Clinical Engineering/Health Technology Management 2015 Global Update

By T Judd,1 A Hernandez,2 W Gentles,3 and S Calil4

1IFMBE CED Secretary, ACCE, USA.
2WHO-PAHO / Former Senior Advisor Health Technology (HT), ACCE IC Chair, USA.
3BT Medical Technology Consulting / Past President, CMBES, ACCE, Canada.
4CEB-FEEC – UNICAMP / Professor, IFMBE CED Past Chairman, Brazil.

ABSTRACT

Medical device systems Clinical Engineering (CE)/Health Technology Management (HTM) strategies and best practices are now well established in most first world and many developing countries (DC).

Progress is being made to address identified gaps in DC CE/HTM, such as appropriate equipment selection and lifecycle management. One contributor to this progress is the 25 years of CE/HTM Seminars provided by WHO-PAHO, ACCE, and more recently, IFMBE CED, to 80 countries. There is also a new emerging challenge; the requirement for medical device (clinical data) integration (MDI) into electronic health records (EHRs) to improve care quality and safety (aka CE-IT).

This study will review CE/HTM progress, gaps, and new challenges since the last study in 2011. It will provide a framework to direct the global CE/HTM movement forward in collaborative fashion, alongside other initiatives in 2015, such as the 1st International CE-HTM Congress and the Global CE Summit held in Hanzhou, China, in October, 2015.

Keywords: Clinical Engineering, Health Technology Management, CE, HTM, CE/HTM seminars, medical device lifecycle management, CE education, CE-Information Technology (CE-IT), medical device integration, IFMBE CE Division.

INTRODUCTION

“In the 1980s, it became clear to the World Health Organization (WHO), academia, and various global non-government organizations (NGOs) that there were many failed medical device technology transfer projects in the previous 2 decades, resulting in a large amount of inoperable sophisticated equipment and unmet healthcare needs in spite of significant financial investment.”

“In 1988, WHO organized a virtual international roundtable with input from experts around the world and published the discussion in World Health Forum.2 The roundtable not only confirmed the 2 challenges identified earlier – acquisition planning and maintenance, but also pointed out fundamental underlying issues. First and foremost is the fact that unlike drugs and vaccines, medical equipment requires continual outlay of funds, on order of 6–15% of original acquisition price, for the life of equipment, often up to 10–20 years after acquisition.1 Thus, it is useless for NGOs and financing organizations to provide equipment donations or investment loans if the recipient countries cannot pay for recurrent expenses,
even if adequate planning and maintenance are available. Another serious deficiency is the lack of a framework for proper HTM in most developing countries. Without a framework defined and supported by policies, procedures, defined responsibilities, and earmarked resources for HTM, it is difficult to perform technology planning in harmony with the country’s health policies and priorities, ensure appropriate human and material resources necessary to operate the equipment, and maintain it in safe and operational conditions.\textsuperscript{1}

\section*{Definitions and Context}

\textbf{Definitions}

\textit{Health Technologies (HT)}: The term refers to the application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures & systems developed to solve a health problem and improve quality of lives.\textsuperscript{3}

\textit{Clinical Engineer}: A Clinical Engineer (CE) is a professional who supports and advances patient care applying engineering and managerial skills to health care technology. (Sometimes also referred to as a Biomedical Engineer [BME].)\textsuperscript{4}

\textit{Health Technology Management (HTM)}: For USA CE certification, defined by the ACCE Body of Knowledge survey of CE practitioners, HTM is broadly defined as “lifecycle management of medical devices and systems.”\textsuperscript{5}

\textbf{Context and Key Acronyms}

The main elements of developing country HTM and its key health system relationships are outlined in Figure 1.\textsuperscript{1}

The 60\textsuperscript{th} World Health Assembly, convened by WHO in 2007, passed the Resolution WHA60.29 relating to Health Technologies.\textsuperscript{6} This resolution urges Member States:

1. “to collect, verify, update and exchange information on \textit{health technologies (HT)}; in particular medical devices as an aid to prioritization of needs and allocation of resources”;

