Deep Health® Overview

Know your Health

Introduction

We all want better health and lower healthcare costs.

A look inside an accessible new technology that measures health and motivates individuals to become healthier.

Chronic Disease: A Very Costly Epidemic

Ch. 1
Chronic Disease: A Very Costly Epidemic

Despite rapid technological advances in medicine and health information systems, most people are not getting healthier. The USA spends more on medical care than the next 10 top spending countries combined, yet we have the world's highest incidence of chronic disease. According to a National Center for Health Statistics survey, about half of Americans are on at least one prescription drug, including 85% of senior citizens.

Nearly three-quarters of US adults are either overweight or obese, and half have other chronic health conditions. Many of these conditions are directly caused by poor diet and lifestyle habits. They've become so common they are considered normal. Sadly, there is very little actual "healthcare" focused on improving health and preventing diseases. There's mostly an expensive struggle to manage pre-existing chronic illnesses: the US spent an astronomical $3.28 trillion on "sick-care" in 2016 alone.

The rising financial costs and human suffering are not sustainable. We must act now to help people take ownership of their health, avoid chronic use of prescription drugs, and save themselves from costly 'slow-motion suicide' via deadly but preventable chronic diseases. We desperately need a smarter approach to maintaining our health.

Individual Health vs Population Health

Ch. 2 Chronic Disease: A Very Costly Epidemic

It is natural for businesses and governments to demand that healthcare behave like other industries– where the rules of business and economics of efficiency & scale apply.

The driving factor for healthcare systems design is to improve quality and efficiency. The goal of efficiency is set by thinking in terms of population health. Population health management uses big data analytics to define patient cohorts, classifying members by their event risk, and finally delivering individual care. By design, it requires aggregation of individuals into representative groups and treating them as cohorts.

This logic seems reasonable, but there are significant downsides. The American Cancer Society recommends that women over 45 years of age get annual mammogram exams. They do not recommend it for women under 45, primarily to save cost for insurance companies. This decision was made on a population basis but makes no sense for individuals. Adult women, at high risk, should get mammograms starting at age 25. Women over 55, who are low risk, who have undergone regular mammograms don't need to get one every year.

If you aren't feeling well, the doctor normally orders lab tests. If these test results are "normal," i.e., the numbers are "in range," the doctor assumes that everything is fine. Even if you feel that something is still not right, the system isn't set up to probe any
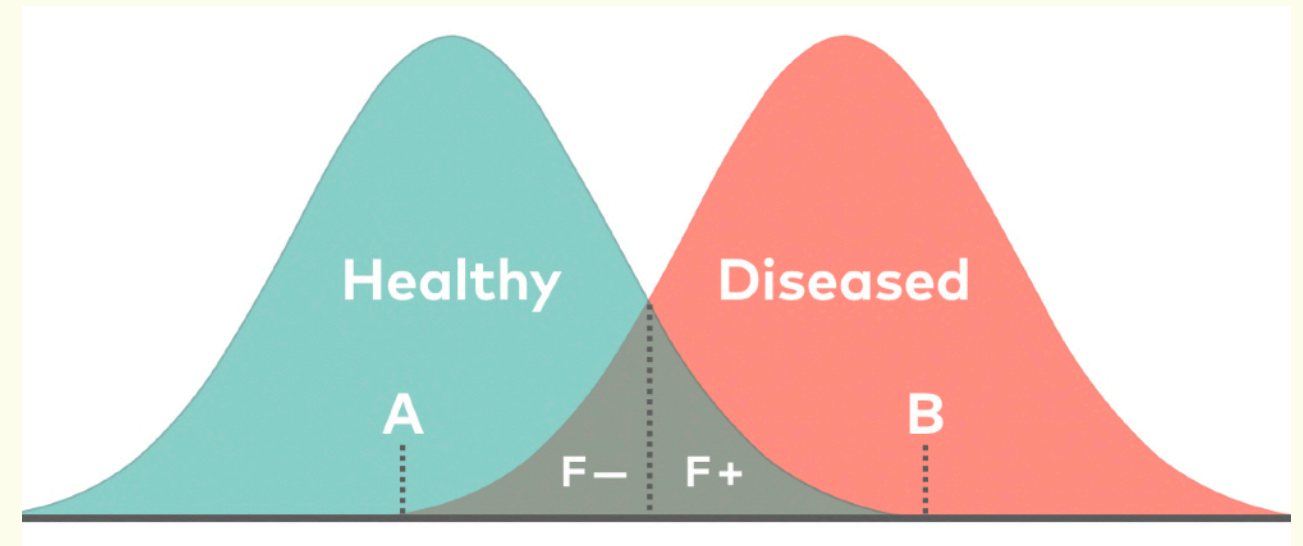
The healthcare system views us as a population in binary terms as "diseased, or "healthy".

shaped "normal" range is based on a data sample of relatively few people. Oftentimes the so-called "normal ranges" are skewed and don't truly reflect a truly "healthy range."

Just because something is common, it doesn't make it normal. Most people in the USA are overweight. A reference range of Americans' weight is not going to represent healthy body compositions, it will skew overweight. Chronic health problems are ubiquitous today but we should not normalize them. The current system is not designed to care for individuals with unique physiologies. It can be confusing and even dangerous for them to rely heavily on diagnostic lab work.

