JKKI: Jurnal Kedokteran dan Kesehatan Indonesia
Indonesian Journal of Medicine and Health
Journal homepage: https://journal.uii.ac.id/JKKI
P-ISSN 2085-4145 | E-ISSN 2527-2950

Cancer Vaccines

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EDITORIAL

ARTICLE INFO
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DOI: 10.20885/JKKI.Vol15.Iss1.art1
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The history of cancer vaccines is a story of relentless scientific pursuit, unfolding over the years to where we are today, with advanced medical tools at our disposal. This journey began with the rudimentary passive immunotherapy, exemplified by Coley's Toxins, which was developed in the late 19th century after an observation of tumor regression linked to infections.[1] Since then, a systematic refinement has occurred, leading to the development of therapeutic vaccines that stimulate the patient's immune system to identify and destroy cancerous cells.[2]

However, the effectiveness of these vaccines has often been undermined by the immune evasion mechanisms adopted by cancers.[3] The emergence of prophylactic vaccines, like the Hepatitis B and HPV vaccines, marked a significant milestone, reducing the incidence of liver and cervical cancers.[4] In today's world, the urgency for more effective cancer vaccines is accentuated by the global cancer burden, with millions of new cases and deaths occurring annually.[5]

Recognizing cancers as diseases of the immune system has positioned immunotherapy, including cancer vaccines, at the epicenter of cancer research.[6] These vaccines offer hope due to their specificity and minimal collateral damage to healthy tissues compared to treatments like chemotherapy.[7] They potentially foster memory T cell populations, enabling long-term immune vigilance against tumors.[8] The advent of personalized immunotherapies, like neoantigen-based vaccines, underscores the adaptability and promise of these vaccines.[9] However, challenges exist. The immune system's complexity, coupled with its compromised nature in advanced cancer cases, poses obstacles.[10] Cancers' adeptness at evading immune surveillance and the intricate process of antigen selection are significant challenges.[11] Personalized vaccines, though promising, are accompanied by logistical and financial challenges.[12] The vista of possibilities is widening, with potential applications including combination therapy and ongoing research aimed at optimizing immunotherapy.[13]

Moreover, the role of artificial intelligence (AI), deep learning (DL), and machine learning (ML) is emerging as transformative.[14] This convergence promises a paradigm shift in identifying and targeting individual-specific neoantigens, potentially enhancing vaccine efficacy.[15] The ML's capability to decode the complex tumor antigenic landscape and DL's ability to unravel patterns within vast datasets are instrumental.[16] Studies have highlighted the effectiveness of DL in enhancing the precision of neoantigen identification, marking a significant step towards personalized cancer immunotherapy.[17]

The integration of AI in vaccine design has streamlined the antigen selection process, marking a pivotal moment in oncological research.[18] This convergence promises not only to disrupt the current cancer therapeutic landscape but also to shape a new paradigm in the fight against cancer.[19] However, the realization of this promise is contingent on continuous exploration and rigorous validation through preclinical and clinical studies.

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