The Origin of Cardiovascular Disease

Now explained
The origin of Cardiovascular Disease and the role of lipoproteins

- What is Cardiovascular Disease (CVD)
- Conventional understanding of CVD
- Inadequacy of the current concept of CVD – the need for a new rationale
- Modern new understanding of CVD developed by Dr. Rath
- Lipoproteins and their role in CVD
- Vitamin C and cardiovascular health
- Implications of this new understanding
What is Cardiovascular Disease (CVD)

Disease of the blood vessels of the heart and the body.

The underlying disease process is called **Atherosclerosis:**

- Hardening and narrowing of the arteries.
- Risk of blocking the blood flow in the arteries causing heart attack and stroke.
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Modern Concept

- Long-term vitamin deficiencies initiate the structural impairment of the artery wall.
- Fat transporting molecules, primarily Lipoprotein(a), enter the artery wall to be deposited there for the purpose of structural repair.
- The deposition serves a distinct biological purpose: mend the injuries and prevent fatal blood loss.

Conventional Thinking

- High levels of cholesterol circulating in the bloodstream damage the inside of the blood vessel walls.
- Fat transporting molecules, primarily Low-Density-Lipoprotein (LDL), enter the artery wall and deposit their fat content inside the wall.
- The deposition serves no biological purpose.
## Heart Disease

**Focus 1:**

**Conventional Thinking**

### What causes Cardiovascular Disease

<table>
<thead>
<tr>
<th>CONVENTIONAL MEDICINE</th>
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Conventional Thinking

Development of Atherosclerosis

1. A fatty streak develops between the intima and the media. 

2. Thick fibrous shell

3. Plaque can sometimes rupture into the bloodstream
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Conventional Thinking

Advanced Thrombosis

4. If the blood clot enlarges to completely block the artery, all tissues supplied by that artery begin to die below the blockage.

5. Thrombosis is the clotting of blood which begins at the site of the plaque rupture.
Stage 1: Damaged endothelium

Conventional thinking assumes that elevated blood levels of cholesterol-carrying molecules — primarily **Low Density lipoproteins (LDL)** — damage the endothelial cells of the blood vessel wall.

Thereby, so the conventional theory goes, the process of atherosclerosis is initiated.

Since the cholesterol blood levels are the same throughout the blood vessel system, this theory would necessarily mean that we get infarctions in all organs of our body at the same rate — not just heart attacks and strokes.

*Note: The endothelium is the thin layer of cells that lines the interior surface of blood vessels, forming an interface between circulating blood and the vessel wall.*
Stage 2: Following the alleged damage by cholesterol, the endothelium becomes more permeable to fat transporting molecules (LDL).

Stage 3: LDL particles penetrate the vascular wall. They are deposited in the intima, where they may undergo oxidation.

Stage 4: Endothelial cells respond by attracting white blood cells (monocytes) from the blood stream that allegedly enter the blood vessel wall to eat up the abundantly deposited cholesterol.
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Stage 5:
Monocytes enter the arterial walls and transform into ‘police cells’ (macrophages).

Stage 6:
The macrophages absorb (oxidized) LDL molecules and transform into foam cells. Conglomerates of foam cells form fatty streaks.

Stage 7:
Eventually, so the conventional theory goes, the macrophages ‘overeat’ and burst, releasing free cholesterol and other molecules into the artery wall.

Note: Foam cell = lipid loaded macrophages, generated from massive uptake of modified LDL.
Stage 8: Fibrous cap
Stimulated by signal molecules (cytokines), so the theory goes, smooth muscle cells (from the muscular layer of the artery wall) start to multiply and form a fibrous cap covering the lipid center (atherosclerotic plaque).
Stage 9: Plaque rupture
Eventually, the fibrous cap ruptures leading to undesirable consequences:

- thrombus formation at the site of the plaque rupture
- impaired blood flow, which can lead to **heart attacks** or **strokes**
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Conventional Thinking
Overview