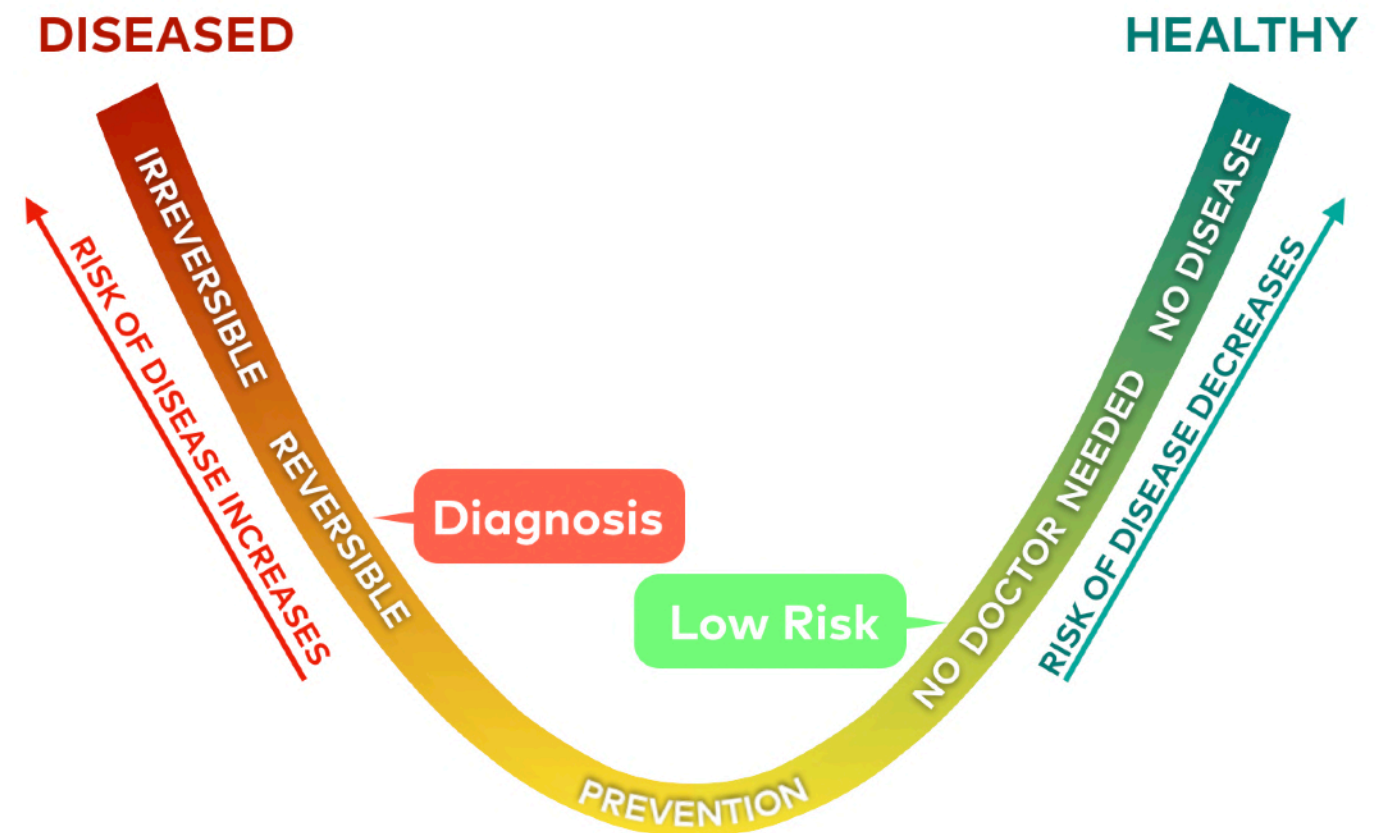# Why Measurement is Crucial for Good Health

Ch. 3 Measure Health

Towards the end of our lives we wish for better health, not more money. Health is our most important asset and that is reflected in our enormous spending on healthcare. Today, 86% of worldwide premature deaths are due to chronic diseases. The irony about chronic disease is that it slowly develops, on average for 7 to 10 years, years before it is diagnosed. We should look at the slow progression of chronic disease as a window of opportunity, a grace period during which we can do things differently, improve our lifestyle and reclaim our health.

At Deep Health®, we've figured out how to get significant, non-invasive, biometric health information with minimal effort and discomfort. We analyze and compare an individual's data in many ways. Some data is compared to an optimal point for the individual. Other data gives us a measure of variables that can be continuously improved. Each bit of data has a weighted contribution to an overall "health score." We call this the Deep Health® Index. It gives us an accurate, current measure of how healthy we are.

