The Future of Healthcare...

Cool stuff coming!

Lyle Berkowitz, MD, FACP, FHIMSS (UIC Med ‘92)
CEO, Back9 Healthcare consulting
Associate Professor of Clinical Medicine, Northwestern University

Email: Lyle@drlyle.com
WEB: www.drlyle.com
Twitter: @drlyleMD
AGENDA

• Introduction
• Telehealth
• Precision Medicine
• Internet of Things (IoT)
• Drones
• 3D Printing
• Nanobots
• Artificial/Augmented Intelligence (AI)
My Journey

Clinical, IT, Business

Northwestern Medicine

Penn Engineering

Advanced Health Technologies

Proxicom

healthfinch

OneView

MDLIVE Always there.
What Might The Future Look Like?

We usually know what, we just don’t know when...
Introduction

Why we need Innovation In Healthcare

Introduction

How to think about Innovation

“A car is not merely a faster horse. And email is not a faster fax. And online project management is not a bigger whiteboard. And Facebook is not an electronic rolodex. Play a new game, not the older game but faster” - Seth Godin
Introduction

Doing new things in Healthcare

The glory of medicine is that it is constantly moving forward, that there is always more to learn. The ills of today do not cloud the horizon of tomorrow, but act as a spur to greater effort.

William James Mayo

The aim of medicine is to prevent disease and prolong life, the ideal of medicine is to eliminate the need of a physician.

William James Mayo
Introduction

What the Future of Healthcare might look like…

http://scienceroll.files.wordpress.com/2013/10/medical_infographic_final.jpg?w=581&h=1024

https://thefutureishere.economist.com/healthcare/thefutureofhealthcare-infographic.html
Telehealth
Telehealth

Tech + Services across multiple use cases

https://reports.chartis.com/telehealth_trends_and_implications-aug2020/
Telehealth Examples

Urgent, Chronic, Preventive Care

Connect face to face using your phone, tablet or computer, 24/7.

Just like an in-person visit, the doctor takes your history and symptoms, performs an exam and may recommend treatment - including prescriptions and lab work.

HEALTHCARE. REFRESHINGLY SIMPLE.

Get a doctor’s prescription for $29.

Birth Control Pills → Urinary Tract Infection UTI → Sinus Infection → STD Testing →
A1C Blood Sugar Test → Erectile Dysfunction → Cholesterol → Hair Loss →
Acne → Flu → Acid Reflux

Telehealth

Virtual Care = TeleHealth (TH) + Autonomous Health (AH)
Precision Medicine
Precision Medicine
Diagnosis and Treatment across a Spectrum
# Precision Medicine

*Genomics for Risk Evaluation and Treatment Choices*

<table>
<thead>
<tr>
<th>Provider</th>
<th>Entertainment Genetics</th>
<th>Medical Genetics</th>
<th>Cancer Genetics</th>
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<tbody>
<tr>
<td></td>
<td>Ancestry</td>
<td>Pharmacogenomics</td>
<td>Risk Factors</td>
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<tr>
<td>ActX</td>
<td>Limited</td>
<td>Reviewed screening</td>
<td>Reviewed screening</td>
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<tr>
<td>23andMe Service</td>
<td>Reviewed screening</td>
<td>Reviewed screening</td>
<td>Reviewed screening</td>
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<tr>
<td>⚠ ancestry</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>23andMe</td>
<td>✓</td>
<td>✓</td>
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</tr>
</tbody>
</table>

- Limited non-professional without review
- Reviewed screening
- Reviewed comprehensive screening
Precision Medicine

Genomics for Cancer Detection

Shelter-In-Place Impact on Cancer Screenings

Mammograms -87%
Pap Smears -83%
Colonoscopies -90%
CT Scans -39%
PSA Test -60%

Source: IQVIA Real World Claims, April 17, 2020

#DetectCancerEarly
**Precision Medicine**

*Proteomics for Biometrics and Risk Detection*

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**SAME GENOTYPE. DIFFERENT PHENOTYPE.**

Protein assays complement genomics to identify:

- Patient subpopulations
- Novel therapeutic targets
- New disease applications for approved drugs
- Possible safety concerns
- Mechanisms of action

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<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Primary Cardiovascular Risk</strong></td>
<td>What is my risk of having a heart attack, stroke or heart failure within the next 4 years?</td>
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<tr>
<td><strong>Secondary Cardiovascular Risk</strong></td>
<td>What is my risk of having a new issue with my heart such as a heart attack, stroke or heart failure within the next 4 years?</td>
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<tr>
<td><strong>Liver Fat</strong></td>
<td>Do I have excess fat in my liver?</td>
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<tr>
<td><strong>Cardiorespiratory Fitness – VO2 Max</strong></td>
<td>What is my aerobic fitness level?</td>
</tr>
<tr>
<td><strong>Percent Body Fat</strong></td>
<td>What is my body fat percentage?</td>
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<tr>
<td><strong>Lean Body Mass</strong></td>
<td>What is my lean body mass?</td>
</tr>
<tr>
<td><strong>Alcohol Impact</strong></td>
<td>Is my body showing the effects of my weekly alcohol consumption?</td>
</tr>
<tr>
<td><strong>Glucose Tolerance</strong></td>
<td>If I have simple sugars, does my blood glucose spike to unhealthy levels?</td>
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<tr>
<td><strong>Visceral Fat</strong></td>
<td>How much fat is around my organs?</td>
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<tr>
<td><strong>Resting Energy Rate</strong></td>
<td>How many calories does my body burn at rest when I am not doing physical activity?</td>
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Precision Medicine

Gene Therapy

What is Gene Therapy?

