The Personalized Medicine Revolution

*Diagnosing and Treating Disease Are About to Change Forever*

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Why Do We Need Personalized Medicine?

- Many drugs don’t work for or harm the patients they are prescribed for due to a “one size fits all” approach.
- Need to determine who will benefit and who will not, avoid “trial and error” therapy.
- Currently disease is often detected too late, leads to high costs and poor outcomes.
- Need to detect and treat signs of disease before it becomes a problem, not after becoming ill.
Current Medicine: “One Size Fits All” Healthcare

The problem is, we are all very different!
How Are We Different From Each Other?

1) Different genetic makeup
   - Up to three million differences in genetic makeup between you and anybody else (sex, ethnicity, physical appearance etc)

2) Different clinical background
   - Different ages, disease history, drug prescriptions

3) Different environmental factors
   - Different bacteria living in and on our bodies
   - Differences in lifestyle, nutrition, exercise, pollution, climate
Personalized Medicine: A Revolution In Medical Practice Enabled By Technology

Present Practice
- Physiological Diagnosis
- Late Diagnosis
- One Size Fits All Therapy
- Poorly Informed
- Preventive Medicine
- Ineffective/Harmful Therapy
- Patient Lacks Knowledge And Power

Personalized Medicine
- Molecular Diagnosis
- Early Diagnosis
- Individualized Therapy
- Preventive Care Based on Molecular Data
- Patient Specific, Effective Treatment
- Patient Empowerment

TECHNOLOGY
Forces Driving Personalized Medicine

1) Rapid technological change (inexpensive molecular level analyses, information technology)
2) Patient safety (adverse drug reactions)
3) Drug efficacy (50% of drugs don’t work for individuals)
4) Consumer demand (individualized, effective, non-toxic treatment)
5) Preventive medicine (need individualized, definitive data)

A tsunami of change is about to hit the medical system
Technological Change: Costs of Personalized Molecular Measurements are Decreasing Dramatically

The cost of genome sequencing has decreased by nearly a million-fold since 2000
Patient Safety: Adverse Drug Reactions Are the Fourth Leading Cause of Death in North America

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Number of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart disease</td>
<td>743,460</td>
</tr>
<tr>
<td>Cancer</td>
<td>529,904</td>
</tr>
<tr>
<td>Stroke</td>
<td>150,108</td>
</tr>
<tr>
<td>Adverse drug reactions</td>
<td>106,000 (range 76,000-137,000)</td>
</tr>
<tr>
<td>Pulmonary disease</td>
<td>101,077</td>
</tr>
<tr>
<td>Accidents</td>
<td>90,523</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>75,523</td>
</tr>
<tr>
<td>Diabetes</td>
<td>53,894</td>
</tr>
</tbody>
</table>

90% of adverse drug reactions are not reported
ADR Example: Doxorubicin-Induced Heart Toxicity

- Anticancer drug doxorubicin (used for 70% of childhood cancers, breast cancer patients, 1M patients/yr)
- 10-30% of patients suffer heart failure; increased severity in children
- May cause death, require heart transplant or reduced heart function that lasts a lifetime
- Some people are much more susceptible than others due to their genetic makeup
12 year-old boy presents with pain in abdomen
- Diagnosed with lymphoma
- Undergoes chemotherapy
- After second round of chemotherapy becomes breathless after walking a few steps
- Diagnosed with heart failure
- Requires heart transplant
Drug Efficacy: Less Than 50% of Drugs Work on the Patient They are Prescribed For

<table>
<thead>
<tr>
<th>Drug</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-Depressants</td>
<td>62 %</td>
</tr>
<tr>
<td>Asthma</td>
<td>60 %</td>
</tr>
<tr>
<td>Diabetes</td>
<td>57 %</td>
</tr>
<tr>
<td>Arthritis</td>
<td>50 %</td>
</tr>
<tr>
<td>Alzheimer</td>
<td>30 %</td>
</tr>
<tr>
<td>Cancer</td>
<td>25 %</td>
</tr>
</tbody>
</table>

Drug does not work
How Can Personalized Medicine Help Prevent Adverse Drug Reactions and Ensure Efficacy?