The simple act of measuring our health and getting a numerical health score (0 to 120) serves as a powerful motivator for improving it.
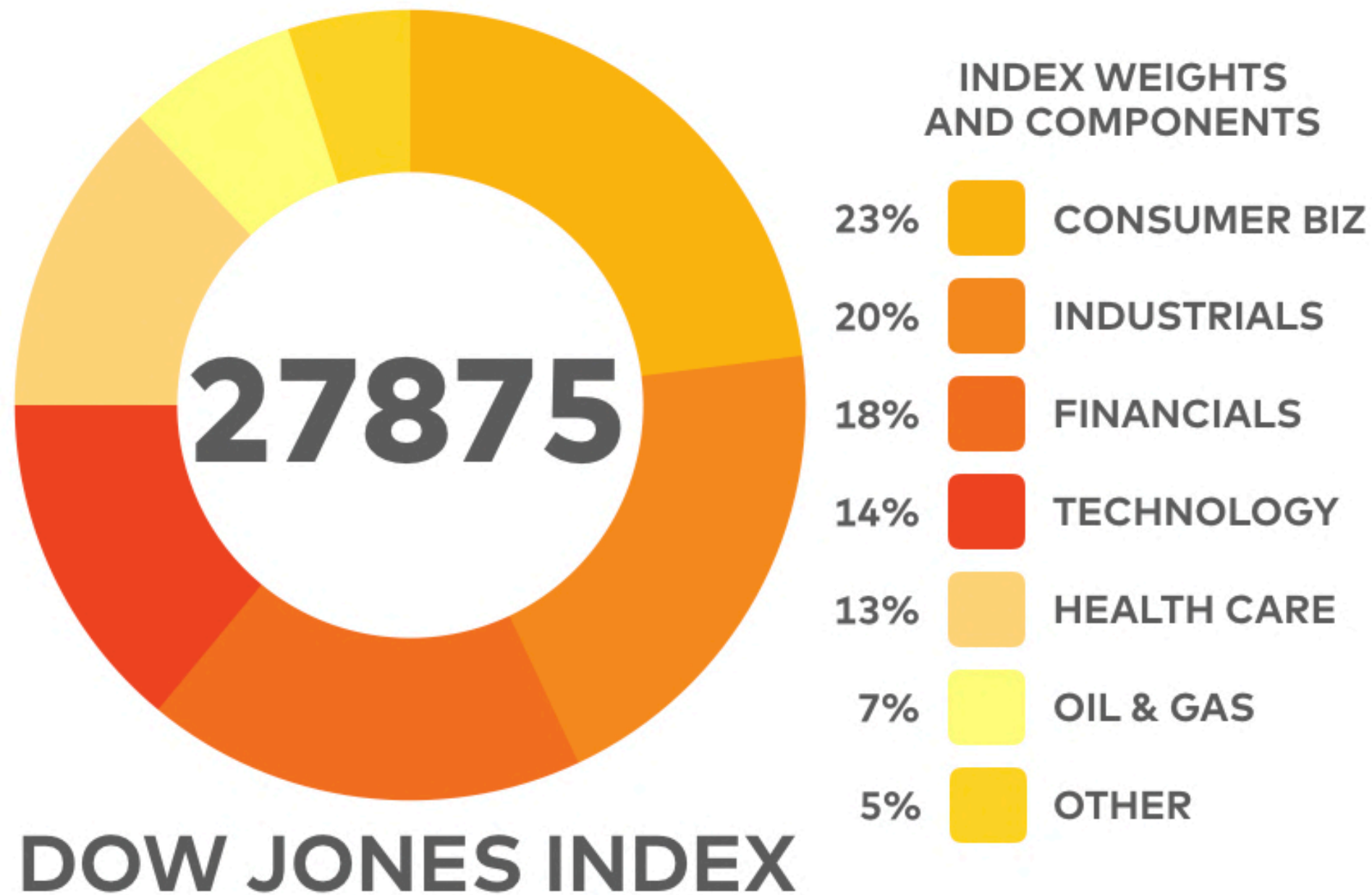
DISEASED

HEALTHY

IRREVERSIBLE

REVERSIBLE

RISK OF DISEASE INCREASES

NO DISEASE

RISK OF DISEASE DECREASES

NO DOCTOR NEEDED

Diagnosis

Low Risk

PREVENTION

WELLNESS RISK SPECTRUM

Care costs escalate exponentially while moving along the continuum after chronic disease diagnosis.

"Measure, understand and improve your health from the comfort of home."