2. “to formulate as appropriate national, strategies and plans for the establishment of systems for the assessment, planning, procurement and HT management in particular medical devices, in collaboration with
personnel involved in health technology assessment (HTA) and biomedical engineering (BME);

3. “to draw up national or regional guidelines for good manufacturing and regulatory practices, to establish surveillance systems and other measures to ensure the quality, (risk,) safety and efficacy of devices and where appropriate participate in international harmonization” (HTR, Risk & Safety or R&S);

4. “to establish where necessary national and regional institutions of health technology, and to collaborate and build partnerships with health care providers, industry, patients’ associations and professional, scientific and technical organizations;” (e.g., MOH HT units); and

5. “to collect information that interrelates medical devices which deal with priority public health conditions at different levels of care and in various settings and environments, with the required infrastructure, procedures and reference tools;” (to improve Maternal Child Health (MCH), such as HT improving MCH care outcomes).

To illustrate these points, we include a figure from our previous article, which is a graphical representation of the main elements of Health Technology Management, and how it relates to other areas of the health system (see Figure 1).

As a capital investment, equipment needs to be managed from deployment (strategic planning, acquisition, installation / acceptance) until retirement, guided by a country’s health technology policy (HTP).

During its useful life, proper maintenance and management are essential to ensure safe, efficient, and cost-effective patient care. Often neglected, feedback provided by users and maintainers is essential to continually improve HTM within the country or system, and avoid mistakes made previously.

HTM is intimately related to but distinct from health technology regulation (HTR, and Risk & Safety), as the latter is focused on safety and efficacy, with little concern on costs and management challenges.

Health Technology Assessment (HTA) is a multidisciplinary process that summarizes information about the medical, social, economic and ethical issues related to the use of a health technology in a systematic, transparent, unbiased, robust manner. Its aim is to inform the formulation of safe, effective, health policies that are patient focused and seek to achieve best value. Despite its policy goals, HTA must always be firmly rooted in research and the scientific method. HTA provides the foundation for successful planning and subsequent use of health technologies.

HTM GAPS AND PROGRESS

Earlier HTM Study: Our prior article described progress in HTM in 51 countries, including Africa (11 countries) Asia (11 countries), Latin America & the Caribbean (19 countries), and other (10 countries). In that article, the following gaps in HTM were identified:

- A lack of competent staff (Human Resource development - HR)
- Limited access to technical documentation & spare parts (HTM)
- Poor planning and lack of commitment (HTM)
- Irrational HT incorporation and deployment (HTM)
- Limited influence with decision makers (e.g., <10 countries then had designated Ministry of Health, Health Technology- HT Units)
- Donations provided that do not align with Ministry of Health (MOH) priorities

In addition, the article identified the following root causes of HTM challenges:

- Lack of: training to develop human resources-HR; experience; awareness; and influence with decision makers regarding HTM
- Equipment is often considered a status symbol instead of a service production tool
- Greed and short-sightedness of manufacturers and distributors
- Selfishness of some “aid,” “cooperation,” and “donation” programs that are actual sales-promoting schemes or publicity stunts
- Lack of vision and courage among HTM professionals
Global HTM Seminars: Further progress in HTM has been documented in a series of Seminars presented from 1991-2015 by ACCE and WHO-PAHO.\(^8\) As a result of these seminars, progress was seen in the following areas (with aggregate evidence noted below summarized):

- HT Policy (HTP) developed, e.g., in 27 of 51 countries (>50%)
- HTM training provided (HR), e.g., 40+ of 51 countries (>80%)
- National professional societies created; e.g., in 20 of 51 (~40%)

WHO Global Forums: Further progress in HTM was documented in the WHO 2\(^{nd}\) Global Forum on Medical Devices, 2013 (2GFMD).\(^9\) This progress was documented in a series of country reports presented at the Forum, and is summarized in the following tables (Tables 1A-D).

The 2013 WHO 2\(^{nd}\) Global Forum provided an important update on the information presented in our prior paper.\(^1\) We now see indications of further progress.

