ROME IS BURNING

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National Health Council
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LET THEM EAT CAKE...

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Vice Chancellor for Health Data Science
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TECHNOLOGY ENABLED HEALTHCARE: CAN WE ACHIEVE PERSONALIZED APPROACHES TO CARE?

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Vice Chancellor for Health Data Science
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CONFLICTS OF INTEREST

• Employment
  • Duke University
  • Verily Life Sciences
• Corporate Board
  • Cytokinetics
• Consulting
  • Astra Zeneca
  • Merck
  • Boehringer Ingelheim
  • Amgen
  • Biogen
  • Genentech/Roche
  • Lilly
### History of Digital Disruption

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Photographic Film &amp; Paper</td>
<td>Digital Photography</td>
<td>NO</td>
<td>✗</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BARNES &amp; NOBLE</td>
<td>Selling Books from Stores</td>
<td>Online Book Orders</td>
<td>NO</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>Lending Money</td>
<td>ATMs and Online Banking</td>
<td>YES</td>
<td>✓</td>
<td></td>
<td>All Modern Banks</td>
</tr>
<tr>
<td>Video Rental</td>
<td>Digital Streaming</td>
<td>NO</td>
<td>✗</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fee-for-Service Health Care</td>
<td>Value-based, Digitally Enabled Medicine</td>
<td>NO</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Sell more drugs at higher prices</td>
<td>Value-based reimbursement</td>
<td>NO</td>
<td>?</td>
<td>?</td>
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</tr>
</tbody>
</table>

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**LIFE EXPECTANCY AT BIRTH BY COUNTY, 2014**

- Counties in South Dakota and North Dakota had the lowest life expectancy, and counties along the lower half of the Mississippi, in eastern Kentucky, and southwestern West Virginia also had very low life expectancy compared with the rest of the country. Counties in central Colorado had the highest life expectancies.

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CHANGE IN LIFE EXPECTANCY AT BIRTH BY COUNTY, 1980 TO 2014

- Compared with the national average, counties in central Colorado, Alaska, and along both coasts experienced larger increases in life expectancy between 1980 and 2014, while some southern counties in states stretching from Oklahoma to West Virginia saw little, if any, improvement over this same period.


Variables Included in the Regression Analysis With Summary Statistics and Bivariate Regression Results

Table 1: Variables Included in the Regression Analysis With Summary Statistics and Bivariate Regression Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Summary Statistics</th>
<th>Coefficients and 95% CI (p-value)</th>
<th>Standardized Regression Coefficients (95% CI)</th>
</tr>
</thead>
</table>

Table Title: Variables Included in the Regression Analysis With Summary Statistics and Bivariate Regression Results

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Midlife mortality from “deaths of despair” across countries

Men and women ages 50–54, deaths by drugs, alcohol, and suicide, 1989–2014


Life expectancy at birth (years) in 18 high income countries for women and men during 2010-16 and 1990-2015.

Jessica Y Ho, and Arun S Hendi BMJ 2018;362:bmj.k2362

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Four industrial revolutions

FIRST
Water and steam power mechanize production.

Jacob Leupold, Steam Engine, in *Theatri Machinarum Hydraulicae* (1720)
Four industrial revolutions

SECOND
Electric power creates mass production.

THIRD
Electronics and information technology automate production.
Four industrial revolutions

FOURTH
The digital revolution—characterized by a fusion of technologies—blurs the lines between physical, digital, and biological spheres.

Qualities of the New Data Environment

• Volume
  —New methods of data storage allow access to huge amounts of data

• Ubiquity/Liquidity
  —Data are available anywhere across geography, social and economic classes

• Latency
  —There is no delay in access to data inherent in the technology

• Analysis
  —Data, information, knowledge, wisdom continuum is being shifted to the right
“To learn the truth, we must put all the parts together.”
16.3M results in 0.57 second
The cost of a smartphone in 1985: $32M

- Mobile Phone: $9,000 (DynaTAC)
- Text Messaging: $1,105 (fax machine)
- GPS: $6,630 (Magellan GPS)
- Voice Recorder: $110 (Realistic CTA)
- Digital Watch: $45 (Casio DBC)
- Music Player: $400 (Sony Discman)
- Video Camera: $3,745 (Sony V8)
- Video Player: $1,105 (Sony VCR)
- Encyclopedia: $2,200 (Encyclopedia)
- Processor: $32M (Cray)
- Portable TV: $665 (Casio Mini TV)
- Video Conference: $110,520 (Future Sys)

Today: $250 (with contract)

Project Baseline
WE’VE MAPPED THE WORLD. NOW LET’S MAP HUMAN HEALTH.

www.projectbaseline.com
Collecting comprehensive health data
Generate tools and technologies to collect diverse, comprehensive health data in-clinic, at-home, and remotely.

Terabytes of health data per patient

6 TB of collected data on each Project Baseline participant per year
**Big Challenges in Biomedicine**

- Lack of significant information over time dimension
  - Measurements to assess biology and human health are made periodically in visits to healthcare or for research

- Missing systems biology
  - When developing concepts of human biology or drug development we make limited measurements focused on specific mechanisms — *we look “under the lamppost”*

- Missing the opportunity to measure interactions of biology, sociology, environment and decision-making that could enable optimization of individualized and population health
  - Although we know that health and disease are the product of the interactions of genes, multiple derivative biological systems, environment, social context and personal decisions, we tend to look at one part of the time

**Phenotype stack**

- Integration across scales requires new data, new tools, new taxonomy
- Unifying metadata: **small molecules, biophysical stimuli**
- Breadth vs Depth
- Co-clinical modeling