How the "Deep Health®" Index works

27875

DOW JONES INDEX

INDEX WEIGHTS AND COMPONENTS

- 23% CONSUMER BIZ
- 20% INDUSTRIALS
- 18% FINANCIALS
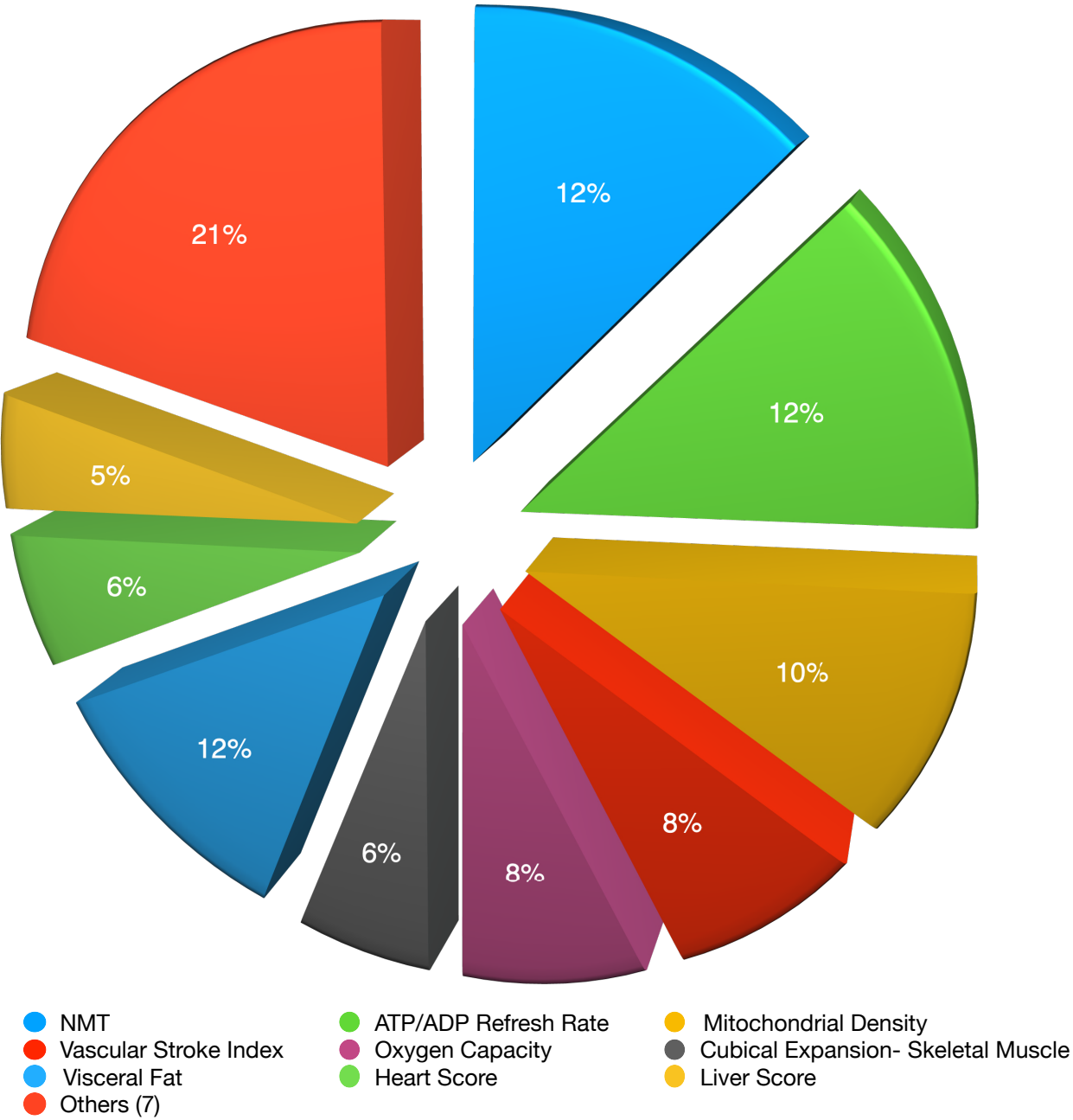- 14% TECHNOLOGY
- 13% HEALTH CARE
- 7% OIL & GAS
- 5% OTHER

Ch. 4 The 'Deep Health® Index'

What exactly does it mean to be in good health? Over the last 30 years, Dr. Bomi Joseph and Dr. Avi Cohen have combined their experience as scientists and physicians to design new health metrics. They mapped out the structure of the human body in detail and examined the link between health issues and measurable signals that can indicate them. The result is the patent-pending Deep Health® Index, which places individuals in a risk continuum on the "diseased vs. healthy" scale.
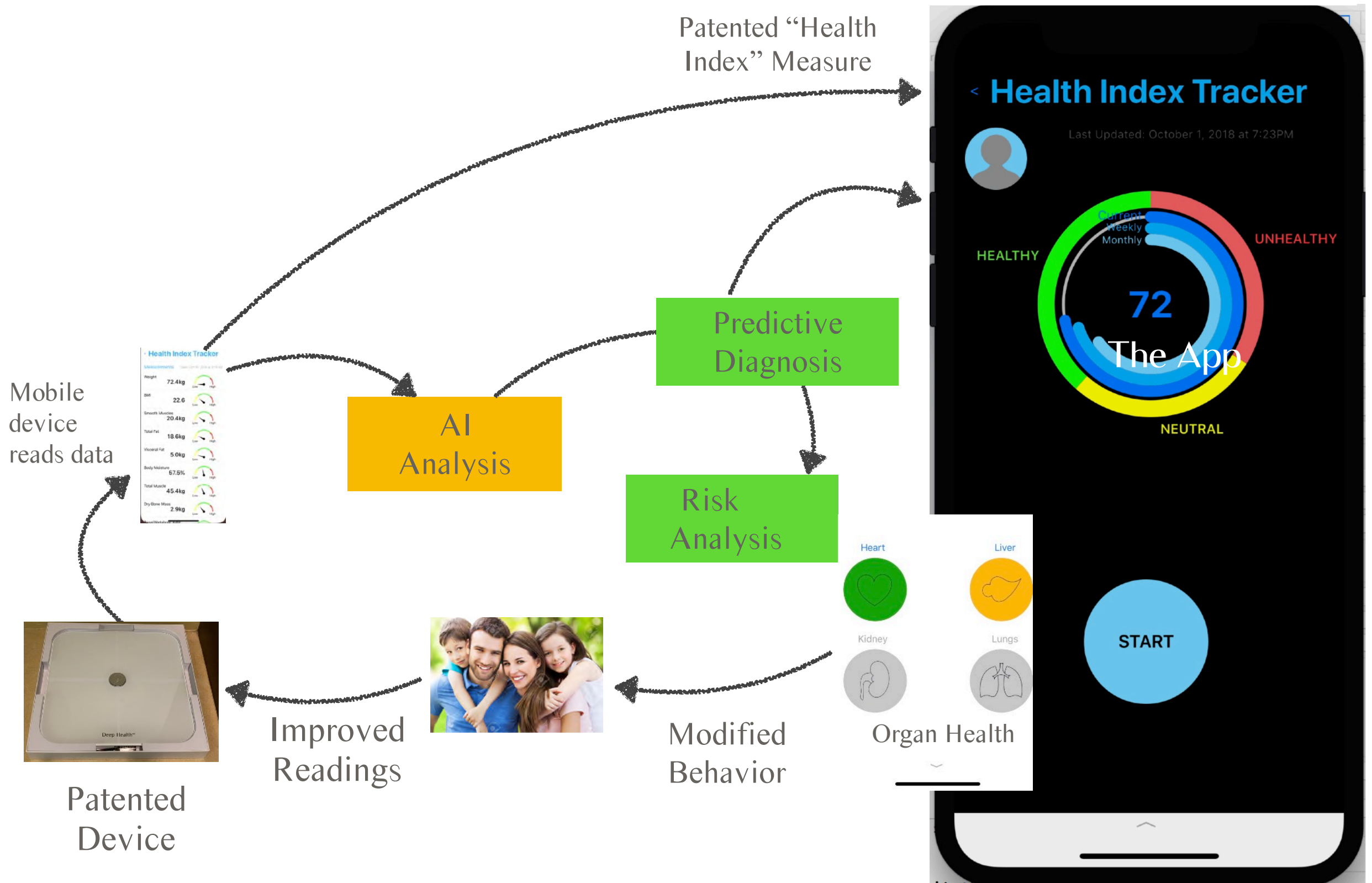
To understand the Deep Health® Index, consider a market index like the Dow Jones Industrial Average ("Dow"). It is the weighted index of the 30 largest companies trading on the New York Stock Exchange and the NASDAQ. The Dow is a robust indicator of financial market health that is closely watched by everyone making investment decisions.

