DATA EXTRACTION BIOMARKERS

Extraction of Data Related to BioMarkers :-

Sources :-

https://medcraveonline.com/JSRT/emerging-biomarkers-of-congenital-heart-diseases-and-disorders.html
https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2773467
https://www.mdpi.com/1422-0067/23/9/4993

Types of Biomakers explained in the scientific journal article:-

:- Hemodynamic, Physiological, Genetic, Molecular, Immunological, Clinical and Therapeutic biomarkers

"*Some of the above are explained below with proper example*"

1. Physiological Biomarkers

Physiological biomarkers are measurable indicators of the body's functions or states, providing valuable information for diagnosing diseases, monitoring treatment response, and assessing overall health. They encompass various types, such as blood markers, genetic markers, imaging markers, and vital signs, enabling objective assessments and personalized healthcare interventions.

Biomarker Type	Examples	Sources	Applications
Blood Biomarkers	C-reactive protein (CRP), glucose	Blood	Assess organ function, detect inflammation, diagnose diseases
Genetic Biomarkers	BRCA1, BRCA2	DNA	Assess disease risk, personalize treatment plans
Imaging Biomarkers	X-rays, MRI, CT, PET	Imaging techniques	Detect abnormalities, assess organ function, monitor treatment

Vital Signs	Body temperature, heart rate, blood pressure, respiratory rate	Measurement devices	Assess overall health, detect abnormalities
ECG Biomarkers	Heart rate, rhythm, cardiac function	Electrocardiogram	Diagnose heart conditions, monitor heart health
Biochemical Biomarkers	Prostate-specific antigen (PSA), neurotransmitters	Bodily fluids (urine, saliva, CSF)	Diagnose diseases, monitor treatment response, measure physiological processes
Wearable Device Biomarkers	Activity levels, heart rate, sleep patterns	Wearable devices	Assess overall health, monitor physical fitness, identify trends or abnormalities

2. Hemodynamic Biomarker

Hemodynamic biomarkers are measurements that provide information about the movement of blood in the body. They help doctors understand how well blood is flowing, how strong the heart is pumping, and if there are any blockages or problems in the blood vessels, which can be important for diagnosing and treating heart conditions.

Hemodynamic Biomarker	**Definition**	**Role**
Blood Pressure	Force exerted by blood against vessel walls	Indicates workload on the heart and resistance within blood vessels
Heart Rate	Number of heartbeats per minute	Reflects cardiac output and can be influenced by various factors
Cardiac Output	Volume of blood pumped by the heart per minute	Provides information about the heart's efficiency in delivering oxygenated blood
Stroke Volume	Volume of blood ejected from the heart with each beat	Indicates cardiac function and can be influenced by heart size, contractility, and more

Central Venous Pressure	Pressure in the central veins	Assesses fluid status and guides fluid management in critical care settings
Pulmonary Artery Pressure	Pressure in the pulmonary artery	Evaluates the right side of the heart, pulmonary circulation, and fluid balance

3. Genetic Biomarkers

Genetic biomarkers are specific variations or patterns in our DNA that can give doctors clues about our risk of developing certain diseases or how we might respond to certain treatments. By studying these genetic markers, doctors can personalize medical care and make more informed decisions about our health.

Genetic Marker Type	**Function**
Single Nucleotide Polymorphism (SNP)	SNPs are the most common type of genetic variation, where a single nucleotide differs between individuals. SNPs can be associated with disease susceptibility, drug response, and traits.
Microsatellites / Short Tandem Repeats (STR)	Microsatellites are short DNA sequences repeated in tandem. They are used for DNA profiling, forensic analysis, and population genetics studies.
Variable Number Tandem Repeats (VNTR)	VNTRs are DNA sequences consisting of repeated units of variable lengths. They can be used for genetic mapping and disease diagnosis.
Gene Expression Markers	Gene expression markers measure the activity of specific genes. They can indicate disease subtypes, prognosis, and treatment response.
Haplotype	A haplotype is a set of genetic variations inherited together. Haplotypes can be associated with disease susceptibility and population genetics studies.

4. Molecular Biomarkers:-

Molecular biomarkers are specific molecules or substances found in the body that can provide information about the presence, progression, or risk of certain diseases, including congenital heart defects (CHDs). In the context of CHDs, molecular biomarkers can be used to aid in early diagnosis, predict disease severity, monitor treatment response, and assess the overall prognosis of individuals with CHDs.

Molecular Biomarker	**Examples**	**Sources**	**Applications**
Genetic Markers	GATA4, NKX2.5, TBX5	DNA (Blood, Tissue)	Assess risk, identify genetic causes, predict disease severity
Protein Biomarkers	Troponin T, Brain Natriuretic Peptide (BNP)	Blood, Urine, Tissue	Diagnose CHDs, assess cardiac injury or stress, monitor treatment response
MicroRNA	miR-1, miR-133, miR-21	Blood, Tissue	Predict disease progression, identify subtypes, assess prognosis
Metabolomic Markers	Lactate, Glutamate, Citrate	Blood, Urine	Assess metabolic changes, identify biomarkers of disease subtypes
Oxidative Stress Markers	Reactive oxygen species (ROS), Malondialdehyde (MDA)	Blood, Tissue	Assess oxidative stress levels, evaluate cardiac damage
Inflammatory Markers	C-reactive protein (CRP), Interleukins	Blood, Tissue	Assess inflammation levels, identify immune system activation

5. Immunological Biomarker:-

Immunological biomarkers in CHDs provide insights into the immune system's role in disease development, progression, and complications. They can help identify immune dysregulation, inflammation, and autoimmune processes associated with CHDs.