LDL cholesterol as primary risk factor for cardiovascular disease

LDL cholesterol allegedly damages the endothelial cells

LDL particles penetrate the vascular wall

Plaque disruption

Advanced atherosclerotic plaque

Formation of Foam Cells

Thrombosis

Heart attack/stroke
Problem Statements

Why the conventional thinking about high cholesterol levels as the primary origin of human cardiovascular disease has to be urgently replaced
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High blood cholesterol is evenly distributed in the arteries and veins of the 60,000 miles (100,000 km) long vascular system of the human body. If cholesterol was damaging the blood vessels we would inevitably develop:

a. Atherosclerotic deposits all along our blood vessel system – and not primarily in the short coronary arteries of the heart (about 30 cm long).

b. Infarctions in ears, nose and all other organs at the same rate – not just heart attacks.

c. Atherosclerosis not just in the arteries but also the veins.

PROBLEM: Conventional thinking cannot solve these basic questions of cardiology (I)
PROBLEM: Conventional thinking cannot solve these basic questions of cardiology (II)

c. Animals that sleep through the winter (hibernators) have extremely high blood cholesterol levels (400mg/dl and above). If high cholesterol was damaging the artery walls, thereby initiating atherosclerosis, these animals would have been extinct long ago.

“Heart disease in animals is not impossible, 
it simply does not generally occur.

If the reason for this could be determined, it may cast a useful light on its occurrence in humans.”

Smith & Jones, Textbook of Veterinary Pathology
Despite a missing scientific and logical rationale, the conventional thinking of CVD serves as the basis for an over $30 billion market in cholesterol-lowering drugs.

These huge expenses are burdening the people and strangulating economies around the world.
Conventional Thinking

In summary:

There are scientific and economic reasons why conventional thinking about the origin of cardiovascular disease has to be urgently replaced.
The modern approach can solve this and other puzzles of cardiology.

Let’s see how....
What causes Cardiovascular Disease

Old versus new thinking

MODERN CONCEPT

- Long-term vitamin deficiencies initiate the structural impairment of the artery wall.
- Fat transporting molecules, primarily Lipoprotein(a), enter the artery wall to be deposited there with the purpose of structural repair.
- The deposition serves a distinct biological purpose: mend the injuries and prevent fatal blood loss.
New Understanding
Introducing a new Concept of CVD

1990

Publications by M. Rath & L. Pauling

✓ Atherosclerosis is an early form of scurvy.
✓ Lipoprotein(a) is a repair molecule that functions as a surrogate for vitamin C in the impaired vascular wall.

Proceedings of the National Academy of Sciences 1990, 87: 6204-6207
Proceedings of the National Academy of Sciences 1990, 87: 9388-9390
European Atherosclerosis Society (AES)

The AES stresses the significance of Lp(a) & recommends screening for elevated Lp(a) levels.

... the evidence clearly supports Lp(a) as a priority for reducing cardiovascular risk, beyond that associated with LDL-C...
Conclusive evidence:

Publication by J. Cha, A. Niedzwiecki and M. Rath
American Journal of Cardiovascular Disease, vol.5, no.1

Conclusions:

- Depletion of dietary ascorbate (vit C) leads to Lp(a) accumulation in the vascular wall and parallels atherosclerotic lesion development.
- Dietary deficiency of ascorbate (vit C) increases serum levels of Lp(a).
- Vitamin C supplementation prevents atherosclerosis.
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Moving from the old to the new: Key modifications

1. Micronutrient deficiency

2. Endothelial dysfunction, decreased collagen production

3. Repair process: deposition of repair molecules in blood vessels – Lp(a)

4. Repair mechanism overshoots. Outcome = heart attack / stroke
1. The underlying cause of endothelial dysfunction and artery wall instability

1. Micronutrient deficiency

2. Endothelial dysfunction, decreased collagen production

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Moving from the old to the new: Key modifications
The origin of Cardiovascular Disease and the role of lipoproteins

Long term deficiency of micronutrients, in particular vitamin C, results in a structural weakness of the blood vessel wall & the development of cracks.

This deficiency is primarily manifested at those sites of our cardiovascular system that are exposed to the highest mechanical stress: the coronary arteries of the heart.
In summary:

Cardiovascular disease does **not** start with **elevated cholesterol** levels that allegedly damage the artery walls.