Need to use molecular profiles to “stratify” patients so they receive the most appropriate therapy.
Example: Genetic Tests To Guide Drug Prescription For Cancer Treatment

Problem:

- 75% of cancer drugs do not work on the person they are given to
- All cancer drugs can be very toxic

Solution:

- Sequence the cancer genome to determine cancer-causing mutations
- Treat cancer with drugs that target the mutations
- Sequence the normal genome to determine potential for adverse drug reactions
Personalized Medicine: Genetic Tests To Guide Drug Prescription For Cancer Treatment

Same diagnosis

Test to see which drugs will be safe and effective

Match therapy to the patient

Molecular Profiling

Prognostic Markers
Personalized Medicine Can Revolutionize Cancer Treatment

- Trish Keating: diagnosed with colon cancer 6 years ago
- Multiple rounds of chemotherapy, relapsed each time
- Stage 4 cancer-disseminated throughout her body
- Cancer genome sequenced, cancer cells relied on a gene that could be inhibited by a blood pressure drug
- Six weeks after treatment cancer disappeared, still in remission 1 yr later
What About Drugs For Other Diseases?

The more drugs you take the greater the chance of an adverse drug reaction
We Take a Lot of Drugs

20% of people over 65 take 10 or more drugs every day
Personalized Medicine: Genetic Tests For Drug Prescription

Problem:

- Over 100,000 deaths per year are due to adverse reactions to prescription drugs

Solution:

- For ~200 common drugs there is genetic guidance on the package insert
- Not used currently because the doctor does not know the genetic profiles of his patients
- Can use a simple genetic test to guide drug prescription
A Drug Package Insert Containing Genetic Guidance for a Gout Medication
Personalized Medicine: Genetic Tests To Avoid Adverse Reactions to Prescription Drugs

GenXys Healthcare Systems

- Genetic test (in EMR)
- Physician diagnosis
- Computer algorithm

- Personalized prescription

Fewer adverse drug reactions, More efficient healthcare
We Can Measure Much More About You Than Your Genetics

You: Your genes code for proteins which produce metabolites

Your environment: Your microbiome produces proteins that produce metabolites

Genomics  Proteomics  Metabolomics  Microbiomics

The “Omics”
Your Blood Contains Many Proteins and Metabolites That Can Be Used to Detect and Diagnose Disease

Each organ secretes proteins and metabolites into the blood that can be diagnostic for the health of that organ:

- Early detection of disease
- Monitor disease progression
- Monitor effects of therapy
- Detect re-occurrence of disease

We can now detect hundreds of proteins and metabolites in your blood simultaneously to diagnose disease anywhere in your body.
Your Microbiome: Bacteria Living In and On Your Body Can Also Influence Your Health

You contain 10 times as many bacterial cells as human cells; your “microbiome”. The wrong microbiome can contribute to:

- Inflammatory bowel disease
- Diabetes
- Rheumatoid arthritis
- Muscular dystrophy
- Multiple sclerosis
- Obesity
- Autism (?)

We can measure a thousand or more bacteria in your gut (fecal sample) to characterize your microbiome.
The Future of Medicine: “Omic” Profiling To Enable Personalized Medicine

Molecular data-clouds for each individual

- Early detection of disease
- Disease stratification
- Better matching of treatment to disease
- Identification of new biomarkers/targets associated with disease
- Effective preventive medicine

Well people, disease cohorts
We Started A Company To Do Molecular Profiling: The Molecular You Corporation

“Molecular You” Omic Profiling
# How Many Molecules and Bacteria Can We Measure?

<table>
<thead>
<tr>
<th>Genetic Profile</th>
<th>Protein Profile</th>
<th>Microbial Profile</th>
<th>Metabolite Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of genome</td>
<td>Analysis of</td>
<td>Analysis of</td>
<td>Analysis of small molecules in</td>
</tr>
<tr>
<td>sequence:</td>
<td>proteins in the</td>
<td>bacteria in gut:</td>
<td>urine and blood:</td>
</tr>
<tr>
<td>Whole exome</td>
<td>blood:</td>
<td>~1,000</td>
<td>~300 metabolites</td>
</tr>
<tr>
<td>ONCE</td>
<td>240 proteins</td>
<td>bacteria</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

This is just the start!
The Molecular You Process

Doctor → Patient

Samples

Comparative analysis

Individual “multi-Omic” data cloud

Report
Your Data Cloud is Compared to a Curated Reference Database

World’s clinical information: Omic biomarkers associated with more than 300 diseases (1-12 studies per disease)

“Big data” storage and analytics

Disease-associated outliers
The Molecular You Analysis Provides Diagnostics/Risks for >300 Diseases

- Heart disease
- Diabetes
- Hypertension
- Stroke
- Breast cancer
- Prostate cancer
- Colon cancer
- Lung cancer
- IBD
- Pancreatic cancer

- Dementia
- Depression
- Autism
- Osteoporosis
- Arthritis
- Kidney disease
- Pneumonia
- COPD
- Multiple myeloma
- Leukemia
- etc
The Molecular You Analysis Provides Diagnostics/Risks for >300 Diseases