Similarly, the Deep Health® Index represents the most significant weighted composite portfolio of key metrics that impact human health. The individual weight of these metrics was calibrated and cross-validated using longitudinal data from 58,000 people – some who were studied over 34 years. Some of the key metrics that contribute to the Deep Health® Index include: blood flow rate, oxygen utilization, coefficient of expansion & contraction of tissues, ratios of smooth/skeletal/cardiac/neuromuscular tissue, ratios of essential cellular lipids vs. environment (subcutaneous) fats vs. degenerative (visceral) fats, etc.

Like a visual debugger that allows a programmer to clean up his code, the Deep Health® Index is a visual tool that enables us to "debug" and manage our health. People usually overestimate their Deep Health® Index score. Regardless of what we measure, the Deep Health® Device gives a detailed breakdown of various tissue components: muscle, fat, neuromuscular tissue (tendons & ligaments) and bone mass. It helps us understand the all the elements that adds up to the total health score.

Pie chart: 21%, 12%, 12%, 10%, 8%, 8%, 6%, 6%, 5%, 12%

Legend:
- NMT
- Vascular Stroke Index
- Visceral Fat
- Others (7)
- ATP/ADP Refresh Rate
- Oxygen Capacity
- Heart Score
- Mitochondrial Density
- Cubical Expansion- Skeletal Muscle
- Liver Score

Components of the Deep Health® Index

Patented "Health Index" Measure

Health Index Tracker

Mobile device reads data

Predictive Diagnosis

AI Analysis

Risk Analysis

Patented Device

Improved Readings

Modified Behavior

Organ Health

The App

Ch. 5 Components

Oxygen is essential for life and is used in every function– from tissue growth to the synthesis of food to energy. The amount and rate of oxygen flowing to cells, tissues and organs is dependent on the quality of our respiratory and vascular systems. Higher flow of oxygen invariably means more oxygen to tissues, which in turn indicates that our tissues are in better health. So measuring the variables related to the transport of oxygen, replenishment of our tissues, and removal of waste matter make up one set of components of the Deep Health® Index. Measuring the composition of the various muscle fractions and the composition of the various fat fractions make up another set of components in the Index. Of these, neuromuscular tissue (NMT) is weighted the highest towards indicating good health and visceral fat is weighted the most heavily towards poor health.

What Exactly Do We Measure?

We started in 1984 by manually measuring elite athletes at The Ohio State University. Over the next two years, we developed the first six components of the Deep Health® Index. To automate, speed the process and increase accuracy, we instrumented a histology device with embedded sensors to measure:

| Measurements |
| --- |
| Temperature |
| Pressure |
| Acoustic Waveforms |
| Ultrasonic Waveforms |
| Multivariate Bioelectrical Signals |
| Amperometric Signals |
| Cardiac Sino Atrial Node Signals |

We use multiple signal generators to stimulate the sensors and take the corresponding measurements. The Deep Health® Device was purpose-designed in collaboration with the Department of Mechanical and Aerospace Engineering at The Ohio State University. The early version was bulky because it used early generation analog and electromechanical sensors. Starting in 1991, the clunky original generators and sensors were transformed into sleek, mixed-signal ASICs (application specific integrated circuits) by Integrated Device Technologies. This enabled the first digital, embedded systems-based devices that could be used to measure high volumes of people.

Our patented array of sensors can provide an accurate measure of physiological elementals like: fluid flow, mass transfer, heat transfer, colloidal flow, tissue flux. This allows us to measure static tissue composition and the composition of tissue as blood flows through it.

