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Commentary

Developing the Precision Oncology with Cancer Stem Cell Markers

Alex Henry*

Department of Internal Medicine, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, United States of America

DESCRIPTION

Cancer is a complex and devastating disease that continues to challenge the medical community worldwide. Despite significant advances in cancer research and treatment modalities, the pursuit for a complete cure remains elusive. One developing area of research with the potential to revolutionize cancer therapy is the study of Cancer Stem Cells (CSCs) and their markers. Cancer stem cell markers play a pivotal role in identifying, isolating, and targeting these elusive cells, which are believed to be at the core of tumor initiation, progression, and recurrence. In this comprehensive review, we will be exploring the domain of cancer stem cell markers, exploring their significance, identification methods, and therapeutic implications. Cancer stem cells often referred to as tumor-initiating cells or cancer-initiating cells, represent a subpopulation of cells within a tumor that possess distinct characteristics. These cells are believed to drive tumor growth, metastasis, and therapy resistance, making them an acute focus of cancer research. Instead, a small fraction of cells exhibited the ability to generate heterogeneous tumors when transplanted into animal models. One prominent feature of CSCs is their capacity for self-renewal, which allows them to maintain the tumor's growth over extended periods. Additionally, CSCs can differentiate into various cell types found within a tumor, giving rise to the heterogeneity characteristic of many malignancies. This differentiation potential makes CSCs particularly challenging to target with conventional cancer therapies, as they can evade treatment by assuming different cell fates. CSCs play a pivotal role in cancer progression and recurrence. Conventional cancer therapies, such as chemotherapy and radiation, often target rapidly dividing cancer cells. While these treatments may initially shrink tumors and alleviate symptoms, they frequently fail to eliminate CSCs, which can lead to disease relapse. The survival of CSCs after treatment has been attributed to several factors, including their quiescent state, enhanced DNA repair mechanisms, and expression of drug efflux transporters that pump out chemotherapy drugs. CSCs are also implicated in metastasis, the process by which cancer spreads from the primary tumor to distant sites in the body. These cells possess migratory and invasive properties, allowing them to permeate into blood or lymphatic vessels and the leak at secondary sites, where they can initiate the growth of new tumors. Metastasis is a significant contributor to cancer-related mortality, and understanding the role of CSCs in this process is acute for developing effective therapeutic strategies.

Cancer stem cell markers

CD44: CD44 is a cell adhesion molecule that has been identified as a CSC marker in various cancers, including breast, colon, and head and neck cancers. It is involved in cell-cell interactions and is associated with CSC self-renewal and metastasis.

CD133 (Prominin-1): CD133 is a glycoprotein that has been implicated as a CSC marker in brain tumors (glioblastoma), colon cancer, and pancreatic cancer. It is associated with tumor initiation and resistance to therapy.

EpCAM (Epithelial Cell Adhesion Molecule) : EpCAM is a trans membrane glycoprotein expressed in epithelial tissues and has been linked to CSCs in breast and colorectal cancers. It plays a role in cell adhesion and signaling.

ALDH (Aldehyde Dehydrogenase): ALDH is an intracellular enzyme that detoxifies aldehydes. High ALDH activity has been associated with CSCs in multiple cancer types, including breast, lung, and ovarian cancers.

LGR5 (Leucine-Rich Repeat-Containing G Protein-Coupled Receptor 5): LGR5 is a receptor protein associated with Wnt signaling, and it serves as a marker for CSCs in colorectal cancer and other malignancies.

CD24: CD24 is a cell surface marker that is overexpressed in CSCs of various cancers, including ovarian, pancreatic, and breast cancer. It has been linked to tumor progression and metastasis.

The discovery of CSC markers has significant therapeutic implications, as they provide potential targets for the development of novel cancer therapies. Targeting CSCs has become a promising strategy to improve cancer treatment outcomes and reduce the risk of disease recurrence.

Correspondence to: Alex Henry, Department of Internal Medicine, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, United States of America, E-mail: henry.alex@gmail.com

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Therapeutics approaches based on CSC markers:

Antibodies or small molecule inhibitors that specifically target CSC markers can be developed. For example, monoclonal antibodies targeting CD133 have been investigated for the treatment of glioblastoma. Inducing CSCs to differentiate into non-tumorigenic cell types can render them susceptible to conventional therapies. Agents that promote CSC differentiation are being explored as potential treatment options. Immunotherapies, such as Chimeric Antigen Receptor (CAR) T-cell therapy and immune checkpoint inhibitors, are being investigated to target CSCs by harnessing the immune system's power. Combining traditional chemotherapy or radiation with agents targeting CSC markers can enhance the efficacy of treatment by eliminating both the bulk of the tumor and the CSC population. Nanoparticles can be engineered to deliver therapeutic agents specifically to CSCs by targeting CSC markers. This approach minimizes off-target effects and improves drug delivery.

Cancer stem cell markers represent a fascinating frontier in cancer research and therapy. They offer insights into the complex biology of CSCs and provide potential targets for novel treatments. While significant progress has been made in identifying and understanding these markers, many challenges remain, and further research is needed to utilize their full therapeutic potential Cancer is a complex and devastating disease that continues to challenge the medical community worldwide. Despite significant advances in cancer research and treatment modalities, the pursuit for a complete cure remains elusive. One emerging area of research with the potential to revolutionize cancer therapy is the study of Cancer Stem Cells (CSCs) and their markers. Cancer stem cell markers play a pivotal role in identifying, isolating, and targeting these elusive cells, which are believed to be at the core of tumor initiation, progression, and recurrence.