Engineering World Health

and

The Role of BME in Global Health

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Engineering World Health
Global Health

Global Health Care Is Fashionable, But Falls Short
Robert Bazell
NBC News

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I've never met Bill Gates. I have heard he is a tyrant in business negotiations and I resent the decades I've struggled with Microsoft operating systems. MSNBC.com, by the way, is a joint venture of Microsoft and NBC Universal.

But the man deserves the Nobel Prize, many prizes - sainthood, perhaps - for his global health programs. He also merits sympathy and support in the face of growing criticisms about the effectiveness of his giving.

The Board of Trustees approved a $1.8-billion budget during their May meeting this weekend that will bring some major goals of the University's new strategic plan to fruition.

The fiscal year 2007-2008 budget, which sees revenues jump 9.9 percent and expenditures increase 8.5 percent, will fund the new DukeEngage initiative and Duke's Global Health Institute, among other projects.

Gates gives $9.7m for AIDS research

The Times of India - Breaking news, views, reviews, cricket from across India

Gates gives $9.7m for AIDS research

19 May, 2007 | 0250 hrs IST | AP

SMS NEWS to 8888 for latest updates

SEATTLE: The Bill & Melinda Gates Foundation will give a $9.7 million grant to the Elizabeth Glaser Pediatric AIDS Foundation to study ways to prevent HIV/AIDS transmission to children via breast milk.

$29 billion

$31 billion
What are they all talking about?
What is Global Health?
What is global?

Dry, ice and green on earth
What is Global?

Earth at Night
What is Global?

Population Density

(Millions per square mile)
What is Global Health?

% Without safe water

[Map showing % of the world without safe water]
What is Global Health?

% Stunting
What is Global Health?

% HIV Positive
What is Global Health?

Life Expectancy
What is Global Health?

UN Human Development Index
- High Human Development (most, first)
- Medium Human Development
- Low Human Development (least, third)
So, what can we do?

Conclusion: Send $$

Per Capita Spending (International Dollars)

Inequality in World Healthcare Spending

Least Developed Nations
Not so fast!
Not so fast!
Conclusion: Send Stuff
80% of hospital equipment in least developed nations is donated

WHO Guidelines for Medical Equipment Donations
My Experience at Kissy Eye Clinic
Freetown, Sierra Leone

Arrival with cataract surgeon

At the end of the day, this girl was waiting
Where Sierra Leone?

UN Human Development Index
- High Human Development (most, first)
- Medium Human Development
- Low Human Development (least, third)
Sierra Leone

- Life Expectancy - 38 years
- Safe Drinking Water - 54%
- Infant Mortality - 170/1000
- Under Five Mortality - 286/1000
Something Was Wrong

- It was late at night
- Cataract patients waiting
- Phaco and XYZ = 20 minutes
Got to Work

In 30 minutes
Fixed the XYZ
All Patients Treated

Needed
• Spare parts
• Tools
• Knowledge

Training Paul to work on XYZ Scope
EWH Experience
with donated medical equipment

• 62 Hospitals in 18 Countries
  – (almost all low HDI)
• 1710 Failure Analyses
• 176 compliant long interviews
• About 1500 short interviews
• About 450 reported long interviews
Spare Parts

Parts (29% power supply)*

Training/Installation (24% - incl. user error)*

Training

*Malkin, Annual Review of Biomedical Engineering, 2007
O2 sensor
Needs replacement

Tracy Lipps with donated Siemens Ventilators
Worked for 4 months, then stopped
Jinotepe, Nicaragua

Sideline due to consumables
Needles
Electrodes
Sensors
Test strips
Reaction Cartridges
Blood Pressure Cuffs
Printing Paper
Sterilization Check strips
IV Pump Cartridges
Reagent Packs
Bovie Pens
Tubing
Canulae

Consumables
70% of all donated medical equipment does not work*

Mostly due to **

- lack of spare parts
- consumables
- Training/installation

*WHO Guidelines for Medical Equipment Donations
** Malkin, Annual Review of Biomedical Engineering, 2007
Wrong Stuff