Components of Deep Health System

The Deep Health® Device uses this data to calculate standard measures such as:

1. Health Score

2. Weight

3. Body fat analysis and composition

4. Body mass index (BMI)

5. Dynamic body water composition

6. Dynamic tissue expansion and contraction

7. Basal metabolic rate (BMR)

8. Muscle mass and composition

9. Heart rate

10. Heart density and health

11. Stroke volume (of blood pumped with each heartbeat)

12. Liver mass and composition

13. Liver health

14. Etc.
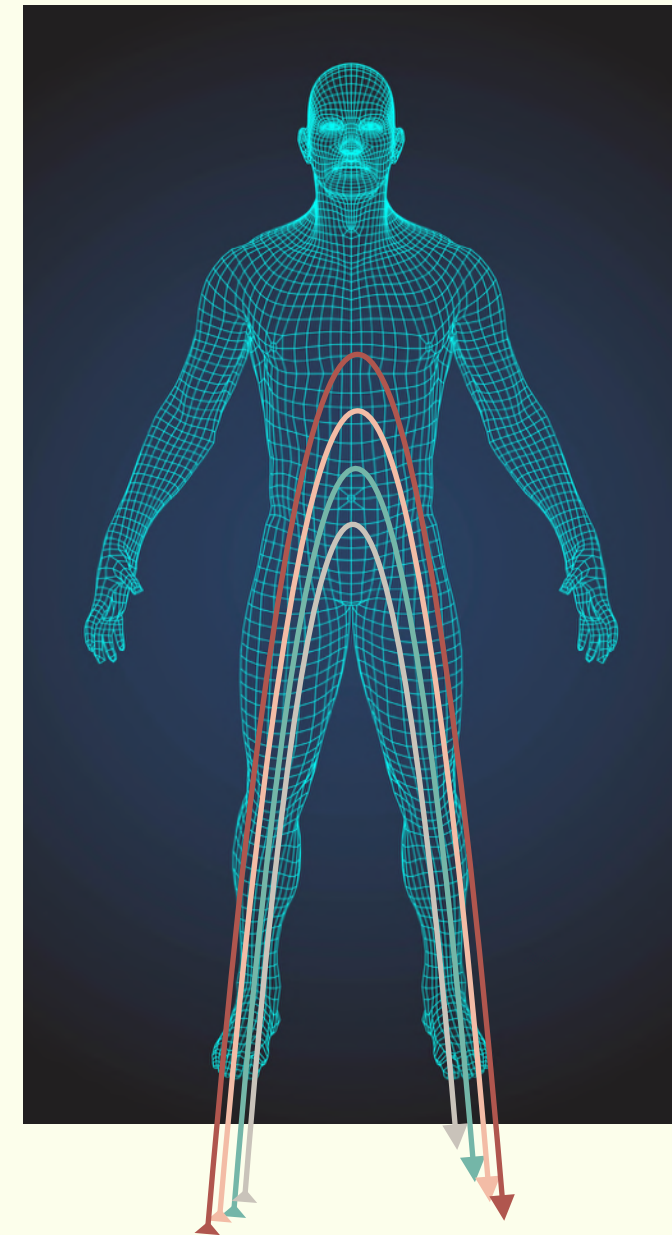
Its array of deep histological data is unique. For example, the Deep Health® Device measures total intercellular and extracellular water. It not only measures body water, it measures how much of it is within the cells (not flowing) versus how much of it is outside the tissue and flowing through our vascular system. This dynamic view of body water is a far more useful tool than just a static body water measure.

Measuring Tissue Oxygen & Cellular Energy Production

We calculate tissue oxygen levels by measuring the sino-atrial (SAT) signal and the responsiveness of blood flow through it. We not only measure oxygen diffusion rates but also amino acid oxidase, cholesterol oxidase, galactose oxidase, urate oxidase and alcohol oxidase levels. The volumetric changes in various tissues are used to compute the coefficients of expansion and coefficient of contraction of multiple muscles and organs. This enables us to detect the qualitative and quantitative changes in these tissues and organs as blood flows through it.

The ATP-to-ADP refresh rates are the most accurate measure of metabolic activity within a human body. The estimated mitochondrial density is calculated based on measuring changes in the cardiac, skeletal, NMT, and smooth muscles. These complex computations require a deep understanding of steady and unsteady state transfers of heat, mass, momentum, and fluids. It also requires understanding and accurate computational models of colloidal chemistry, viscous elasticity of vascular tissue, and electrophysiology. By analyzing first-order data, second-order changes, and the third-order analytics, we are able to compute the Deep Health® Index and can accurately place an individual on the "Wellness – Disease Risk" spectrum.

How The Deep Health® Device Measures

When a person steps on the Deep Health® Device it measures *weight*, but the four independent pressure sensors also measures the *tilt*, *balance* and *stability* of the individual.

The *SAT signal*, the *heart rhythm*, and the *left ventricle signals* are all measured along with the *heart rate* to give us a clear indication of heart health and vascular flow. Deep tissue ultrasonics senses the volume changes in tissue due to blood flow. The heavy pressure applied by standing on the device, and the flattening of the skin, allows it to capture blood pressure waveforms even in deep arteries and veins. Ultrasound elastography capture tissue images in real time.

Electrical signals are sent to perform *raw electromyography (EMG)* on neuromuscular tissue (NMT) concentrated in the ankles and the bottoms of the feet. The strength of the NMT and the person's balance and stability are significantly related.

The ratios of *smooth muscle, skeletal muscle, cardiac muscle* and *neuromuscular tissue* are calculated. The ratios of *essential cellular lipids, environmental fats (subcutaneous)* and *degenerative fat (visceral)* are also determined. These measure the inner condition of a human body with unprecedented resolution.