Atherosclerosis starts with vitamin deficiency causing **increased gaps** between endothelial cells and the **structural impairment** of the connective tissue in the artery walls.
New Understanding

Atherosclerosis – An overshooting repair process

Our body initiates a repair process by depositing repair molecules inside the blood vessel walls, including:

- fat carrying lipoprotein molecules
- carbohydrates (sugars)
- blood clotting (coagulation) factors
New Understanding

Atherosclerosis – An overshooting repair process

Conclusion:

Atherosclerosis is **not an arbitrary development** but the result of a biological regulatory process, which **protects** the walls against blood loss.

If this repair mechanism lasts for too long it overshoots, leading to the development of atherosclerotic plaques and clogging of the coronary arteries, which might result in a **heart attack**.
Moving from the old to the new: Key modifications

2. The role of Lp(a)

1. Micronutrient deficiency

2. Endothelial dysfunction, decreased collagen production

3. Repair process: deposition of repair molecules in blood vessels – Lp(a)

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Before we continue:

What are Lipoproteins?

Lipoproteins: Transport function

Molecules that transport lipids (cholesterol) through the body

Lipids (oil-soluble substances such as fat and cholesterol) do not travel through the body by themselves but are carried through the bloodstream in association with proteins as lipoproteins.
What are Lipoproteins?

The different Subtypes

They have different densities. The higher the ratio of fat-protein, the lower the density. In other words: more fat means lower density.
What are Lipoproteins?

The different Subtypes

Lipid Globule
- Cholesterol
- Triglycerides
- Others

Protein (Apolipoprotein B-100, Apo-B-100)

Lipo-Protein (Low Density Lipoprotein, LDL)

LDL – ‘Bad cholesterol’
What are Lipoproteins?

Lipoprotein(a) – the most dangerous of all

LDL + Apo (a) = Lp(a)
Lp(a) is a genetic variation of LDL (known as ‘bad cholesterol’)

Composed of

- A low-density lipoprotein (LDL) molecule
- An additional surface protein: apolipoprotein (a)

Apolipoproteins = protein molecules; help to stabilize the particle and serve to identify the specific lipoprotein. Allows tissues to recognize and interact with the particle.
What are Lipoproteins?

Lp(a) as a repair molecule

Key features of Lp(a):

1) Contains a very large biological adhesive tape – the apo(a) protein molecule.
   - One of the largest & stickiest molecules in nature
   - Structural homology to plasminogen, one of the most important molecules in the process of blood clot formation and dissolution.

2) Contains the LDL component: an essential substrate for the growth of new cells within the area of repair.
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Because of its unique structure, Lp(a) – as opposed to LDL – easily binds to:

1. **Endothelial cells** – which form the cellular barrier between the bloodstream and the artery wall.

2. **Connective tissue** components such as collagen and elastin, as well as blood-derived molecules, for instance fibrinogen/fibrin, that are deposited inside the artery walls.

New Understanding

Advantages of the unique structure of Lp(a)

Important for repairing an artery wall that has been weakened by dietary vitamin deficiency
New Understanding

Studies confirm association between Lp(a) & atherosclerosis

I. Lp(a) – not LDL – is the primary fat-transporting constituent of atheriosclerotic plaques.

II. Lp(a) is present in atherosclerotic lesions in amounts proportional to circulating plasma levels, but not in normal arterial walls.

III. Both low-density lipoprotein and lipoprotein(a) have an important role in the pathogenesis of atherosclerosis.
(Virchows Archiv of Pathological Anatomy and Histopathology, 1990 417(2):105-11)
New Understanding

Studies confirm association between Lp(a) & atherosclerosis

IV. Lp(a) is more strongly retained in the arterial wall than LDL.

V. Lp(a) promotes clot formation and prevents their dissolution as part of the atherosclerotic process.

VI. Lp(a) promotes the adhesion of monocytes to the endothelial surface and enhances their migration across the endothelial barrier – a function thus far attributed primarily to LDL.
I. Elevated lipoprotein(a) (Lp[a]) is a causal genetic risk factor for cardiovascular disease.  

