HEALTH EQUITY METRICS TO AMELIORATE HEALTH DISPARITIES INEQUITY: A USER’S GUIDE

Outline

- Health equity: what is it?
- How do we measure it?
- How important is it?
  - Taking into account social preferences (for equity in health)
- Examples from CVD
  - Population health: tracking CVD risk factors
  - “Personalized medicine”: equity-aware evaluation of CVD risk calculators could improve clinical decisions & ameliorate CVD inequity
- Incorporating equity concerns into translational, comparative, cost-effectiveness analysis: a proposal
Health equity

- “the absence of systematic disparities in health (or its social determinants) between more and less advantaged social groups.” – Braveman et al 2000
- Health inequity: “a difference or disparity in health outcomes that is systematic, avoidable, and unjust.” -- CDC

- SES difference in health outcomes is inherently avoidable and unjust -- and therefore inequitable -- unless compelling evidence exists demonstrating that the difference is attributable to genetic factors
  - socioeconomic patterning of unhealthy behaviors such as smoking, sedentary behavior and dietary “choices” are assumed not to be genetically determined


Social gradients circa 1844:
poor households in poor neighborhoods increase mortality

Mortality by household and neighborhood SES, Chorlton-on-Medlock, United Kingdom (1844)

Friedrich Engels (1820 - 1895)
Engels, The Condition of the Working Class in England, 1845
Health Gradient -- neighborhood deprivation

![Graph showing health gradient by neighborhood deprivation](image)

Health Gradient -- education

![Graph showing health gradient by education level](image)

Adapted from Rogers et al. Biodemography and Social Biology, 56:80–99, 2010
Health Gradient -- education

Homicide Death Rates

Death rate per 100,000 person-years

Less than High School
High School
College

Health Gradient -- income

Heart Disease Death Rates < age 64

Death rate per 100,000 person-years

Low Income
Low-Middle Income
Upper-Middle Income
Upper Income
Health Gradient -- income

Lung Cancer Death Rates < age 64

Death rate per 100,000 person-years

Low Income Low-Middle Income Upper-Middle Income Upper Income


CHD incidence per 1000 person-years

First Second Third

Household income

Neighborhood deprivation

Diez-Roux et al NEJM 2001
Inequity of what?

- **Health Outcomes**
  - Death, disability, HRQoL

- **Health Care**
  - Access, technology
  - Quality
    - unbiased clinical decisions
    - equity-sensitive guidelines, prediction rules
    - does “personalized medicine” regime know this patient is poor?

- How can we harness clinical & public health services to improve (the equitable distribution of) health outcomes?

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Inverse care law

*The Lancet* · Saturday 27 February 1971

**THE INVERSE CARE LAW**

JULIAN TUDOR HART
Glyncorreg Health Centre, Port Talbot, Glamorgan, Wales

Summary
The availability of good medical care tends to vary inversely with the need for it in the population served.

Kevin Fiscella, MD, MPH; Peter Shin, PhD, MPH

*J Ambulatory Care Manage*  
Vol. 28, No. 4, pp. 304-312  
© 2005 Lippincott Williams & Wilkins, Inc.
aka “differential diffusion”

Differential diffusion cardiac testing

Relative Risk and Rate of Exercise Echo by SES and Year

“Low SES” = > 20% residents in Block Group with incomes < poverty

Fremont, Wickstrom, Escarce 2003 Does Differential Diffusion of Innovations Contribute to Disparities in Health Care? (AHRQ)
“We found that racial and SES disparities varied depending on the stage of diffusion of cardiac technologies with larger disparities observed for relatively new and rapidly diffusing technologies whereas disparities for more established technologies or those with newer alternatives were smaller or not present.”

Fremant, Wickstrom, Escarce 2003 Does Differential Diffusion of Innovations Contribute to Disparities in Health Care? (AHRQ)

Trends in 5-year relative survival from rectal cancer in men and deprivation gap in survival England and Wales, 1973–2004

Lyratzopoulos 2011
aka “inverse equity hypothesis”

What is Translational Research?

**T3: Translation to Practice**
Explore ways to implement recommendations from clinical studies to general practice
- phase 4 clinical trials, health services research, clinical outcomes research

**T4: Translation to Population Health**
Examine factors and interventions that influence the health of a population.
- population outcomes research, social determinants of health
Comparative effectiveness: Which intervention: A or B?

Which intervention: A or B?

