Global Contributions in HTM
Wanted: *How You Can Positively Impact Those in Need*

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Technical Services Partnership

[www.tsp-uvm.org](http://www.tsp-uvm.org)
University of Vermont
World Health

Highest: Japan = 84

Lowest: Chad = 49

USA

- #31 in life expectancy; 79 and dropping
- Last related to top 11 high income countries
- 2X more $ per person
- 18% of GDP, next 12%
- Price of “goods” highest
- 8% of costs administrative - highest

Wikipedia

JAMA, March 13, 2018
<table>
<thead>
<tr>
<th>Low Income Countries: Average Life Expectancy 62</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFGHANISTAN</td>
</tr>
<tr>
<td>BENIN</td>
</tr>
<tr>
<td>BURKINA FASO</td>
</tr>
<tr>
<td>BURUNDI</td>
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<tr>
<td>CENTRAL AFRICAN REPUBLIC</td>
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<tr>
<td>CHAD</td>
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<tr>
<td>COMOROS</td>
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<tr>
<td>CONGO, DEM. REP.</td>
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<tr>
<td>Eritrea</td>
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<tr>
<td>ETHIOPIA</td>
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<tr>
<td>GAMBIA, THE</td>
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<tr>
<td>GUINEA</td>
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<tr>
<td>GUINEA-BISSAU</td>
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<tr>
<td>HAITI</td>
</tr>
<tr>
<td>KOREA, DEM. PEOPLE’S REP.</td>
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<tr>
<td>ZIMBABWE</td>
</tr>
</tbody>
</table>

Red indicates bottom 10% in life expectancy
# Technology in Low Income Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Population</th>
<th>Regulations</th>
<th>MRI</th>
<th>CT scanner</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFGHANISTAN</td>
<td>30 million</td>
<td>No, only RX</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>BENIN</td>
<td>10 million</td>
<td>No, only RX</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>BURKINA FASO</td>
<td>16 million</td>
<td>None</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>CHAD</td>
<td>13 million</td>
<td>None</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>CONGO, DEM. REP.</td>
<td>67.5 million</td>
<td>No, only RX</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>MALI</td>
<td>15 million</td>
<td>No, only RX</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>TANZANIA</td>
<td>49 million</td>
<td>No, only RX</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>JAPAN</td>
<td>127 million</td>
<td>Yes</td>
<td>5841</td>
<td>12865</td>
</tr>
</tbody>
</table>

...
# Technology Management Impacts

## Medical Devices

<table>
<thead>
<tr>
<th>Maintenance</th>
<th>20-30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Investment through planning</td>
<td>10-20%</td>
</tr>
<tr>
<td>Reduced Development Time for Acquisition Specifications</td>
<td>2-4 weeks</td>
</tr>
<tr>
<td>Appropriate Technology Introduction</td>
<td>10-90%</td>
</tr>
<tr>
<td>User Training reducing maintenance</td>
<td>10%</td>
</tr>
<tr>
<td>Device life expectancy</td>
<td>30-80%</td>
</tr>
</tbody>
</table>

Ziken International for WHO
Indicators for the Impact of Health Technology Management on Investment / Use of Resources

1. Development of HT inventory and HT budget
2. Development of Human Resources for HTM
3. Expenses (waste) for the procurement of inappropriate equipment
4. Development of expenses for the replacement of devices
5. Process to reduce equipment down times (defects, missing supplies, lack of operator)
6. Degree of equipment use to capacity
7. Equipment life cycle in comparison to benchmarks
8. Life cycle cost analysis
Indicators for the impact of Health Technology Management on the Quality of Health Care

1. Wait time for specific clinical procedures due to equipment issues
2. Percentage of scheduled surgical procedures cancelled due to problems with equipment and devices
3. Rate of equipment incidents/events during surgery
4. Rate of fatal events during surgery due to equipment problems
5. Rate of fatal events during surgery due to operator errors, e.g. HTM user training
6. How many equipment problems during surgery not resolved due to lack of HTM personnel (e.g. CEs, BMETs) on duty
7. Infection rate due to reprocessing of multiple-use devices
8. Infection rate due to reuse of single use devices
9. How many adverse events due to malfunctioning equipment reported
10. Number/% of referrals to higher level facility due to equipment problems
11. Accident Trauma survival rates – equipment in place for rapid response

... 20 indicators
What is the Status of HTM in the Developing World?