II. Genetic variants associated with Lp(a) lipoprotein level and coronary disease.  

III. Under a wide range of circumstances, there are continuous, independent, and modest associations of Lp(a) concentration with risk of CVD and stroke.  
I. **Users of vitamin C supplements appear to be at lower risk for CVD.**  
Source: Vitamin C and risk of coronary heart disease in women.  

II. **In patients undergoing elective percutaneous coronary intervention, preprocedure intravenous treatment with vitamin C is associated with less myocardial injury.**  
Source: The effect of intravenous vitamin C infusion on periprocedural myocardial injury for patients undergoing elective percutaneous coronary intervention.  
New Understanding
Many studies confirm preventive role micronutrients

III. Combined treatment with vitamins C and E has beneficial effects on endothelium-dependent vasodilation and arterial stiffness in untreated, essential hypertensive patients.
Source: Supplementation with vitamins C and E improves arterial stiffness and endothelial function in essential hypertensive patients.

IV. The relation of the mortality ratio for all causes of death to increasing vitamin C intake is strongly inverse for males and weakly inverse for females.
Source: Vitamin C intake and mortality among a sample of the *Epidemiology* (1992).
Moving from the old to the new: Key modifications

Importance of Vitamin C

Health Benefits of Vitamins

Prevent

Micronutrient deficiency

Repair mechanism overshoots. Outcome = heart attack / stroke

Endothelial dysfunction, decreased collagen production

Repair process: deposition of repair molecules in blood vessels – Lp(a)
Vitamin C is essential for the production of **collagen** molecules, the stability structures in our blood vessels and the entire body.

**Animals**: produce high amounts of vitamin C and an optimum amount of collagen. → their artery walls are protected and stable.

**Humans**: have lost the ability to produce vitamin C and frequently get too few vitamins in their diet. As a consequence, impaired production of collagen leads to impaired stability of their artery walls.

New Understanding

**Vitamin C & stability of the artery walls**

*Vitamin C crystals under microscope*
Collagen
The substance that holds the entire body together

✓ A large fibrous protein, made up of three chains of amino acids, the majority of which are Lysine and Proline

✓ The main component of connective tissue
As such, collagens have an important role in
• Tissue architecture/integrity
• Tissue strength
There seems to exist an inverse relationship between the internal production of Lp(a) and vitamin C (ascorbate).

- **Animals**: produce high amounts of Vitamin C, but they don’t produce Lp(a)
- **Humans**: produce Lp(a), but don’t produce Vitamin C

During the evolution of man, Lp(a) surfaced as a life-saving repair molecule after our ancestors had lost the ability to synthesize vitamin C.
New Understanding
Vitamin Body Pool

Vitamin C Production in Liver

Humans
0

Body Pool of Vitamin C
Low

Animals
1–20 grams

Additional Nutritional Factors
- Cooking
- Processed Food
- Fruits
- Greens

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The origin of Cardiovascular Disease and the role of lipoproteins

New Understanding
Now, we can solve these medical puzzles

Medical Puzzles:
1. Why do atherosclerotic deposits develop primarily in the arteries of the heart – but rarely in other organs?
2. Why do these deposits develop in our arteries – but not in our veins?

Answers:
✓ The arteries of the heart – exposed to the high mechanical stress of a constant heart beat – have the highest demand for micronutrients.
✓ Here the deficiency of vitamin C and other nutrients are unmasked the earliest, causing weakening of the artery wall structure and starting a ‘repair’ process.
Most animals, with a few exceptions, produce vitamin C in their bodies. This assures optimum collagen production and strong, elastic arteries.

Humans cannot produce vitamin C and with an inadequate dietary intake the collagen production becomes compromised, leading to a loss of vascular wall integrity. This triggers biological ‘repair’ mechanisms, resulting in increased deposition of lipoproteins (Lp(a) and LDL) and atherosclerosis.
Now that we can correctly identify the underlying cause of heart disease, the road to its natural control is wide open.