Inequity (difference) 70% 10%

Mean reduction $A = B = 30\%$

Inequity (difference) 20% 10%

Mean reduction $A = B = 30\%$
Which intervention: A or B?

![Bar chart showing mean reduction for interventions A and B.]

Mean reduction

A = B = 30%

Relative risk reduction

Remaining risk

John Stuart Mill
1806 - 1873

Measuring inequity – common approaches

- Ratio & difference in... risks-, prevalence-, rates
  - dichotomized
  - categorized into x-tiles (tertile, quartile, quintile etc)

- Limitations
  - arbitrary cutoffs
  - data loss (1/3, ½, 3/5...)
    - lose “power”; unwieldy interactions
  - ignores health gradient
Accounting for the gradient

- Health Lorenz curve; $G_{\text{health}}$
- Concentration curve & index
  - relative, absolute
- Achievement index
- Inequity aversion parameter

- Other methods
  - Slope index of inequality
  - Equity-weighted QALYs
  - Cost-based equity weights (Ong 2009)

Health Lorenz Curve & $G_{\text{health}}$

\[ G = \frac{\sum_{i=1}^{n-1} |p_i - q_i|}{\sum_{i=1}^{n} p_i} \]
Concentration curve (for CVD)

Modified from Zhang & Wang Int J Epi 2007

Data requirements

Enter data on group sizes, group means, and grouped std deviations in area below. No other data need be entered. Other cells are locked.

<table>
<thead>
<tr>
<th>Quintile</th>
<th># persons per quintile</th>
<th>Quintile means</th>
<th>Quintile std devs</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1002</td>
<td>0.0595</td>
<td></td>
<td>CI</td>
</tr>
<tr>
<td>2</td>
<td>949</td>
<td>0.0341</td>
<td></td>
<td>var(CI)</td>
</tr>
<tr>
<td>3</td>
<td>1002</td>
<td>0.0405</td>
<td></td>
<td>se(CI)</td>
</tr>
<tr>
<td>4</td>
<td>1082</td>
<td>0.0281</td>
<td></td>
<td>t-test(CI)</td>
</tr>
<tr>
<td>5</td>
<td>1280</td>
<td>0.0218</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wealth group</th>
<th>No. of births</th>
<th>% birth</th>
<th>% cumul</th>
<th>R</th>
<th>USRM</th>
<th>f. mu</th>
<th>cum f. mu</th>
<th>q</th>
<th>CI</th>
<th>f. mu R</th>
<th>a</th>
<th>f. a.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poorest</td>
<td>1,002</td>
<td>18.9%</td>
<td>18.9%</td>
<td>9.4%</td>
<td>0.0595</td>
<td>0.0112</td>
<td>0.0112</td>
<td>0.3124</td>
<td>-0.1841</td>
<td>0.0112</td>
<td>0.6482</td>
<td>0.0792</td>
</tr>
<tr>
<td>2nd</td>
<td>949</td>
<td>17.9%</td>
<td>36.7%</td>
<td>27.8%</td>
<td>0.0341</td>
<td>0.0061</td>
<td>0.0173</td>
<td>0.4819</td>
<td>-0.1841</td>
<td>0.0173</td>
<td>0.9086</td>
<td>0.1641</td>
</tr>
<tr>
<td>Middle</td>
<td>1,002</td>
<td>18.9%</td>
<td>55.6%</td>
<td>46.1%</td>
<td>0.0405</td>
<td>0.0076</td>
<td>0.0249</td>
<td>0.6945</td>
<td>-0.1841</td>
<td>0.0249</td>
<td>0.9440</td>
<td>0.1680</td>
</tr>
<tr>
<td>4th</td>
<td>1,082</td>
<td>20.4%</td>
<td>75.9%</td>
<td>65.7%</td>
<td>0.0281</td>
<td>0.0057</td>
<td>0.0397</td>
<td>0.8538</td>
<td>-0.1841</td>
<td>0.0397</td>
<td>0.8421</td>
<td>0.1443</td>
</tr>
<tr>
<td>Richest</td>
<td>1,280</td>
<td>24.1%</td>
<td>100.0%</td>
<td>88.0%</td>
<td>0.0218</td>
<td>0.0053</td>
<td>0.0359</td>
<td>1.0000</td>
<td>0.0000</td>
<td>0.0359</td>
<td>0.7188</td>
<td>0.1244</td>
</tr>
<tr>
<td>Total/average</td>
<td>5,315</td>
<td>0.0359</td>
<td>0.0359</td>
<td>-0.1841</td>
<td>-0.1841</td>
<td>0.8201</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ CI_{relative} = \left( 1 - \frac{2}{R} \right) \times y_{i} (1 - R) \]
\[ y_i = \text{ith person's III health} \]
\[ \mu = \text{mean of } y_i \]
\[ R_i = \text{fractional rank according to income} \]
\[ CI_{absolute} = \mu \times CI_{relative} \]
Intervention (or health state) B or C? health achievement also matters