- Limited medical device regulations,
- A high percentage of devices that are out of service
  ✓ *Engineering World Health estimates 40%*
- Weak after sale device support with nearly all service from manufacturers or their representatives,
- A shortage of technical staff in hospitals with few trained in medical technology support
- Few universities/technical schools with programs on biomed/BME/CE
- Very limited maintenance budget,
- Limited technology management,
- Lack of awareness and/or respect for HTM career
  ✓ *Many degreed engineers do maintenance*
- Many failed efforts to improve
  ✓ *Lack of coordinated approach*
Global Stakeholders in HTM Improvement

- Students
- Trainers, Faculty, and Educators
- Universities, Training Institutions, and Polytechnics
- Governments, Policymakers (Ministry of Health, Ministry of Education, Regulators)
- Clinical Facilities
- Healthcare Providers
- Intergovernmental Organizations (IGOs)
- Nongovernmental Organizations (NGOs)
- Private Sector
- Manufacturers
- Funders, Donors
- Associations
- Certifying Organizations and Bodies
- Researchers
- Communities
- Patients, Families, Health Care Consumers
- Local Champions and Advocates
- Concerned Global Citizens

From AAMI-GE BMETS in Low Resource Countries, 2015
Global Health Technology Management: *World Health Org (WHO)*

- Incredible resources on website
- Sponsors HTM workshops worldwide
- Focus on Africa
- Pan American Health Organization serves the Western Hemisphere
WHO and PAHO Leaders

- Adriana Velazquez Berumen, Senior Advisor on Medical Devices, WHO
- Alexandre Lemgruber, Senior Advisor, PAHO
- Antonio Hernandez, former Senior Advisor, PAHO
Global Health Technology Management: *World Health Org (WHO)*

Global Forums on Medical Devices:
- 2010 Bangkok
- 2015 Geneva
- 2017 Geneva
- 2020 Delhi
Global Health Technology Management: *American College of Clinical Engineering (ACCE)*

Antonio Hernandez, International Committee Chair
– Former director of PAHO HTM

**International Committee**

- Identify priority activities within HTM and identify partners we can work with to operationalize these activities

- Share CE/HTM knowledge through training and information exchange according to the local needs (e.g., workshops tailored to local needs with local participation)

- Promote & advocate CE/HTM starting with highest priority countries, then moving on to others on continuum

- Build recognition for the profession of CE/HTM
Activities of the International Committee

• Collaborations with other international organizations and societies.
  ➢ World Health Organization
  ➢ Pan American Health Organization
  ➢ Clinical Engineering Division of the International Federation of Medical and Biomedical Engineering (IFMBE-CED)
  ➢ Regional CE, Biomedical Engineering, and HTM societies
  ➢ CORAL
  ➢ IUPESM - International Union for Physical and Engineering Sciences in Medicine

• Increase international membership
• Advanced Clinical Engineering Workshops (ACEWs)
Advanced Clinical Engineering Workshops (ACEW)

25 Years
50 ACEWS
30 Countries Hosted ACEW
69 Countries have Participated in ACEW
4,300 + Attendees
MoH, regulatory, academic, BME, clinical
80 Faculty Members of ACCE
25 Former ACEW Attendees
2000 + Hours of Lecture
Global Health Technology Management: *International Federation of Medical & Biological Engineering (IFMBE) Clinical Engineering Division*

Ernesto Iadanza, Leader
- Many projects
- Focused on clinical engineering
- Online training for Africa
- **Tools for Techs**
  - The Canadian Medical & Biological Engineering Society

~ Visit the CED Global website at [http://cedglobal.org/](http://cedglobal.org/)
Global Health Technology Management: Association for the Advancement of Medical Instrumentation (AAMI)

