificity of diagnostic tests, clinical feasibility of biomarkers and the impact of preventive strategies on reducing morbidity and mortality associated with pancreatic cancer [12,13]. This integrative approach made it possible to synthesize the best available evidence, offering support for improving clinical practice and contributing to the development of more effective guidelines for the early detection of the disease [12,13].

RESULTS

EPIDEMIOLOGY AND TRENDS

Pancreatic cancer has shown an increase in incidence globally, making it a growing public health concern [12,13]. Although rates vary between different geographical regions, the general trend indicates a significant increase in the number of cases, especially in developed countries [12,13,14]. This increase may be related to multiple factors, including changes in lifestyle habits, improvements in diagnostic methods and greater longevity of the population [13,14]. However, even with advances in the identification of the disease, the majority of cases are still diagnosed in advanced stages, which has a negative impact on the survival rate [13,14,15].

Population ageing plays a fundamental role in this scenario, since the risk of developing pancreatic cancer increases with age [13,14,15]. Most cases occur in individuals over the age of 60, reflecting the accumulation of genetic mutations over a lifetime, as well as prolonged interaction with harmful environmental factors [13,14,15]. With life expectancy increasing in many parts of the world, the incidence of pancreatic cancer is expected to continue rising, making it essential to develop effective screening and prevention strategies for this age group [13,14,15,16].

In addition to ageing, environmental factors have a significant impact on the incidence of pancreatic cancer [13,14,15,16]. Smoking is one of the main modifiable risk factors and is associated with a significant increase in the risk of the disease [13,14,15,16]. Other elements, such as obesity, diets rich in saturated fats and processed foods, as well as exposure to toxic chemicals, also contribute to the increase in cases [14,15,16]. Urbanization and the adoption of less healthy lifestyles intensify these risks, highlighting the need for public health policies aimed at raising awareness and preventing the disease [14,15,16,17].

Despite advances in the understanding of risk factors and in medical technology, the overall survival of patients with pancreatic cancer remains extremely low, with rates of less than 10% over five years [14,15,16,17]. This unfavorable prognosis is largely due to the aggressive nature of the tumor and the lack of effective methods for early detection [15,16,17]. Symptoms often only appear in advanced stages, when therapeutic options are limited [15,16,17]. Therefore, investing in new strategies for early diagnosis and the development of more effective therapies is essential to reverse this scenario and improve patients' clinical outcomes [15,16,17,18].

Pancreatic Ductal Adenocarcinoma (PDAC) is the most prevalent type of pancreatic cancer, accounting for approximately 90% of cases, with an incidence that increases with age and risk factors such as smoking, obesity and type 2 diabetes [18,19]. Its mortality rate remains high due to late detection and the aggressive nature of the tumor [18,19]. Pancreatic neuroendocrine tumors (PNETs) are less common, accounting for around 5% of cases, and have a more favorable clinical course, especially when diagnosed early, being more frequent between the ages of 40 and 60 [18,19,20].

Improvements in diagnostic methods have contributed to an increase in the detection of these tumors. Cystic neoplasms, which also account for approximately 5% of cases, have been identified more frequently due to advances in imaging techniques [18,19,20,21]. These neoplasms include serous variants, which are generally benign, and mucinous variants, which have significant malignant potential [19,20,21]. The epidemiology of pancreatic cancer reflects the need to improve screening, early identification and the development of new therapeutic approaches to improve clinical outcomes [19,20,21,22].

RISK FACTORS AND RISK ASSESSMENT

Traditional risk factors for pancreatic cancer include smoking, obesity, type 2 diabetes and chronic pancreatitis [20,21,22,23]. Smoking, in particular, is associated with an up to three-fold increased risk of developing the disease, with effects that can persist even after stopping the habit [21,22,23]. Obesity and type 2 diabetes also play a significant role, contributing to a chronic inflammatory state and insulin resistance, which can favor pancreatic carcinogenesis [21,22,23]. Chronic pancreatitis, a persistent inflammation of the pancreas, leads to progressive cell damage, creating an environment conducive to mutations and uncontrolled proliferation of malignant cells [23,24,25].

In addition to environmental and metabolic factors, advances in genetics have shown that some mutations significantly increase the risk of pancreatic cancer [23,24,25]. Alterations in genes such as BRCA2, PALB2 and STK11 have been associated with the development of the disease, especially in cases of family history [23,24,25]. A mutation in the BRCA2 gene, known for its role in breast and ovarian cancer, also predisposes to pancreatic cancer by compromising DNA repair mechanisms [24,25,26]. Mutations in STK11, found in Peutz-Jeghers syndrome, increase the risk of pancreatic malignancy throughout life [24,25,26].