Immunological Biomarker	Examples	Sources	Applications
Cytokines	Interleukin-6 (IL-6), Tumor Necrosis Factor-alpha (TNF-α)	Blood, Tissue	Assess inflammation, immune response, and cardiac remodeling
Chemokines	CXCL8 (Interleukin-8), CCL2 (Monocyte Chemoattractant Protein-1)	Blood, Tissue	Indicate immune cell recruitment and inflammation
Autoantibodies	Anti-cardiac myosin antibodies, Anti-endothelial cell antibodies	Blood	Indicate immune responses targeting cardiac tissue
Cellular subsets	T-helper cells (Th1, Th2), Regulatory T cells (Tregs)	Blood, Tissue	Assess immune cell profiles and immune regulation in CHDs
Inflammatory Markers	C-reactive protein (CRP), Erythrocyte sedimentation rate (ESR)	Blood, Tissue	Indicate systemic inflammation and disease activity
Damage-associated molecular patterns (DAMPs)	High-mobility group box 1 (HMGB1), Heat shock proteins (HSPs)	Tissue, Blood	Reflect tissue damage and immune responses in CHDs

6. Clinical Biomarkers : -

Clinical biomarkers are measurable characteristics or parameters that are directly observable or detectable through medical examinations or tests.
Clinical biomarkers for CHDs can include various measurements, imaging findings, and diagnostic tests. These biomarkers are used to assess and diagnose CHDs, monitor disease progression, evaluate treatment response, and determine prognosis.

Clinical Biomarker	Examples	Sources	Applications
Echocardiographic measurements	Ejection fraction, Cardiac dimensions (e.g., ventricular size), Valve abnormalities	Ultrasound	Assess cardiac structure and function, diagnose specific CHD types

Electrocardiogram (ECG) findings	Heart rate, Rhythm abnormalities (e.g., arrhythmias), QT interval	Electrical activity of the heart	Assess cardiac electrical activity, detect conduction abnormalities
Oxygen Saturation Levels	Pulse oximetry measurements (SpO2)	Non-invasive device (e.g., finger probe)	Assess blood oxygen levels, screen for cyanotic CHDs
Cardiac Imaging Results	X-rays, Magnetic resonance imaging (MRI), Computed tomography (CT)	Imaging techniques	Visualize cardiac structures, detect abnormalities, aid in diagnosis
Biomarkers of Heart Failure	B-type natriuretic peptide (BNP), N-terminal pro-B-type natriuretic peptide (NT-proBNP)	Blood	Assess cardiac strain and heart failure severity

7. Therapeutic biomarkers:-

Therapeutic biomarkers in the context of Congenital Heart Defects (CHDs) are measurable indicators used to guide and optimize treatment strategies for individuals with CHDs. By incorporating therapeutic biomarkers into clinical practice, healthcare providers can optimize treatment decisions and improve patient outcomes in the management of CHDs.

Therapeutic Biomarker	**Examples**	**Sources**	**Applications**
Genetic Markers	Genetic variants affecting drug metabolism (e.g., CYP2C9, VKORC1)	DNA (Blood)	Personalize medication selection and dosing for optimal response
Protein Biomarkers	Brain Natriuretic Peptide (BNP), Troponin T	Blood	Assess cardiac function, guide heart failure treatment
Imaging Markers	Echocardiographic response to medication, Cardiac MRI findings	Imaging techniques	Monitor treatment response, assess changes in cardiac structure

Biomarkers of Inflammation	C-reactive protein (CRP), Interleukins	Blood, Tissue	Guide anti-inflammatory therapies, assess response to treatment
Metabolic Markers	Metabolites indicating drug metabolism or therapeutic efficacy	Blood, Urine	Optimize medication selection, monitor treatment response
Cardiac Remodeling Markers	Galectin-3, Matrix metalloproteinases (MMPs)	Blood, Tissue	Assess cardiac remodeling, guide treatment strategies
Biomarkers of Oxidative Stress	Reactive oxygen species (ROS), Antioxidant enzyme levels	Blood, Tissue	Evaluate oxidative stress levels, assess response to antioxidants

List of Other Related Biomarkers Extracted Related to CHDs ➖

Biomarker	**Explanation**
Cardiac troponins I and T (cTnI and cTnT)	Proteins released into the bloodstream when there is damage to the heart muscle.
Natriuretic peptides (BNP and NT-proBNP)	Hormones produced by the heart in response to increased stretching of heart muscle cells.
Galectin-3	A protein involved in inflammation and fibrosis.
High-sensitivity C-reactive protein (hs-CRP)	A marker of systemic inflammation.
Beta-amyloid (Aβ)	A protein fragment that accumulates in the brain in Alzheimer's disease.
Tau protein	A protein involved in stabilizing microtubules in nerve cells.
Malondialdehyde (MDA)	A reactive compound formed during lipid peroxidation, indicating oxidative stress.

Advanced oxidation protein products (AOPP)	Products formed by the oxidation of proteins, indicating oxidative stress.
Isoprostanes	Prostaglandin-like compounds formed by the oxidation of lipids, indicating oxidative stress.
Protein carbonyls	Oxidized proteins that serve as markers of oxidative stress.
8-hydroxy-2'-deoxyguanosine (8-OHdG)	A marker of oxidative damage to DNA.
C-reactive protein (CRP)	A protein produced by the liver in response to inflammation.
Tumor necrosis factor-alpha (TNF-α)	A pro-inflammatory cytokine involved in immune regulation.
Interleukin-6 (IL-6)	A pro-inflammatory cytokine involved in immune responses.
Interleukin-1 beta (IL-1β)	A pro-inflammatory cytokine involved in immune responses.