<table>
<thead>
<tr>
<th></th>
<th>below median</th>
<th>above median</th>
<th>below median</th>
<th>above median</th>
<th>below median</th>
<th>above median</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inequity (difference) 10% 10%
Achievement (mean risk reduction) 30% 15%

Achievement Index & Plane

- Achievement index: mean health taking into account inequity
  \[ I = \mu(1 - CI) \]

Clarke 2009
AI: population trends in CVD risk factors

Clarke 2009

Accounting for aversion to inequity

- Inequity aversion parameter ($\nu$): a weighting function for lower income individuals

$$C(\nu) = (1 - \frac{\nu}{n\mu} \sum_{i=1}^{n} y_i (1 - R_i)^{\nu-1})$$

Wagstaff J Health Econ. 2002;21(4)
Bootstrap replications for the change in absolute inequalities and proportion of the population not exercising, 1989 – 1995 (Australia)

Clarke 2009

Equity-naïve guidelines and decision rules may exacerbate health inequity

- Appropriate, quality care demands delivering the care people need and want (and nothing more)
  - Application to (individual) patients of evidence of benefits & risks established in studies (of populations)
  - Relative risk reduction (RRR) frequently constant
  - Absolute risk reduction (ARR) proportionate to absolute risk
  - Harms of low-risk treatments (ie: medications) are frequently fixed
  - Key component of “personalized medicine” is (absolute) risk prediction
  - Failure to account for social gradient in risk will result in inappropriate-, lower quality care and may exacerbate inequity
Example: ASA for primary prevention of CVD
Example: Framingham poorly calibrated to income gradient of CVD

Calibration plots of observed vs. predicted risk of hard CVD, by income

Ratio of observed : predicted risk of hard CVD, by income

<table>
<thead>
<tr>
<th>Income Range</th>
<th>Observed</th>
<th>Predicted</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;$5K - 7.9K</td>
<td>6.6%</td>
<td>13.1%</td>
<td>0.83</td>
</tr>
<tr>
<td>$8 - 15.9K</td>
<td>5.5%</td>
<td>13.1%</td>
<td>0.83</td>
</tr>
<tr>
<td>$16 - 34.9K</td>
<td>2.3%</td>
<td>13.1%</td>
<td>0.83</td>
</tr>
<tr>
<td>$35 - 49.9K</td>
<td>1.7%</td>
<td>13.1%</td>
<td>0.83</td>
</tr>
<tr>
<td>&gt;$50K</td>
<td>6.6%</td>
<td>13.1%</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Men

FRS 0.83 1.34

Women

FRS 0.79 1.34

Poor calibration leads to under-treatment of the poor

Observed vs Predicted 10-year Risk Among Low SES Participants

*Low SES: Income <$16,000 OR < high school education
Improved targeting of treatment to individuals: Predicting & reducing relative CVD inequity

Concentration curves for observed and predicted CVD risk by four models (FRS, SES-5, NSES and Education alone) in ARIC

Relative CVD inequity based on four statin treatment strategies

<table>
<thead>
<tr>
<th>Treatment Strategy</th>
<th>Concentration Index</th>
<th>Improvement vs. no treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal</td>
<td>-0.133</td>
<td></td>
</tr>
<tr>
<td>Framingham</td>
<td>-0.126</td>
<td>0.007</td>
</tr>
<tr>
<td>Hybrid</td>
<td>-0.123</td>
<td>0.010</td>
</tr>
<tr>
<td>SES-5</td>
<td>-0.122</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Extended concentration index and achievement index for four statin treatment approaches, with increasing aversion to inequity

<table>
<thead>
<tr>
<th>Inequity Aversion parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed (No Treatment)</td>
</tr>
<tr>
<td>FRS</td>
</tr>
<tr>
<td>SES-5</td>
</tr>
<tr>
<td>Hybrid</td>
</tr>
<tr>
<td>Universal Rx</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extended Concentration Index</th>
<th>Achievement index * mean * (1 - CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed (No Treatment)</td>
<td>FRS</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Inequity Aversion parameter:

1. Observed (No Treatment)
2. FRS
3. SES-5
4. Hybrid
5. Universal Rx
Extended concentration index and achievement index for four statin treatment approaches, with increasing aversion to inequity

<table>
<thead>
<tr>
<th>Inequity Aversion parameter</th>
<th>Extended Concentration Index</th>
<th>Achievement index = mean * (1 - CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed (No Treatment) FRS SES-5 Hybrid Universal Rx</td>
<td>Observed (No Treatment) FRS SES-5 Hybrid Universal Rx</td>
</tr>
<tr>
<td>1</td>
<td>0 0 0 0 0</td>
<td>5.47 5.01 5.01 4.97 4.37</td>
</tr>
<tr>
<td>2</td>
<td>-0.133</td>
<td>6.19</td>
</tr>
<tr>
<td>5</td>
<td>-0.311</td>
<td>7.16</td>
</tr>
</tbody>
</table>

Column A B C D E
Extended concentration index and achievement index for four statin treatment approaches, with increasing aversion to inequity

<table>
<thead>
<tr>
<th>Inequity Aversion parameter</th>
<th>Extended Concentration Index</th>
<th>Achievement index = mean * (1 - CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observed (No Treatment)</td>
<td>FRS</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>-0.133</td>
<td>-0.133</td>
</tr>
<tr>
<td>3</td>
<td>-0.311</td>
<td>-0.311</td>
</tr>
</tbody>
</table>

Inequity-weighted absolute risk reduction (IArr)
universal treatment strategy = (column A - column D)
hybrid strategy = (column A - column E)
Inequity-weighted absolute risk reduction

Equity-weighted cost effectiveness

- Effectiveness now equity-weighted (iARR)
  - Assessed across a range of values for \( \nu \)
  - \( \nu = 1 \) represents status quo (ignores equity)

- “Equity-efficiency tradeoff”
  - Inherently progressive interventions may “dominate” others when they are also more efficient
  - Some comparisons will depend on the value of \( \nu \)
  - Facilitates and informs a rational discussion
Can agreement to disagree yield consensus?

- Multiple philosophies of justice exist
  - eg. utilitarian, libertarian, Rawlsian, capabilities approach

- Health is central to the idea of justice
  - most political philosophy ignorant of social determinants of health
  - health holds intrinsic as well as instrumental value

- Consensus on the “right” (appropriate) policy choice may not require agreement on an ideal vision for a fair society

- Facilitated by open, inclusive and rational discourse

- Availability of information on health equity facilitates this discourse

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Health equity & human rights

- Countries should track “progressive realization” of the right to health
  - Mean health is insufficient; requires improving health among disadvantaged groups

- Possible in the US?
  - Census Bureau reports Gini, Atkinson index for income
  - Technically not possible for mortality in US (“income not included on death certificates”)
“New” equity measures complement traditional methods: program evaluation

- Intervention & control both pro-rich (CI \(\approx 0.55\))
- Mean use higher in intervention (PSI)
- Thus achievement would be greater
- CI / AI alone would miss potentially important gap in Q2
- Lesson: look at data

![Graph showing wealth quintiles and contraceptive use](image)

Chakraborty 2013

Summary of summary health equity measures

- Accounts for entire SES gradient
  - Increase sample size & statistical power
- Permits explicit specification of otherwise implicit equity-related assumptions
  - accommodates diverse attitudes towards equity
- Applicable to most areas of HSR
  - processes & outcomes
  - epi, demography, CER, RCTs, T3-4 translational research & implementation science, evaluation, cost effectiveness...
- May strengthen the case for:
  - “ancillary services” (Robin Clarke PCORI)
  - community- (population) based interventions (Rose)
  - innovative & progressive incentives (Dudley Adams NYC)
Thank you

- Improved health equity measurement allows us (you) to:
  - track success over time (epidemiology, surveillance)
  - target interventions (demography, social- and clinical epi)
  - evaluate & compare equity impact of interventions, policies (CER, implementation science)
  - cost effectiveness: cost of “equity-weighted” effectiveness
Demography: inequity “crossover” at older age

Table 8.
Difference in period life expectancy for male Social Security-covered workers, by age between selected earnings group for the period 1999–2000 (in years)