In addition to genetic mutations, epigenetic alterations also play a relevant role in pancreatic oncogenesis [25,26,27,28]. Mechanisms such as aberrant DNA methylation, histone modification and regulation by microRNAs can influence the expression of tumor suppressor genes and oncogenes, promoting uncontrolled cell proliferation [25,26,27,28]. Recent studies have explored epigenetic biomarkers to predict susceptibility to pancreatic cancer and identify therapeutic targets for more precise treatments [27,28,29,30].

Given the complexity of risk factors, researchers have invested in the development of risk scores based on artificial intelligence and machine learning [27,28,29,30]. These models combine clinical, genetic and imaging data to create more accurate predictions about the likelihood of an individual developing pancreatic cancer [28,29,30,31]. By integrating large volumes of information, these tools can help in the early identification of the disease and in the stratification of patients for targeted screening tests [29,30,31,32,33].

The application of advanced risk scores could transform the preventive approach to pancreatic cancer [29,30,31,32,33]. Patients with a high genetic risk or a family history could be monitored more closely, with periodic examinations such as magnetic resonance imaging and echoendoscopy [31,32,33]. In addition, early interventions, such as lifestyle changes and, in some cases, prophylactic surgery, could be indicated to reduce the incidence of the disease in vulnerable populations [31,32,33,34].

With the continuous evolution of research into genetics, epigenetics and artificial intelligence, it is expected that new diagnostic and predictive strategies will be incorporated into clinical practice [32,33,34]. The combination of molecular knowledge and advanced technology can improve the early detection of pancreatic cancer, increasing the chances of effective treatment and improving clinical outcomes for patients [33,34,35].

EARLY DETECTION

Imaging tests play a fundamental role in the diagnosis of pancreatic cancer, allowing visualization of the location and extent of the tumour [34,35,36,37]. **Computed tomography (CT)** is often used as the initial examination, providing detailed images of the pancreatic anatomy and helping to identify suspicious masses [34,35,36,37]. **Magnetic resonance imaging (MRI)**, in turn, offers better resolution for differentiating tumors and adjacent structures, and is especially useful in assessing pancreatic cystic lesions [36,37,38]. **Endoscopic retrograde cholangiopancreatography (ERCP)** combines endoscopy and radiography to examine the bile and pancreatic ducts and can be used to obtain biopsies [36,37,38]. However, these techniques have limitations in detecting small or early-stage tumors, reducing the effectiveness of early diagnosis [37,38,39].

In addition to imaging tests, **tumor biomarkers** play a complementary role in the detection of pancreatic cancer [37,38,39]. **CA 19-9** is the most widely used marker in clinical practice, but its sensitivity and specificity are limited [37,38,39]. It can be elevated in other benign conditions, such as pancreatitis and liver disease, which makes it difficult to use as a stand-alone diagnostic tool [38,39]. In addition, around 10% of the population does not express CA 19-9 due to genetic variation, making the marker even less reliable. For this reason, there is great interest in identifying **new biomarkers,** such as **GPC1 in exosomes, circulating microRNAs and specific plasma proteins**, which can improve diagnostic accuracy, especially in the early stages of the disease [38,39].

Given the difficulty of early diagnosis, **screening programs** are essential for individuals at high risk of developing pancreatic cancer [38,39]. People with mutations in genes such as **BRCA2, PALB2, STK11** and those with a family history of pancreatic cancer are candi-

dates for intensified screening protocols [39]. These programs combine imaging tests, such as **MRI with cholangioresonance** and **echo-endoscopy**, with serum biomarkers, allowing for a more targeted approach [39]. Although large-scale population screening is not yet recommended due to the low overall incidence of the disease, screening high-risk groups can significantly increase the chances of early detection [39].

The combination of imaging techniques and biomarkers has been increasingly studied to improve diagnostic accuracy [39]. Recent studies explore the integration of **artificial intelligence and machine learning** to analyze patterns in imaging exams and identify molecular signatures associated with pancreatic cancer [39,40]. This approach can reduce false positive and false negative rates, improving the efficiency of screening programs [39,40]. In addition, the use of **multiplex panels of biomarkers** may allow for earlier and more specific detection of the disease, potentially increasing survival rates [39,40].