Powered by AI Machine Learning
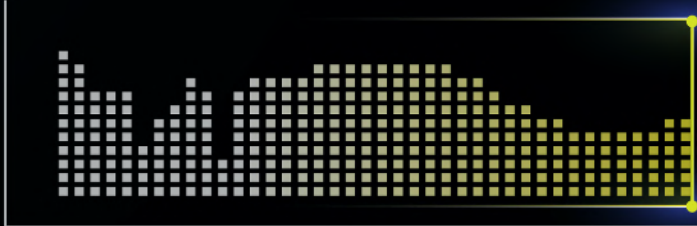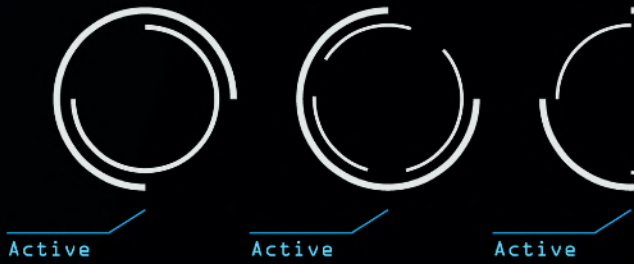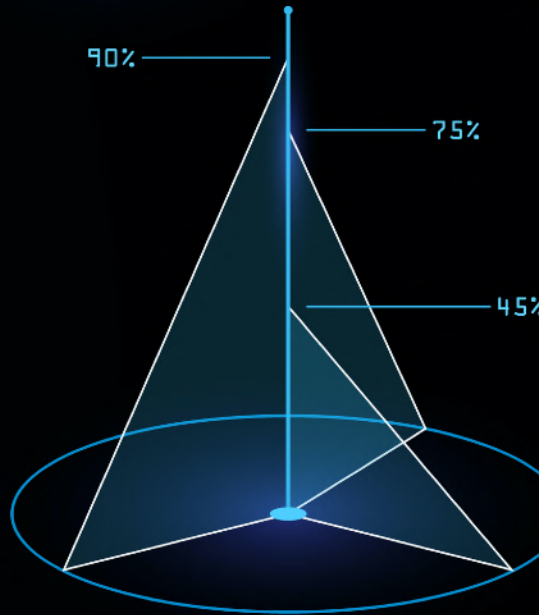
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AI and Machine Learning

The Deep Health® Device guides both patients and practitioners to make better health decisions. It uses advances in signal processing, knowledge of coupling measures, and artificial intelligence machine learning (AI-ML). The longitudinal data from an individual is broken down to identify patterns and biomarkers, which are then analyzed.

Using a pattern detection algorithm called unsupervised learning, the Deep Health® Device identifies physiological themes that frequently occur in an individual. It also compares an individual's measurements to the general population data. This is very useful in the diagnosis and treatment of chronic diseases. Our AI-ML engine can accurately predict what will happen over time to individual's condition. This enables us to make risk assessments with significantly higher confidence.

Smart Alerts to Home Users & Healthcare Providers

Deep Health's AI-ML engine can also proactively intervene and provide invaluable triage services. When the device measures a cautionary negative "event" or notices a degenerative health decline, it can notify the user on his or her smartphone. On the backend, it can discreetly alert the physician or healthcare provider with more sensitive
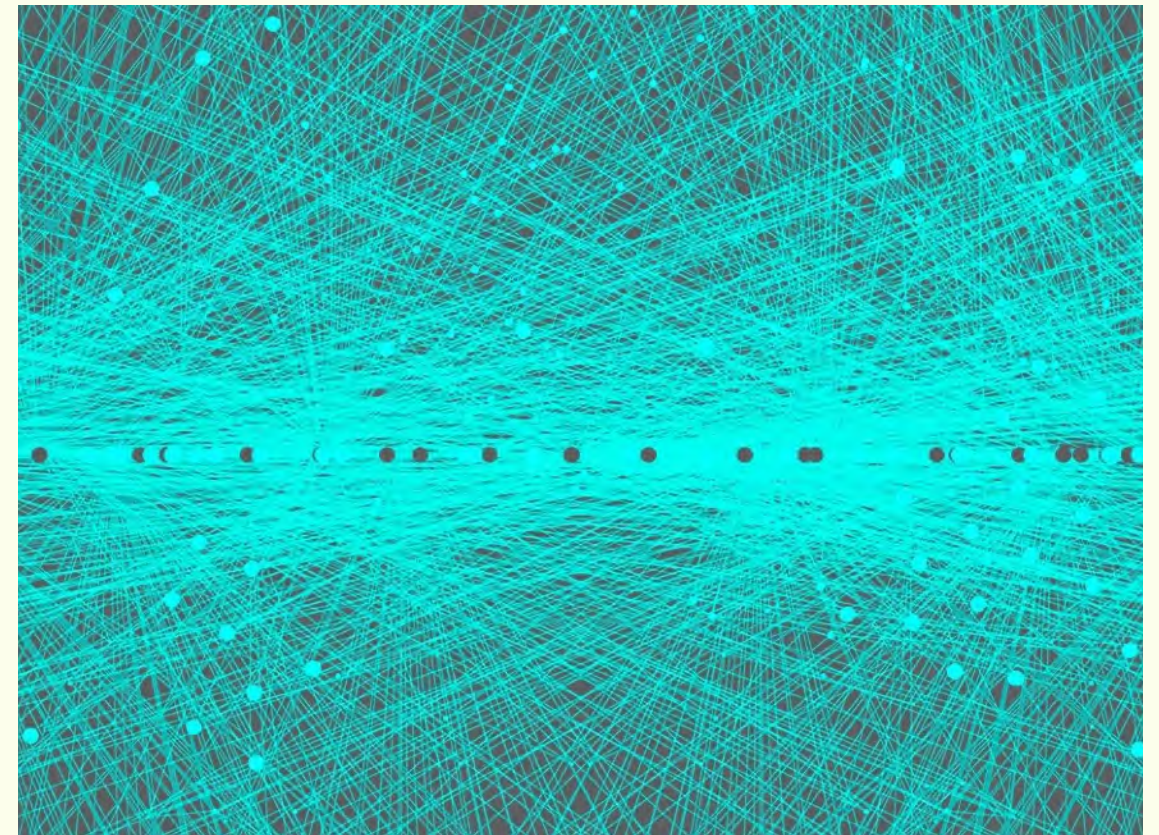
diagnostic data. This helps providers focus on the crucial issues, saving valuable time and resources .