<table>
<thead>
<tr>
<th>Age</th>
<th>Top half minus bottom half</th>
<th>Top quarter minus bottom quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>2.6</td>
<td>3.3</td>
</tr>
<tr>
<td>65</td>
<td>1.9</td>
<td>2.3</td>
</tr>
<tr>
<td>70</td>
<td>1.2</td>
<td>1.3</td>
</tr>
<tr>
<td>75</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>80</td>
<td>0</td>
<td>-0.4</td>
</tr>
<tr>
<td>85</td>
<td>0.4</td>
<td>-0.9</td>
</tr>
</tbody>
</table>

Waldron 2007; Tranvag 2013

Mortality distribution for highest and lowest wealth quintiles in Ethiopia, 2011

Earlier aging of the poor

Number of survivors (out of 100,000 alive at age 20) for poor and nonpoor, men and women, by number of biological risk factors (NHANES III)

Crimmins, Kim & Seeman 2009

Age-SES interaction p<0.001 all models
At what age does the gradient in CVD death disappear?

Relative concentration index of CVD death in NHANES III for men and women, by 10-year age bands

Predicting CVD risk?
Include age interaction term

UK Framingham is QRISK2
- Includes a measure of social deprivation
- 8 interaction terms for age
AI: compare countries

Mean and inequality-weighted mean in under-five mortality


SES gradients larger among blacks

Years of potential life lost and years of unhealthy and healthy life lived at age 30 sex–race groups with 13+ and 0–8 years of schooling.

"Life lost" "Unhealthy" "Healthy"
Health equity: fundamental to a just society?

- “For the distribution of wealth is the product of the legal order: a citizens wealth massively depends on which laws his community has enacted – not only its law governing ownership, theft, contract and tort, but its welfare law, tax law, labor law, civil rights law… and laws of practically everything else. When government enacts or sustains one set of such laws rather than another, it is not only predictable that some citizens’ lives will be worsened by its choice but also, to a considerable degree, which citizens these will be… We must be prepared to explain, to those who suffer in that way, why they have nevertheless been treated with equal concern that is their right.”

- Ronald Dworkin

Example: child death in India

<table>
<thead>
<tr>
<th>Wealth group</th>
<th>No. of births</th>
<th>rel % births</th>
<th>cumul % births</th>
<th>USMR per 1000</th>
<th>No. of deaths</th>
<th>rel % deaths</th>
<th>cumul % deaths</th>
<th>Conc. Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poorest</td>
<td>29939</td>
<td>23%</td>
<td>23%</td>
<td>154.7</td>
<td>4632</td>
<td>30%</td>
<td>30%</td>
<td>-0.0008</td>
</tr>
<tr>
<td>2nd</td>
<td>28776</td>
<td>22%</td>
<td>45%</td>
<td>152.9</td>
<td>4400</td>
<td>29%</td>
<td>59%</td>
<td>-0.0267</td>
</tr>
<tr>
<td>Middle</td>
<td>26528</td>
<td>20%</td>
<td>66%</td>
<td>119.5</td>
<td>3170</td>
<td>21%</td>
<td>79%</td>
<td>-0.0592</td>
</tr>
<tr>
<td>4th</td>
<td>24089</td>
<td>19%</td>
<td>85%</td>
<td>106.9</td>
<td>2145</td>
<td>14%</td>
<td>95%</td>
<td>-0.0842</td>
</tr>
<tr>
<td>Richest</td>
<td>19739</td>
<td>15%</td>
<td>100%</td>
<td>54.3</td>
<td>1072</td>
<td>7%</td>
<td>100%</td>
<td>0.0000</td>
</tr>
<tr>
<td>Total/average</td>
<td>129671</td>
<td></td>
<td></td>
<td>118.8</td>
<td>15419</td>
<td></td>
<td></td>
<td>-0.1694</td>
</tr>
</tbody>
</table>

Table 1: Under-five deaths in India, 1982-92

World Bank Quantitative Techniques for Health Equity Analysis—Technical Note #7
Neurologic Care and Outcomes Research

RCT: Clinical science and knowledge of efficacy under ideal conditions

Comparative Effectiveness Research

Clinical knowledge of comparative effectiveness of alternative therapies

Higher use of RCT-proven treatments

Improved population health

Lower, delayed, or inappropriate use of RCT-proven treatments

Quality improvement interventions to compare different ways of delivering care

Implementation Science