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Review

The Usage Of Biomarkers In The Early Detection Of Diseases

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Abstract

This review discusses the definition and types of biomarkers. It also reviews the potential use of biomarkers in diagnosing, Treating, Predecting the course of various diseases such as cardiovascular, Infectious, Cancer. The current review focuses on biomarkers for CVD, Infectious, Cancer and the procedures that should be consider to establish the comprehensive nature of the expression of biomarkers for cardiovascular diseases. It also discusses how biomarkers can help with treatment decisions and monitoring disease progression.

Keywords: Biomarker, Diagnosis, Therapeutics, Biomolecular system, CVD, Cancer, Infectious disease.

INTRODUCTION

Biomarker is a molecular, Cellular, or Biochemical change that can be accurately and repeatably measured and can be used to identify and monitor physiological and pathogenic processes or responses to pharmacological interventions.[1] Biomarkers include biomolecules like carbohydrates, Proteins, lipids, to genes, DNA, RNA, Platelets, enzymes, hormones, etc. Biomarkers can be found in blood, urine, tissue or genetic material.[2]

TYPES OF BIOMARKERS

Four main types of biomarkers

1. **Molecular biomarkers:**
   - Genomic biomarkers: DNA and RNA characteristics that indicate normal or pathogenic processes, or a response to treatment.

- Proteomic biomarkers: Biomarkers discovered using proteomics platforms.

2. **Physiologic biomarkers:**
   - Blood pressure: A physical measurement that can indicate a condition or disease.
   - Body temperature: A physical measurement that can indicate a condition or disease.[3]
3. **Histologic biomarkers:**
   - Epigenetic biomarkers: Biomarkers such as methylated DNA, histones, and miRNAs that can be analyzed from tissue samples.
4. **Radiographic biomarkers:**
   - Imaging biomarkers: Biomarkers that use advanced medical imaging to visualize biological processes in the body.[4]

Biomarker subtypes

- Predictive biomarkers: Biomarkers that help identify promising subgroups in clinical trials.
- Prognostic biomarkers: Biomarkers that help predict the risk of disease.
- Surrogate endpoint biomarkers: Biomarkers that help shorten randomized trials.[5]

USES OF BIOMARKERS

- Disease diagnosis: Biomarkers can help identify the presence of a disease, such as cancer, cardiovascular disease, or diabetes.
- Disease screening: Biomarkers can help identify the risk of developing a disease, such as prostate cancer or colon cancer.
- Disease staging: Biomarkers can help categorize the severity of a disease.
- Disease prognosis: Biomarkers can help predict the future course of a disease, such as the likelihood of recurrence or response to therapy.[6]
- Disease monitoring: Biomarkers can help monitor a disease over time, such as the effectiveness of a treatment.
- Therapy safety and efficacy: Biomarkers can help identify the safety and efficacy of a therapy, such as antiarrhythmic drugs.
- Environmental exposure: Biomarkers can help identify exposure to environmental chemicals or toxins.[7]

BIOMARKERS USED IN CARDIOVASCULAR DISEASES

1. **Coronary artery disease:** Biomarkers used to diagnose coronary artery disease (CAD) include proteins, enzymes, and microRNAs. These biomarkers can help identify the risk of CAD and predict the course of the disease.

- **Proteins and enzymes-**

Cardiac troponin: A protein that enters the bloodstream after a heart attack and remains elevated for days. Troponin I is the most specific biomarker for a heart attack.
Creatinine kinase (CK): An enzyme that can be measured multiple times over a 24-hour period. CK levels can increase in many conditions, so it's not very specific.
Endothelin-1: A vasoconstrictor peptide secreted by endothelial cells.
Myeloperoxidase (MPO): An enzyme secreted by macrophages and neutrophils during inflammation. MPO is a risk marker for acute coronary syndrome.

- **MicroRNAs-**

miRNA-941: A microRNA that's involved in inflammation and cell proliferation.
miRNA-216a and miRNA-451: MicroRNAs that are involved in endothelial damage and monocyte recruitment.
miRNA-223-3p, miRNA-122-5p, miRNA-93-5p: MicroRNAs that are involved in cell proliferation, migration, apoptosis, and cardiomyocyte hypertrophy.

2. **High blood pressure:** Some biomarkers used to assess high blood pressure (hypertension) include: C-reactive protein (CRP) as an inflammatory marker, urine albumin excretion (UAE) to indicate kidney damage, nitric oxide (NO) levels related to vascular function, plasma aldosterone levels, fibrinogen, renin, B-type natriuretic peptide (BNP), and markers of oxidative stress like isoprostanes.

3. **Cardiac arrest:** Biomarkers used to detect cardiac arrest include troponin, C-reactive protein (CRP), S100B, and galectin-3.

- **Troponin-**

A protein that enters the bloodstream after a heart attack.
The most commonly used biomarker for heart damage.

Levels can rise for up to 12 hours after a heart attack and remain elevated for up to two weeks.
Troponin I is highly specific to the heart and stays higher longer than creatinine kinase-MB

- **C-reactive protein (CRP)-**

A predictor of future cardiac events, including myocardial infarction, ischemic stroke, and sudden cardiac death.