Our Mission: Peak Health

Peak Health

Our mission at Deep Health® is to give individuals control over their own health destiny, while giving physicians and providers detailed insights to help improve care. Our goal is to prevent the 'silent epidemic' of widespread, chronic degenerative diseases. We want to improve healthcare by preventing people from ever having to visit a hospital.

Our bodies all have unique attributes. Improving our health requires data at a personal level and there is no substitute for personalized recommendations. The Deep Health® Index is a unique measure of our own health and wellness. It enables us to manage and improve our health. Deep Health® continually measures the negative consequences of our bad habits. It provides unprecedented feedback and a powerful incentive to break free from them.

When we get our first Deep Health® Index score, most people instinctively want to improve it. Improving our diet and lifestyle habits reduces common medical conditions such as high blood pressure, diabetes, high cholesterol, obesity, etc. It increases cardiac, vascular and musculoskeletal tissue health. As learn about your Deep Health® scores and build a more personal relationship with your activities, you will automatically self correct. You'll find yourself spending more time on activities that improve your score and less time on activities that decrease it.

In prehistoric times, life can be depicted as "A" in the above figure. It was full of danger and chances were that it was going to be cut short abruptly by disease or an attack.
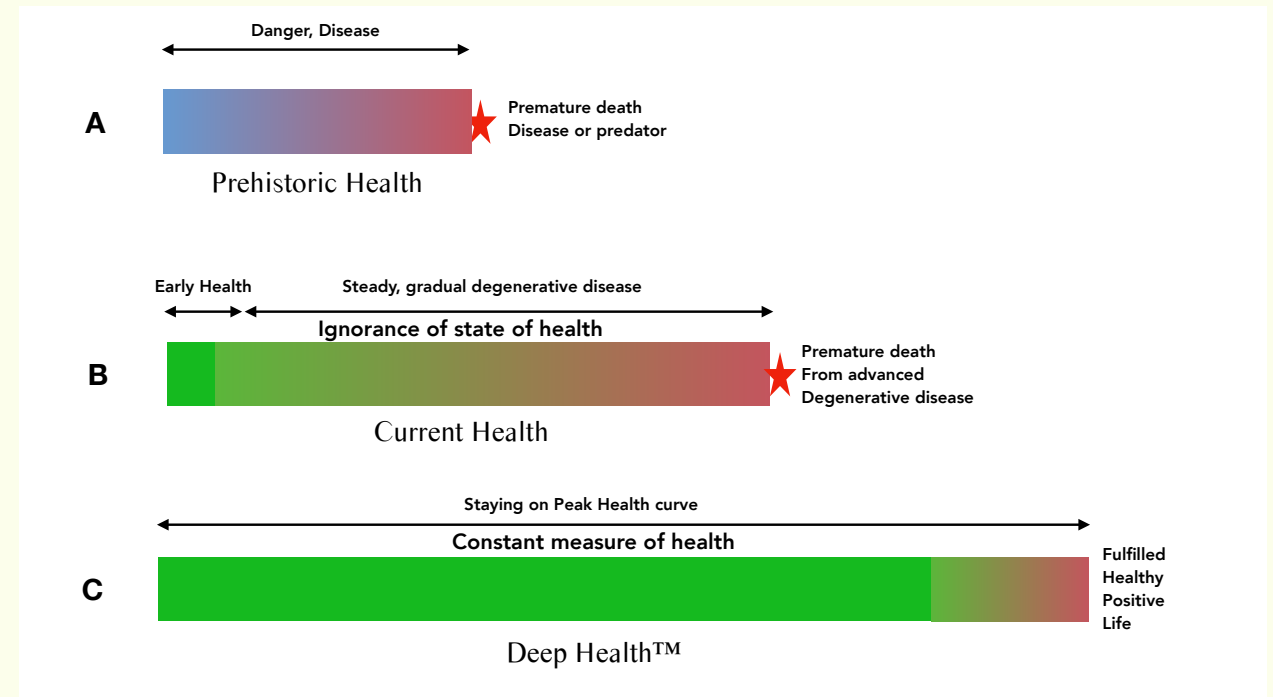
The modern lifestyle is depicted as "B" in the above figure. After the teenage years, chances are very high that health is steadily eroded by degenerative disease, and there is an 86% chance of premature death because of it today.

Deep Health® enables a person to live the life depicted by "C" in the above figure. With Deep Health®, a person can have constant feedback on his health score. He can eat, drink, move and do various activities and get quick feedback of how they affect his health. This cycle of measuring, forecasting, guidance, action and feedback enables a user to move towards and stay in their ideal, healthy state.

Ignorance is deadly.

Forewarned is forearmed.

Measure your health!