Africa (20 countries)
- HTM programs have doubled in the region.
  - Increased NGO HTM involvement has helped, such as, THET-Zambia, MRC-Gambia, and CMBES-Ghana.
  - Increasing HT involvement with MOH decision makers.
  - Growing HTA and HTR initiatives.
  - Earlier HTM programs now aggressively pursuing MCH.
  - Limited CE-IT initiatives.

Asia (13 countries)
- Big 3: strong national programs in China, Japan, and India.
  - MOH Unit in India comprehensively addressing HT.
  - Continued growth of Japan and its national CE society.
  - Rapid growth of China CEs, societies, & certification.
- Countries with prior HTM (2011) pursuing HTA and HTR.
  - Increasing involvement with MOH decision makers.
  - Limited CE-IT initiatives other than Big 3.

Latin & Central America (12 countries)
- PAHO investment in HTM and HR training anchored in academia.
  - Freeing MOHs to work on HTA and HTR.
  - Big 4: historical HT strength of Brazil & Mexico + Colombia & Peru.
    - Brazil largest CE base; very multidisciplinary approach.
    - Mexico MOH Unit; wide-ranging with decision makers.
    - Colombia (strong HT history; introduced IHE to Region); & Peru (developed MOH Unit, key academia partnerships).

Others (26 countries)
- Group with extensive capabilities along HT continuum.
  - Most have mature HTM & are pursuing HTA & HTR.
  - Several key HTM contributors in region and or globally.
  - Also among global leaders for CE-IT and MCH.

2015 HTM Seminar: In June 2015 another major HTM Seminar was organized by ACCE in collaboration with WHO-PAHO, with 32 HTM leaders from 22 countries represented, and one USA NGO.\(^10\) Table 2 lists the participants in this seminar, and their affiliations.

This table illustrates the following indications of progress: HT units now more frequently created at MOH level (15/22 countries) and HTM leaders are emerging with increasing influence at the MOH level.

Table 3 summarizes the gains and challenges in HTM, HTA, HTR, and CE-IT that were reported at the seminar.

The following detail the gains and challenges identified at the 2015 HTM seminar:

Africa (5 countries reporting)
- Tend to have established HTM, but need HR, HTP, and HTR

Asia (3 countries reporting)
- Rapid growth HT capabilities for 2 high population countries
  - India MOH HT Unit leading country-wide initiatives
  - Bangladesh increasing scope of HT work

Latin & Central America (8 countries reporting)
- Two in early stages of HTM; most mature pursuing CE-IT
  - Mexico MOH HT Unit (CENETEC) a global best practice
  - Most countries also need MOH HTP and HTR
**TABLE 1A. Africa – 20 Countries/Entities Presented at 2GFMD**

| Country          | Major Accomplishments | References                              |
|------------------|-----------------------|-----------------------------------------|
| AFRO-WHO         | HTM                   | Ndihokubwayo (AFRO), 2013               |
| Benin            | HTM                   | Adjaratou et al (MOH), 2013             |
| Burkina Faso     | HTM                   | Emmanuel et al (MOH), 2013             |
| Cameroon         | HTM, CE-IT            | Ngaleu-Toko et al, 2013                 |
| Cote D’Ivoire   | HTM                   | YriéUDenis (MOH), 2013                  |
| Ethiopia         | HTM, MCH              | Mulegeta et al (MOH), 2013              |
| The Gambia       | HTM, MCH              | Nyassi et al, Faye et al, 2013          |
| Ghana            | HTM, HR, HTA, MCH     | Adjabu, THET & MOH, 2013                |
| Kenya            | HTM, HR, HTA, HTR, MCH| Owino, Anyango, Mwaru et al (MOH), 2013 |
| Malawi           | MCH                   | Mwanza et al (MOH), 2013                |
| Nigeria          | HTM, HTR, MCH         | Ilonze et al (MOH), Fatunde, 2013       |
| RSA              | HTM, HTA, HTR         | Poluta, Khalaf et al, Mueller, 2013     |
| Rwanda           | HTM                   | Mukama et al (MOH), 2013                |
| Senegal          | HTM                   | Sow et al (MOH), 2013                   |
| Sierra Leone     | HTM                   | Kabia (MOH), 2013                      |
| South Sudan      | HTA                   | Lilford et al, 2013                     |
| Tanzania         | HTR, MCH              | Kijo et al (MOH), 2013                  |
| Togo             | HTM, MCH              | Tsolenyana et al (NGO), 2013            |
| Uganda           | HTM, HR, HTA, MCH     | Wanda et al (MOH), Ssekitoleko et al, 2013 |
| Zambia           | HTM, MCH              | Mullally, Machbani, Musiwa (MOH), 2013  |