Gene Therapy is when a "normal" healthy gene substitutes in for a harmful gene in cell by using a vector.

Pipeline

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<thead>
<tr>
<th>Pre-Clinical</th>
<th>Target Identification</th>
<th>Pre-Clinical Validation</th>
<th>IND Enabling</th>
<th>Clinical Trials</th>
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<tr>
<td>HIV CURE PROGRAM</td>
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<td>PHENYLKETONURIA</td>
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<tr>
<td>LIVER CANCER THERAPY</td>
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The New York Times

A ‘Cure for Heart Disease’? A Single Shot Succeeds in Monkeys

A novel gene-editing experiment seems to have permanently reduced LDL and triglyceride levels in monkeys.

Alzheimer’s

In a trial done on mice, less plaque developed in the brain of the mouse that received gene therapy, resulting in less damage to the part of the brain containing memory.

Cancer

A gene therapy trial to treat leukemia (a cancer affecting the blood) 26 out of 59 patients "experienced complete remission" Immune deficiencies

Heredity Blindness

Patients with LCA after trials with gene therapy, 6 out of 9 experienced better vision
Internet of Things (IoT)
IoT

Sensors in Healthcare

**THE INTERNET OF THINGS**

Being Connected

A more connected world gives us the power to monitor anything, from the environment to our health.

- **Actuators**
  - Rapidly falling prices of microelectromechanical systems (MEMS) will allow us to put sensors on virtually anything—even people.

- **Sensors**
  - RFID tags can attach to almost any object, connecting the physical world with its virtual counterpart.

- **Data Communication Technology**
  - Closed-loop setups will automatically trigger actions based on sensory data.

5x

Within this decade, the number of devices will quintuple, from 50 billion to 250 billion.


IoT

Wearables

Reference: https://www.pnas.org/content/early/2020/07/09/2008422117
IoT

Ingestibles for biometrics and imaging

Traditional

Portable

Ingestible

Capsule Ultrasound Device (CUS)

Sensor goes through the digestive system.

Patch registers sensor, and sends signal to a mobile device that the pill has been taken.

Pill orients, leaving sensor in stomach.

Pill passes through intestines, leaving sensor in stomach.

Fluids in the stomach activate the sensor, which sends a signal to a patch on the patient's body.

Patient ingests pill with sensor made of copper, magnesium and silicon.

Source: Prolabs Digital Health

John Blanchard / The Chronicle
IoT

Implantables

Dust-sized implantable sensor could enable brain-controlled prosthetics, continuous organ monitoring

Researchers at the University of California Berkeley have created a tiny sensor, the size of a grain of sand, that can sit on a nerve, muscle, or organ and monitor the electrical signals passing through it. The sensor, dubbed "neuro dust," was designed as a next-generation control interface for prostheses but could eventually turn out to have a wide range of healthcare applications.
Drones
Drones
Search, Delivery, Care
3D Printing
3D Printing

Prosthetics, Devices, Personalized Surgery, Tissue/Organs
Nanobots
Nanobots
Diagnosis, Surgery, Treatments

Nanobot in action
A nanobot machine roaming through the bloodstream, injecting or taking samples for identification and determining the concentrations of different compounds.

Magnetic Micro Surgery
Around the world, researchers are developing specialized nanobots to perform a wide variety of surgeries using external magnetic fields to direct the bots

- Performing Eye Surgeries
- Clearing Blocked Arteries
- Collecting Biopsies

Nanobots fighting cancer
The nanobots are made from flat, rectangular DNA sheets
Thrombin bound to DNA
The thrombin-loaded DNA nanobot
Tumor-targeting DNA
Tumor
This directs the nanobot to the tumor cells, where the blood clotting enzyme is released, stopping the blood flow to the tumor.

Source: Arizona State University; The Beckman Institute Drugmame © PFT
Artificial/Augmented Intelligence (AI)
AI

Diagnosis, Prognosis, Treatment, Research
AI
How far will we go?

The Reinvention Of Medicine: Dr. Algorithm Vo-7 And Beyond

NYT: Can Computers Replace Doctors?
The Future of Healthcare

*What to expect...*

- **The “Tricorder”**
  - Biometrics + Labs + Imaging = Detect faster, better, cheaper
  - Ambulatory: Predict and Prevent
  - Hospital: Track objects and people

- **Robo-Doc**
  - Replacing Doctors: Automation of routine, repeatable care
  - Augmenting Doctors: Finding edge cases, New Treatments...

- **Bio-hacking**
  - Cyborg (man-computer interface)
  - CRISPR for gene editing
  - Nanotechnology for diagnosis and treatment
  - Regenerative medicine (eg stem cells) for arthritis and other repairs

- **What if computers could manage 80% of health care?**

- **What if we cured heart disease or cancer?**

- **What if most people lived to 120?**
AMARA’S LAW

We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run.
THANK YOU

Lyle Berkowitz, MD, FACP, FHIMSS (UIC Med ‘92)
CEO, Back9 Healthcare consulting
Associate Professor of Clinical Medicine, Northwestern University
Email: Lyle@drlyle.com
WEB: www.drlyle.com
Twitter: @drlyleMD