2015 Stakeholder Meeting Summary

BMETs in Low Resource Countries

GLOBAL FORUM at AAMI Annual Meeting: June 1, 2018
Foundations & NGOs

- Engineering World Health
- Assist International
- THET
- American International Health Alliance
- International Medical Equipment Collaborative IMEC & IMTC
- Biomedical Engineering Technology Aid International
- Global Medical Equipment Repair Training, LLC
- American Medical Resource Foundation Inc
- earthMed
- International Aid
- Project Hope
- Gradian Health Systems
- Biomeds Without Borders
- Center for the Rural Development of Milot (CRUDEM) Foundation
- Global Assistance for Medical Equipment:
  - Operation Smile
  - CardioStart International
  - Samaritan’s Purse
  - Operation Renewed Hope
  - Medisend
Primary Areas of HTM Contributions

- Medical equipment and supplies
  - Donations
- Medical equipment and installations
- Biomed training
- Working and mentoring in country
- “One stop shopping”
- Mobile hospitals
- Clinical outreach
- BME university partnerships
- MoH/national health leader training
Medical equipment and supplies

Examples:
• Project C.U.R.E.
• Medical Ministries International (MMI)
• Hospital Sisters Mission Outreach

Photos from Technation
Donations

Main barriers to effective donation of medical equipment:

• Lack of genuine partnership between donor and recipient
• Insufficient appreciation for the challenges of the recipient’s context
• Limited standardized inventory of medical equipment in resource constrained settings to identify needs
• Insufficient support for the long term integration of new equipment
• Insufficient connectivity between activities undertaken by various organizations working on donations
• Lack accountability - no tracking and monitoring of donations and no existing quantification framework for impact of donations
• Insufficient capacity and capacity building programs for recipients
Donations

• Dr. Margaret Chan, former WHO Director-General
  – "Developing countries are littered with unused, obsolete equipment and devices. Recent studies suggest that only 10% to 30% of donated equipment ever becomes operational."

• Guidelines for donations of medical equipment
Installation of Medical Equipment

• Assist International
  – Jalalabad Public Health Hospital Number One in the Nangarhar Province in Afghanistan
    • GE monitoring installation
    • Brad Carrott, Salinas Valley Memorial
  – Assist International provides many humanitarian services
Biomed and HTM training

• Billy Teninty, Global Medical Equipment Repair Training
  – Teaches technical & management skills
  – Sequence:
    • tools
    • lectures & demonstrations,
    • hands-on lab exercises,
    • field trips to hospitals

• Engineering World Health
  – sends American students to the developing world for 2-month stints repairing medical equipment
  – trains local BMETs through regional educational programs
  – “Train-the-trainer”: local instructors achieve expertise, and the curriculum is then offered by the partner school in the country
  – Robert Malkin, Duke
  – Ed Hutton, EWH

Images from 24x7 magazine
University of Vermont: Bilingual Online Courses

• Grant submitted to Pan American Health and Education Foundation (PAHEF) in December 2005 to develop a bilingual on-line course in Medical Equipment Technology and Clinical Engineering

• Original Funding June 2006-July 2008
  – Course in English completed and taught in year one
  – Course in Spanish completed and taught in year two

• Additional funding
  – WHO & PAHO 2009 (Eastern Caribbean)
  – PAHEF 2011-2012 (Argentina x 2, Mexico)
Course Audience

• Designed for

1. **Primary:** Technical staff in hospitals – BMET, electricians, maintenance and other technical personnel

2. Engineers without training in medical equipment, life sciences, healthcare, and other areas – career changers

3. Nursing and other clinicians

4. Administrators and managers
Overall International Results  
2007 - 2018

– English & Spanish versions taught at:
  • PAHO Virtual Campus for Public Health
  • Universidad CES in Medellin, Colombia
  • Pontificia Universidad Catolica de Peru in Lima, Peru
  • Universidad Technological Nacional/Mendoza, Argentina
  • University of Vermont in Vermont, USA