Malignant neoplasm, % of population
## Leading Causes of Mortality

<table>
<thead>
<tr>
<th>Rank</th>
<th>Most Developed Nations</th>
<th>% of total deaths</th>
<th>Least Developed Nations</th>
<th>% of total deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ischaemic heart disease</td>
<td>23.3%</td>
<td>1 Ischaemic heart disease</td>
<td>9.2%</td>
</tr>
<tr>
<td>2</td>
<td>Cerebrovascular disease</td>
<td>13.4%</td>
<td>2 Cerebrovascular disease</td>
<td>8.4%</td>
</tr>
<tr>
<td>3</td>
<td>Trachea, bronchus, lung cancers</td>
<td>4.4%</td>
<td>3 Lower respiratory infections</td>
<td>7.9%</td>
</tr>
<tr>
<td>4</td>
<td>Lower respiratory infections</td>
<td>3.6%</td>
<td>4 Perinatal conditions</td>
<td>6.0%</td>
</tr>
<tr>
<td>5</td>
<td>COPD</td>
<td>3.2%</td>
<td>5 HIV/AIDS</td>
<td>6.0%</td>
</tr>
<tr>
<td>6</td>
<td>Colon and rectum cancers</td>
<td>2.3%</td>
<td>6 COPD</td>
<td>5.2%</td>
</tr>
<tr>
<td>7</td>
<td>Self-inflicted injuries</td>
<td>1.8%</td>
<td>7 Diarrhoeal diseases</td>
<td>4.6%</td>
</tr>
<tr>
<td>8</td>
<td>Diabetes mellitus</td>
<td>1.7%</td>
<td>8 Tuberculosis</td>
<td>3.6%</td>
</tr>
<tr>
<td>9</td>
<td>Stomach cancer</td>
<td>1.7%</td>
<td>9 Malaria</td>
<td>2.7%</td>
</tr>
<tr>
<td>10</td>
<td>Hypertensive heart disease</td>
<td>1.7%</td>
<td>10 Road traffic accidents</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

WHO data 2003 (COPD= chronic obstructive pulmonary disease)
Leading Causes of Morbidity
(loss of quality of life - DALY)

<table>
<thead>
<tr>
<th>5 Most Developed Nations</th>
<th>% DALY loss</th>
<th>5 Least Developed Nations</th>
<th>% DALY loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Malignant neoplasms</td>
<td>16</td>
<td>1 Lower respiratory infections</td>
<td>14</td>
</tr>
<tr>
<td>2 Unipolar depressive disorders</td>
<td>9</td>
<td>2 Malaria</td>
<td>8</td>
</tr>
<tr>
<td>3 Ischaemic heart disease</td>
<td>7</td>
<td>3 HIV/AIDS</td>
<td>8</td>
</tr>
<tr>
<td>4 COPD</td>
<td>4</td>
<td>4 Diarrhoeal diseases</td>
<td>8</td>
</tr>
</tbody>
</table>
### All Causes of Morbidity

<table>
<thead>
<tr>
<th>All Significant Causes of Morbidity</th>
<th>% of Total DALY's</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 Most Developed Nations</td>
</tr>
<tr>
<td>1 Lower respiratory infections</td>
<td>0.9</td>
</tr>
<tr>
<td>2 Malaria</td>
<td>0.0</td>
</tr>
<tr>
<td>3 HIV/AIDS</td>
<td>0.2</td>
</tr>
<tr>
<td>4 Diarrhoeal diseases</td>
<td>0.2</td>
</tr>
<tr>
<td>5 Birth asphyxia and birth trauma</td>
<td>0.4</td>
</tr>
<tr>
<td>6 Maternal conditions</td>
<td>0.4</td>
</tr>
<tr>
<td>7 Nutritional deficiencies</td>
<td>0.7</td>
</tr>
<tr>
<td>8 Perinatal Low birth weight</td>
<td>0.3</td>
</tr>
<tr>
<td>9 Other unintentional injuries</td>
<td>1.8</td>
</tr>
<tr>
<td>10 Measles</td>
<td>0.0</td>
</tr>
<tr>
<td>11 Road traffic accidents</td>
<td>1.9</td>
</tr>
<tr>
<td>12 Tuberculosis</td>
<td>0.0</td>
</tr>
<tr>
<td>13 Malignant neoplasms</td>
<td>15.9</td>
</tr>
<tr>
<td>14 Unipolar depressive disorders</td>
<td>9.2</td>
</tr>
<tr>
<td>15 Ischaemic heart disease</td>
<td>7.1</td>
</tr>
<tr>
<td>16 Chronic obstructive pulmonary disease</td>
<td>4.5</td>
</tr>
<tr>
<td>17 Cerebrovascular disease</td>
<td>4.3</td>
</tr>
<tr>
<td>18 Alzheimer and other dementias</td>
<td>4.1</td>
</tr>
<tr>
<td>19 Alcohol use disorders</td>
<td>4.0</td>
</tr>
<tr>
<td>20 Hearing loss, adult onset</td>
<td>3.6</td>
</tr>
<tr>
<td>21 Osteoarthritis</td>
<td>2.4</td>
</tr>
<tr>
<td>22 Diabetes mellitus</td>
<td>2.2</td>
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<td>23 Self-inflicted injuries</td>
<td>2.1</td>
</tr>
</tbody>
</table>

**Significant (>=2%)**

**Insignificant (<=1%)**
What is Everyone Talking About?

- Global Health = not us
  - prototype = Africa
- Sending $$ is NOT the answer
  - Only medium human development
- Sending stuff is NOT the answer
  - Spare parts, training, consumable
  - wrong stuff
- There is no silver bullet
What is the answer?