Although there are still challenges in the early detection of pancreatic cancer, advances in imaging tests, biomarkers and screening strategies offer promising prospects for the future [39,40]. The continuous development of new technologies and the validation of more accurate biomarkers could enable earlier diagnosis and more effective treatment, positively impacting patient survival [39,40]. The implementation of personalized screening programs, based on individual risk, could represent an important step in changing the clinical scenario of this highly lethal disease [39,40].

PREVENTION AND INTERVENTIONS

Adopting healthy habits plays a crucial role in reducing the risk of pancreatic cancer [40]. A balanced diet, rich in fruit, vegetables and unprocessed foods, combined with regular physical activity, can help control risk factors such as obesity and type 2 diabetes, which are widely associated with the development of the disease [40,41]. In addition, smoking cessation is essential, since smoking is one of the main risk factors for pancreatic cancer, contributing significantly to the increase in the overall incidence of the disease [40,41]. Lifestyle changes, therefore, not only prevent various chronic diseases, but are also an important strategy in reducing the risk of pancreatic cancer [40,41].

Research is also investigating the potential of chemopreventive agents, such as metformin and aspirin, in the context of pancreatic cancer [40,41]. Metformin, widely used in the treatment of type 2 diabetes, has shown promising effects in the prevention of certain types of cancer, including pancreatic cancer, through the modulation of metabolic and inflammatory processes [40,41]. Similarly, aspirin, with its anti-inflammatory properties, has been studied as a potential preventive tool, especially in individuals at high risk due to genetic factors or pre-existing conditions [40,41]. However, more research is needed to determine the efficacy and safety of these drugs as chemopreventive agents in pancreatic cancer [40,41]. Furthermore, for patients with diabetes, adequate blood glucose control has shown potential to reduce the risk of developing pancreatic cancer, highlighting the importance of proper disease management for the prevention of serious comorbidities [40,41].

DISCUSSION

CHALLENGES AND ADVANCES IN THE EARLY DETECTION OF PANCREATIC CANCER

In recent years, the increase in the global incidence of pancreatic cancer reflects a worrying trend, especially as factors such as an ageing population and an increase in comorbidities such as type 2 diabetes, obesity and smoking become more prevalent [1,2,8,9,11,12,15]. This underlines the urgent need for more effective prevention strategies, such as screening programs in high-risk populations and awareness campaigns about healthy habits [3,11,18,19,22,34,35]. In addition, early identification of the disease could allow for a more effective therapeutic approach, improving survival rates and reducing the morbidity associated with pancreatic cancer [3,11,18,19,22,34,35].

Early detection, however, is a major challenge due to the lack of specific symptoms in the early stages of the disease [3,11,18,19,22,34,35]. Pancreatic cancer often shows no clinical signs until it has reached an advanced stage, which contributes to its late diagnosis [4,10,14,26,33]. This, combined with the intrinsic aggressiveness of pancreatic ductal adenocarcinoma (PDAC), one of the most common types of pancreatic cancer, makes overall survival extremely low [4,10,14,26,33]. Early diagnosis could be the determining factor in choosing more effective treatments, such as surgical resection, which is limited to cases diagnosed in the early stages of the disease [1,9,16,21,29,37,41].

Despite advances in imaging techniques and the development of biomarkers, there is still a significant gap in relation to the early detection of pancreatic cancer [1,9,16,21,29,37,41]. The use of tests such as computed tomography, magnetic resonance imaging and endoscopic retrograde cholangiopancreatography can identify tumors in more advanced stages, but are not yet effective in detecting early lesions [21,29,37,41]. In addition, biomarkers such as CA 19-9 have significant limitations in terms of sensitivity and specificity, which makes it difficult to use them for a reliable diagnosis in early stages [21,22,29,37,41]. The combination of new biomarkers and more sensitive imaging techniques, associated with screening programs for at-risk populations, could be crucial to transforming early detection rates and, consequently, improving prognoses for patients with pancreatic cancer [3,11,18,19,22,34,35].

ADVANCES IN DIAGNOSIS, RISK ASSESSMENT AND PREVENTIVE STRATEGIES IN PANCREATIC CANCER

Advances in pancreatic cancer risk assessment have been promising, with the development of personalized risk scores using clinical, genetic and imaging data [21,22,28]. These scores offer a way of identifying individuals who are more likely to develop the disease, allowing for more targeted and earlier screening [21,22,28]. Furthermore, by combining information from different sources, it is possible to create more accurate risk models, increasing the chances of early detection at more treatable stages [17,18,26,32]. The personalization of these scores, based on individual factors such as family history, genetics and comorbidities, represents a significant advance, offering a more patient-centred approach [20,30,34].