Disease score: number of molecular measures outside normal range that correlate with a particular disease

<table>
<thead>
<tr>
<th>NAME</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>17.5</td>
</tr>
<tr>
<td>Obesity</td>
<td>8</td>
</tr>
<tr>
<td>Insulin resistance</td>
<td>7</td>
</tr>
<tr>
<td>Metabolic syndrome</td>
<td>4.5</td>
</tr>
</tbody>
</table>
The Molecular You Analysis Provides Diagnostics/Risks for >300 Diseases

Can examine your data to see what the molecular measures are and what they should be

<table>
<thead>
<tr>
<th>MEASURE NAME</th>
<th>CURRENT VALUE</th>
<th>VALUE WITHIN RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha-2-HS-glycoprotein</td>
<td>1032.84 µg/mL</td>
<td>400-850</td>
</tr>
<tr>
<td>Apolipoprotein C-II</td>
<td>95.6 µg/mL</td>
<td>5-69</td>
</tr>
<tr>
<td>Apolipoprotein C-III</td>
<td>529.9 µg/mL</td>
<td>30-230</td>
</tr>
<tr>
<td>Fibronectin</td>
<td>464.4 µg/mL</td>
<td>250-450</td>
</tr>
</tbody>
</table>
Dashboard for your health

- Level 1: Overview
  - a top line summary of your health
- Level 2: Disease risk report (>300 diseases)
- Level 3: Organ/system health summary
  - Brain, GI tract, heart, immune system, joint/muscle, kidney, liver, etc
- Level 4: Details of organ/system health
  - Scientific literature
Welcome Back to your Dashboard

OVERVIEW

We’re pleased to present your “Molecular You” profile. We measured a total of 379 metabolites (body chemicals), of which 87 were outside of the usual normal ranges - but, as your doctor can help explain, it’s important to note that not all of these are worrisome. In fact, your profile shows no obvious disease, and very low risks for diabetes and cardiovascular disease.

Your profile does suggest some mild vitamin B vitamin deficiencies and a possible moderate risk for depression, which you may wish to discuss with your doctor.

Please see the sections below for further details.
No overt disease detected!
Brain health is on the low side.
Both carnosine and serotonin levels are low.
### Nutritional Health

<table>
<thead>
<tr>
<th>NAME</th>
<th>VALUE</th>
<th>NORMAL RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B1</td>
<td>0.035</td>
<td>0.04 - 0.12</td>
</tr>
<tr>
<td>Vitamin B3-amide</td>
<td>0.2</td>
<td>0.4 - 0.5</td>
</tr>
</tbody>
</table>

**Vitamin B1 and B3 levels are low**

Low vitamin B1 levels can be associated with regular alcohol consumption, Crohn's disease, trouble digesting carbohydrates, anorexia, kidney dialysis, increased risk of cataracts, &/or depression, but borderline low vitamin B1 levels aren't generally worrisome and can usually be remedied by good diet &/or a daily multivitamin pill. If your levels go lower, you may want to discuss with your doctor.

Low vitamin B3 levels can result from regular alcohol consumption, prolonged treatment with the TB drug isoniazid, or disorders of the digestive system, but can usually be corrected by good diet &/or a daily multivitamin pill. If your levels remain low, you may want to discuss with your doctor.
The MYCO Health Action Plan

- Heart Health
- GI Health
- Vascular Health

- Diet & Nutrition
- Sports & Fitness
- Hydration
- Stress Reduction & Relaxation
- Sleep & Rest
- Supplements
- Daily Life Activity
- Medical Treatment
Early Detection of Trends Towards Disease Will Allow Effective Preventive Care

Healthy

Asymptomatic

Sickness threshold

Sick

Preventive care often diet, exercise, supplements

Molecular profiling

Present Practice

Time
Personalized Medicine Will Revolutionize Healthcare

Molecular Profiling

Detection of early stage disease
Accurate diagnosis of disease
Targeted therapy

Benefits

Patient empowerment
Effective, non-toxic therapy
Effective preventive care
The Revolution Has Already Started

Top 5 events in Personalized Medicine in 2015-16:

- More than 100,000 people have had their genome sequenced
- Cancer therapy increasingly dictated by the genetic makeup of the tumour as opposed to location (breast, prostate, lung etc) of the tumour
- First introductions of genetic tests in drug prescription and cancer therapy to avoid adverse drug reactions
- Personalized immunotherapies for leukemia
- Omic profiling to guide individualized healthcare
“The Personalized Medicine Revolution: How Diagnosing and Treating Disease Are About to Change Forever”

If you want to buy it, go to Amazon.com