Develop a lot of new stuff
Why should you care

Buffet and Gates know this too

$60 billion
What is Engineering World Health doing?

EWH is
TN-based
Non profit
Delivering healthcare technology to those in need
Duke-EWH
Summer Institute

50 Participants in 2008

1 Month Training in
Costa Rica/ Tanzania

1 Month in a poor Hospital
Nicaragua, Honduras, Tanzania, Kenya
Month Training: Intense Study

- Daily Language
- Daily Culture
- Daily Lecture
- Daily Lab
- Additional Training
Then The Trip Starts!
Analysis Failures
Repairing Equipment

29% Spare Parts for the Power Supply
Inventory
What do they have?

Training
24% training including user error and installation
Identifying Needs
“The Long Interview”
Health Impact

• 2003-2007: 1130 pieces placed into service
• $2-$3 million worth
Trip Profile: Stephanie Patnode
University of Southern California, UC Berkeley
“I’d go back tomorrow. I ... for once, felt like an engineer.”
Special Features

• Family Program (day care, family housing)
• Open Internationally
• 1-Year Experiences
  – Engineering Volunteer - domestic
  – One-Year Internship - abroad
• Graduate Fellowships (MEM, MS)
“When we arrived, a nurse produced three ‘broken’ ECG machines. This was in a ward where not one patient was being monitored. We quickly discovered that the machines worked, but hadn’t been set-up correctly. We set them up and before we left, we saw patients being properly monitored for the first time.”

“The summer was an amazing experience, and one I will never forget. I grew and changed. It was the best time of my life.”
CUREs
A non-profit business program

Program takes advantage of three prominent institutions within Duke
CUREs
Non-Profit Business Incubation

Duke Bus/Mgmt Students create bootstrapped start-ups earned-income non-profit, healthcare technology business plans

Examples:
BP Assist Device Project
Cervical Cancer Screening/Detection/Treatment
Bilirubin treatment device
End of Spring
– Winner chosen $$$
Steps

- Needs Finding
- Business Plan
- Engineering Prototyping
- “Winning”
- Redesign/Testing
- Initial Clinical Trials (Duke)
- Field Trials (40 units)
- Redesign/Testing
- Launch – first sales order

30,000 Children
Senior Design Projects that Matter
Design for the Developing World

• Web Site: www.ewh.org/youth
• Lists about 20 Identified Needs
• Anyone can design solutions
  – EWH will pay for prototyping
  – Local manufacturability (new for 2006-2007)
  – May enter distribution system
Vanderbilt
Defibrillation Tester
High School, Middle School, Clubs, EWH Chapters and individuals purchase parts and build equipment coming soon.
• >1000 pieces delivered
• >$1 Million (replacement value)
EWH Chapters

University of Minnesota

Georgia Institute of Technology

University of Wisconsin—Madison

University of North Carolina at Chapel Hill

Texas A&M University

NC State University

The University of Memphis

Vanderbilt University

Cambridge University, England ... and others
EWH
Chapters

5 Core Activities

1) Repair Sessions
2) Designing New Equipment
3) Attending/Hosting Conferences
4) Builds
5) Fellowship Raising

Summer Program: Fellowships, financial aid set-asides
EWH Chapters

• Meet Weekly or Bi-Weekly
• 10-15 Students per meeting

Guidelines available from info@ewh.org

UNC/NC State/Duke EWH Chapters building phototherapy devices

Congressman Price, the Mayor of Durham, Chuck Messer
BME potential not fully realized

- Spare Parts
- Training programs
  - BME, BMT
- Information networks
  - Manuals
  - Tech support
- Donation Guidance
  - Testing, Consumables, Supplies
EWH: Succeeds Through Generous Support of our Partners

- Wallace H. Coulter Foundation
- Edwards Lifesciences
- Hamilton Roddis Foundation
- Gift of Life Foundation
- ANCO Project
- Anthony & Co.
- Oncor International
- Duke University
- Global Health Institute
- AHAD
- Rotary International
- NCI1IA
BME Has a Unique *Role*
You must make that *Role* a **Reality**

www.ewh.org