However, the integration of emerging biomarkers into diagnosis and risk assessment still faces significant challenges [17,18,26,32]. Although biomarkers such as CA 19-9 are widely used, they have limitations in terms of sensitivity and specificity [17,18,,26,32]. Recent research suggests that new biomarkers, as well as epigenetic and genetic biomarkers,

have the potential to improve diagnostic and prognostic accuracy [22,24,28,29]. However, the clinical implementation of these biomarkers requires rigorous validation, more extensive clinical trials and the adaptation of existing technologies to ensure that the results are reproducible and clinically relevant [22,24,28,29].

In terms of prevention, modifying avoidable risk factors plays a crucial role in reducing the incidence of pancreatic cancer [12,13,14,28]. Adopting healthy habits, such as a balanced diet, regular physical activity and smoking cessation, can considerably reduce the risk of developing the disease [12,13,14,28]. Although these risk factors are well established, awareness campaigns and effective public policies are essential to promote changes in lifestyles, especially in populations with a high prevalence of these factors [30,32,33,39]. These behavioral interventions represent a primary prevention strategy that, in the long term, can have a significant impact on reducing the burden of pancreatic cancer [2,3,17,21].

In addition to behavioral interventions, chemopreventive agents such as metformin and aspirin have aroused interest due to their potential to reduce the incidence of pancreatic cancer, especially in patients with risk factors such as type 2 diabetes [2,3,17,21]. Although initial studies show promising results, more scientific rigor is needed to clearly define guidelines for the use of these drugs for prevention [18,19,31,34,36]. Future research should focus on long-term, randomized clinical trials to determine not only the efficacy, but also the safety and best dosages of these agents in at-risk populations [18,19,31,34,36].

FUTURE OPPORTUNITIES IN DETECTION

Despite advances in the diagnosis and risk assessment of pancreatic cancer, there are still significant limitations that need to be overcome [17,24,26,36]. The validation of new biomarkers requires longitudinal studies to confirm their efficacy and clinical applicability at different stages of the disease [17,24,26,36]. Furthermore, although emerging biomarkers and risk scores show great potential, the effective clinical implementation of these tests still faces challenges, such as the lack of standardization and the need for greater sensitivity and specificity for early detection [8,10,12,19]. Another important challenge is the expansion of screening programs to high-risk populations, such as those with a genetic predisposition or family history, which requires adequate resources and a trained health system [8,10,12,19,29,31,33].

With regard to treatment and prevention, future prospects are promising [27,38,37,40]. The exploration of immunological therapies offers an innovative way to combat pancreatic cancer, especially in the early stages, when the disease is more treatable [27,38,37,40]. Personalized medicine, which seeks to adapt treatments based on the patient's genetic and molecular characteristics, is also presenting itself as an innovative strategy for improving clinical results [8,15,17,18,25,33,41]. However, these approaches require more research to establish clear guidelines and ensure that they become accessible and effective for a greater number of patients, which could represent a major advance in the fight against pancreatic cancer [5,17,18,27,28,32,41].

CONCLUSION

Pancreatic cancer remains one of the greatest challenges in oncology due to its high lethality and the difficulty of early detection. Despite advances in imaging techniques, such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), and in the development of biomarkers, the non-specificity of symptoms means that many cases are diagnosed at advanced stages, reducing the chances of curative treatment. In addition, current diagnostic methods, especially biomarkers, still have limitations in terms of sensitivity and specificity, making it essential to improve these diagnostic tools.

Given this scenario, the implementation of screening programs for high-risk populations has emerged as a promising and necessary alternative, enabling early diagnosis and increasing the chances of effective therapeutic intervention. The use of artificial intelligence to analyze clinical patterns and the search for new, more sensitive and specific biomarkers represent important advances for early detection.

In addition to diagnosis, prevention of this aggressive form of cancer is fundamental to reducing its incidence. Adopting healthy habits, such as regular physical activity, a balanced diet and smoking cessation, plays an essential role not only in reducing the risk of pancreatic cancer, but also in preventing other chronic diseases, such as type 2 diabetes. In addition, regular medical follow-up and early identification of risk factors are indispensable measures for a more effective preventive approach.

Finally, pancreatic cancer requires continuous efforts to research new therapies, including immunological approaches and personalized treatments based on patients' genetic and molecular profiles. Advances in these areas could transform the management of the disease, reducing its high lethality and enabling patients to enjoy a better quality of life. The search for innovative solutions, coupled with improved screening and prevention strategies, is essential to meet this growing challenge in oncology.

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