– Over 1000 students from 40 countries have taken course
  – Colombia, Peru, Mexico, Venezuela, Uruguay, Costa Rica, Bolivia, Brazil, Uruguay, Paraguay, Chile, Argentina, Puerto Rico, Dominican Republic, Barbados, Jamaica, Grenada, Antigua, St. Lucia, Belize, British Virgin Islands, St. Vincent, St. Kitts, Turks & Caicos, France, Spain, China, Trinidad and Tobago, Dominica, Barbuda, Guyana, Bahamas, Anguilla, Honduras, Cuba, El Salvador, Panamá, Ecuador, Nicaragua, and the USA
Introduction to Biomedical Technology **100% online course**

- Patient Care and Advanced Technology courses combined into one seven (7) month course
- Healthcare environment; review of the human body and technical principles; intensive care equipment, imaging, surgical, laboratory, therapy, and clinical information systems
- 52 participants chosen through a very careful selection process

**MAIN TOPICS**

- Device principles
- Proper clinical application
- Patient safety

• Common device/technique problems and resolution
• Care, maintenance, and quality assurance
• Technology management

**Spanish version:**

- 252 applications
- 34 selected
- Participants from 20 countries:
  - Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, Uruguay and Venezuela.

**English version:**

- 47 applications
- 19 selected
- Participants from 9 countries:
  - Anguilla, Antigua y Barbuda, Barbados, Bahamas, Belize, Dominica, Guyana, Saint Vincent & the Grenadines and Trinidad & Tobago.
PAHO Virtual Campus for Public Health: Healthcare Technology Planning & Management course

- Teaches best practices to follow over the healthcare technology life cycle
  - assessment, replacement, budgeting, acquisition, deployment, training, patient safety, compliance and maintenance
- English and Spanish versions
- Offered in 2015 and 2017
- 96 students have successfully completed the course
- Adult learners in healthcare
- High level of participant engagement on discussion forums
- Reports focus on countries projects and were of high quality
- 95% overall satisfaction

https://www.campusvirtualsp.org/en
Full scope of HTM Services

• International Medical Equipment Collaborative (IMEC)
  – Provides all equipment necessary for a suite, installs it, and trains staff
  – Transforming Communities Initiative
    • Goes beyond health
  – “Holistic” services

• earthMed
  – To improve medical care in developing countries through medical program development, education, direct patient care, diagnostic support, medical device donations, medical supply donations, and community outreach support with the support of medical volunteers.
Mobile hospitals: Ships, Planes...

• Mercy Ships
  – increase access to healthcare
  – the world’s largest, private hospital ship

• Orbis Flying Eye Hospital
  – a fully equipped mobile teaching hospital aboard an MD-10 aircraft.
  – In 2015, Orbis “enhanced the skills of more than 30,326 eye care professionals, and conducted over 2.13 million screenings/examinations on adults and children around the world,”
University of Vermont: Clinical Outreach

- Imaging the World
  - Kristen DeStigter, MD
- General Surgery in Guatemala
  - Wally Elliott, CCE
- TeamHeart
  - Jean Roberts, CBET
BME university partnerships

- Northwestern – Univ. of Cape Town
  - Develop innovative devices to improve the health in Africa
- Duke University
  - Robert Malkin
- Rice University
- Univ. of Vermont partners
  - PUCP (Peru)
  - EIA & SB (Colombia)
  - UWI (Trinidad & Tobago)
  - Internships
  - Health system projects
UVM International Clinical Engineering Internships

Purpose – To provide orientation, training and mentoring of engineering students in the area of healthcare technology management to allow them to begin a career in clinical engineering.