- **S100B -**

An early biomarker after cardiac arrest, as the level usually peaks at 24 hours.

- **Galectin-3-**

A significant predictor of mortality, even after considering other biomarkers
Elevated galectin-3 levels are associated with ICU admission and a higher risk of ARDS

4. **Congestive heart failure:** The most commonly used biomarkers for diagnosing and monitoring congestive heart failure (CHF) are B-type natriuretic peptide (BNP) and N-terminal pro-B-type natriuretic peptide (NT-proBNP).

5. **Arrythmia:** Biomarkers commonly used in the diagnosis and risk assessment of arrhythmias include troponin, B-type natriuretic peptide (BNP), C-reactive protein (CRP), interleukin-6 (IL-6), galectin-3, soluble suppression of tumorigenicity (sST2), and growth differentiation factor 15 (GDF-15).

6. **Peripheral artery disease:** Biomarkers for peripheral artery disease (PAD) include inflammatory markers, lipid markers, and coagulation factors. Some biomarkers that are associated with PAD include
   - C-reactive protein (CRP): An inflammatory marker that may be used to identify patients at high risk for PAD.
   - Fibrinogen: A coagulation factor that may be used to diagnose PAD.
   - Neopterin: A biomarker that may be used to predict PAD.
   - Apolipoproteins: A lipid marker that may be associated with PAD.
   - Triglycerides: A lipid marker that may be associated with PAD.
   - Monounsaturated fatty acids: A lipid marker that may be associated with PAD.
   - Erythrocyte sedimentation rate (ESR): A biomarker that may be used to diagnose PAD.
   - Fatty acid binding protein 3 (FABP3): A biomarker that may be used to diagnose PAD.

7. **Stroke**
   - C reactive protein (CRP): An acute phase protein that can indicate inflammation.
   - Interleukin-6 (IL-6): A protein involved in inflammation and immune response.
   - Matrix metalloproteinase-9 (MMP-9): A zinc-dependent endopeptidase that activates inflammatory mediators.
   - D-dimer: A molecule involved in acute thrombosis.
   - Fibrinogen: A glycoprotein involved in acute thrombosis.
   - S100B: A glial protein that's highly specific to nervous tissue.
   - Von Willebrand factor (vWF): A molecule that plays a role in thrombus formation.
   - Intercellular adhesion molecule-1 (ICAM-1): An adhesion molecule that's overexpressed in response to inflammation.
   - Atrial natriuretic peptide (ANP): A natriuretic peptide.
   - B-type natriuretic peptide (BNP): A natriuretic peptide.

8. **Congenital heart disease**
   - Troponin: A biomarker of myocardial damage.
   - Amino-terminal procollagen type III peptide (PIIIP): A biomarker of myocardial fibrosis and stromal remodeling.
   - B-type natriuretic peptide (BNP) and N-terminal proBNP: Biomarkers of cardiac load and heart failure.
   - Asymmetric dimethylarginine (ADMA): A potential diagnostic biomarker for PAH-CHD.
   - Vascular endothelial growth factor (VEGF): A potential diagnostic biomarker for PAH-CHD.
   - Betaine, taurine, glutamine, and phenylalanine: Potential serum diagnostic biomarkers for CHD.

BIOMARKERS USED IN INFECTIOUS DISEASE

Biomarkers used in infectious diseases include proteins, cytokines, microRNAs, and other molecules. These biomarkers can help diagnose infections, predict their course, and guide treatment.

1. **Protein biomarkers**
   - C-reactive protein (CRP): A nonspecific protein that increases quickly in response to inflammation. CRP levels can help distinguish between infection and other causes of inflammation.
   - Procalcitonin (PCT): A hormone produced by the thyroid that increases in response to bacterial toxins. PCT is a sensitive biomarker for severe bacterial infections.
   - Urokinase-type plasminogen activator receptor (uPAR): A protein that participates in inflammation and migration of inflammatory cells. Elevated levels of uPAR in the blood, urine, or cerebrospinal fluid can indicate inflammation.

2. **Cytokine biomarkers**
   - Interleukin-1 (IL-1): A cytokine that induces fever by binding to receptors on brain cells.
   - Interleukin-6 (IL-6): A cytokine that induces fever by binding to receptors on brain cells.

3. **MicroRNA biomarkers**
   - MicroRNAs (miRNAs): Small, non-coding RNA transcripts that may be useful for diagnosing infectious diseases.

4. **Other biomarkers**
   - Leucocyte count: A potential biomarker for bacterial infections.
   - Erythrocyte sedimentation rate (ESR): A potential biomarker for bacterial infections.
   - Glutamate dehydrogenase (GDH): A biomarker used to diagnose Clostridioides difficile infection (CDI).
   - (1,3)-β-D-glucan (BDG): A biomarker used to detect invasive candidiasis.

CONCLUSION

In conclusion, biomarkers play a crucial role in the early detection of cardiovascular and infectious diseases, offering valuable tools for improving diagnosis, treatment, and patient outcomes.

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