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Molecular and Clinicopathological Biomarkers in Neoadjuvant Treatment: A Comprehensive Review

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Introduction

Neoadjuvant therapy, administered before primary treatment, has revolutionized cancer management strategies by downsizing tumors, facilitating surgical resection and improving patient outcomes. Biomarkers, including molecular and clinicopathological markers, serve as indispensable tools in optimizing neoadjuvant treatment protocols. This review aims to explore the landscape of molecular and clinicopathological biomarkers in neoadjuvant therapy across various malignancies, shedding light on their predictive and prognostic roles. Neoadjuvant therapy has emerged as a cornerstone in the management of various cancers, offering a window of opportunity for treatment optimization and patient care improvement [1].

Description

Molecular biomarkers in neoadjuvant treatment

Genomic profiling:

- Next-Generation Sequencing (NGS) technologies enable comprehensive genomic profiling, identifying actionable mutations and molecular alterations.
- Targeted therapies tailored to genomic aberrations exhibit promising outcomes in neoadjuvant settings, particularly in breast, lung and colorectal cancers.

Gene expression signatures:

- Gene expression profiling, such as Oncotype DX and Mammaprint, stratifies patients based on risk profiles, aiding treatment decision-making in breast cancer.
- Signature-based approaches predict response to neoadjuvant chemotherapy and guide treatment escalation or de-escalation strategies.

Immunohistochemistry (IHC) markers:

- IHC markers, including hormone receptors HER2 and Ki-67, inform subtype classification and predict response to neoadjuvant therapy in breast cancer.
- PD-L1 expression serves as a predictive biomarker for immune checkpoint inhibitor efficacy in various malignancies, influencing neoadjuvant immunotherapy strategies [2].

Clinicopathological biomarkers in neoadjuvant treatment

Tumor histology and grade:

- Histological subtypes and tumor grade provide valuable prognostic information and guide neoadjuvant treatment selection across multiple cancer types.
- High-grade tumors often exhibit aggressive behavior and may benefit from intensified neoadjuvant regimens.

Tumor microenvironment (tme) characteristics:

- TME features, including Tumor-Infiltrating Lymphocytes (TILs) and stromal composition, impact treatment response and survival outcomes in various cancers.
- TILs serve as predictive biomarkers for immune-based therapies, guiding neoadjuvant immunotherapy decisions [3].

Circulating biomarkers:

- Liquid biopsies offer non-invasive monitoring of treatment response and disease progression through circulating tumor DNA circulating Tumor Cells (CTCs) and exosomes.
- Dynamic changes in circulating biomarkers during neoadjuvant therapy reflect treatment efficacy and facilitate real-time treatment adjustments.

Challenges and future directions

Biomarker validation:

- Robust validation of biomarkers is essential to ensure clinical utility and reproducibility across diverse patient populations.
- Prospective clinical trials incorporating biomarker-driven treatment strategies are warranted to validate predictive and prognostic biomarkers in neoadjuvant settings.

Integration of multi-omics data:

- Integration of genomics, transcriptomics, proteomics and metabolomics data holds promise for comprehensive molecular profiling and personalized treatment strategies.
- Advanced bioinformatics tools are required to unravel complex molecular networks and identify clinically actionable targets [4,5].

Biomarker heterogeneity and tumor evolution:

- Tumor heterogeneity and clonal evolution pose challenges to biomarker-driven treatment strategies, necessitating longitudinal monitoring and adaptive therapy approaches.
- Single-cell sequencing and spatial profiling techniques offer insights into intratumoral heterogeneity and guide targeted therapy selection in neoadjuvant settings.

Conclusion

Molecular and clinicopathological biomarkers are indispensable in guiding

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neoadjuvant treatment decisions, predicting treatment response and improving patient outcomes across various cancers. Molecular and clinicopathological biomarkers play a pivotal role in guiding neoadjuvant treatment decisions, predicting response and refining patient selection. This article provides an extensive review of the molecular and clinicopathological biomarkers utilized in neoadjuvant therapies across different cancer types, highlighting their significance, challenges and future directions. Continued research efforts are essential to validate and integrate biomarkers into routine clinical practice, enabling personalized and precision neoadjuvant therapies.

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Conflict of Interest

There are no conflicts of interest by author.

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