Arrangement – Paid by the hour; responsible for all expenses

• Week 1: Orientation to Vermont program and the clinical engineering field
• Weeks 2-4: Training by Certified Clinical Engineers, online course & readings with written and oral examinations
• Weeks 5-25: Weekly oral and written assessment of student learning

➢ Clinical engineering internship
  o 4 weeks hands-on, QA & maintenance
  o Assist staff clinical engineers in completion of consultation, investigative, and planning work
  o Database orientated projects, e.g. medical device cybersecurity, research end-of-support, purchase price, optimum PM schedule, other as required
  o Other projects as needed, e.g. educational product development, website programming, instrument development

• Week 26: Final report, evaluation, and celebration of achievement

International CE Intern Slideshow
MoH/national health leader HTM training

• Audience
  – Ministry of Health
  – Leaders of other public & private health systems
  – Clinicians
  – HT managers
  – BME/CE
  – Academics
  – Regulatory

• Sponsors
  – WHO/PAHO
  – NGOs
  – Universities
Peru: 2012 ACEW Lima Synopsis

• Proposals
  • Creation of vice health ministry level healthcare technology assessment (HTA) position
  • Streamline and organize national HTM processes
  • Planning for equipment by multidisciplinary team
  • Combined proposal to MoH from multiple universities
  • Improve focus on informatics and digital health
MoH/national health leader training

• Make it engaging!
  – Case studies related to country’s reality
  – Role play
    • India – healthcare delivery
    • Colombia – regulatory, clinical, & industry interaction
  – Entertainment
    • Post earthquake!
Robert Morris: Humanitarian

• Bob Morris
  – Epitomizes humanitarian values
  – Equally comfortable troubleshooting equipment and talking up the value of HTM with the minister of health

• AAMI/ACCE Robert Morris Humanitarian Award
  – Rob Dickinson 2018 winner
  – Awarded since 2001
University of Vermont

- Founded 1791
- Enrollment/Faculty
  - Undergraduate: 10,081
  - Graduate: 1,360
  - Medical: 457
  - 1,196 full-time and 319 part-time faculty
- Research funding: $125 million
- Biomedical Engineering
  - BS, MS, PhD
Technical Services Partnership (TSP)

Healthcare Technology Management

- Non-profit, shared service group 1973 to the present
- 31 hospitals and 400 healthcare sites in 3 states
- ~75,000 medical devices
- 52 Clinical Engineers and BMETS
Organizational Scope

Health Care Technology Life Cycle

Planning
- Budgeting
- Acquisition
- Assessment
- Replacement

Management
- Education
- Compliance
- Safety
- Maintenance

Data Collection & Analysis

Deployment

Outcomes

Request

Disposal

Copyright
Univ of Vermont
WHO Collaborating Center

- History of contributions to WHO and world health
- Recommendation from regional office
  - Pan American Health Organization (Americas)
- Application
  - No conflicts of interest
  - Work plan over 3 year term in alignment with regional and international health technology goals
- WHO/PAHO review (6 months to 2 years!)
- Designation
  - Funding not part of designation but helps to procure grants
- Annual reports on progress related to work plan
- Renewal every 3-4 years
TSP/UVM
WHO Collaborating Center

Terms of Reference:

1. In agreement with WHO/PAHO, to develop and conduct virtual, online educational courses on healthcare technology

2. In agreement with WHO/PAHO, to develop and conduct healthcare technology management and technical services training

3. In agreement with WHO/PAHO, to develop documents and reports on healthcare technology management topics

Only collaborating center for HTM in the USA

http://www.who.int/medical_devices/collaborations/en/
Global Humanitarian Work

• Focus on those in need – the developing world especially lower income countries
• If equipment donation, collaborate with receivers to see if it is needed, potential roadblocks, and the equipment is sustainable
• Funding is critical – difficult to sustain a charity without funding
• Benefits (*Ismael Cordero*)
  – Exposure to challenging new problems.
  – Exposure to new lands, cultures, and customs.
  – A chance to learn new skills.
  – A chance to learn from others.
  – A chance to see things from a different perspective.
  – A chance to teach.
• Volunteerism can be a gift to the world!
  – *Show your altruistic self!*
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- Volunteering: A Unique Way to Enhance Your Skills, July/August 2008
- Biomeds Find Their Volunteer Spirit at Home and Abroad, September/October 2010
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Thank you