**Other (2 countries reporting)**

- Albania HT Unit a global best practice for small countries

**WHO**

- WHO desires the following global Surveys in 2016:
  - Value of Donations, e.g., percent implemented and in use
  - Number BMETs needed at country level, for MOH plans
  - HTM outcome measures; influence MOH decision makers
- WHO facilitating BME/CE global recognition in 2018 by ILO
- Causing WHO to annually track key CE/HTM measures

The 2015 Seminar Participant Recommendations were:

1. *Increase Awareness of CE/HTM Influence on HT Policy*
   - WHO can assist countries to develop/implement HT policies
2. *Communicate global HTM point of view to help countries*
   - How to address when government not involved in HTM
**TABLE 1B. Asia - 13**

| Country     | HTM, HTA, HTR, CE-IT, HTP | Authors and Year |
|-------------|---------------------------|------------------|
| Bangladesh  | HTM, HTA, HTR             | Hasan, Rabbani et al (MOH), 2013 |
| China       | HTM, HTA, HTR, CE-IT      | Zhong et al, 2013 |
| India       | HTM, HTA, HTR, CE-IT, MCH | Sharma et al (MOH), Khambete et al, 2013 |
| Japan       | HTM, HR, HTA, HTR, HTP, CE-IT | Fukuta (MOH), Nakazaki, Sugiura, 2013 |
| Korea       | HTA                       | Hwang et al, 2013 |
| Laos        | HTM                       | Insal (MOH), 2013 |
| Malaysia    | HTR                       | Rahman (MOH), 2013 |
| Myanmar     | HTM                       | Lin (MOH), 2013 |
| Philippines | CE-IT                     | Mojica et al, 2013 |
| Singapore   | HR, HTR, HTA              | Goh et al (MOH), 2013 |
| Sri Lanka   | HTA                       | Galappatthy et al (MOH), 2013 |
| Thailand    | HTA                       | Tantivess, Wibulpolprasert (MOH), 2013 |
| Vietnam     | HTM, MCH                  | Dajer, 2013 |

**TABLE 1C. Latin & Central America - 12**

| Country     | HTM, HR, HTA, HTR, HTP, R&S | Authors and Year |
|-------------|-----------------------------|------------------|
| Argentina   | HTM                         | Giles et al, 2013 |
| Bolivia     | HTM                         | Urioste (MOH), 2013 |
| Brazil      | HTM, HR, HTA, HTR, HTP      | Garcia, Calil, Conto (MOH), 2013 |
| Colombia    | HTM, CE-IT                  | Quintero, Hernandez, Castaneda, 2013 |
| Chile       | HTA                         | Duarte et al, 2013 |
| Cuba        | HTR                         | Pereira et al (MOH), 2011 |
| Ecuador     | CE-IT                       | Silva et al, 2013 |
| Haiti       | HTM                         | Judd et al, 2013 |
| Mexico      | HTM, HTA, HTR, HTP          | Cardenas, Moreno (CENETEC) 2013 |
| PAHO-WHO    | HTM, HTA                    | Lemgruber, Jimenez, 2013 |
| Peru        | HTM, HTA, HTR               | Rivas et al, Pinedo, 2013 |
| Uruguay     | HTP, HTA                    | Galan et al (MOH), 2013 |
| Country       | Organization | Authors/Year                        |
|--------------|--------------|------------------------------------|
| Australia    | HTA, HTR, CE-IT | Babige, Kearney, Tang, McEwan 2013 |
| Belgium      | HTM, HTR      | Demade, Bogg, Merlevede 2013        |
| Bulgaria     | HTA           | Dimitrova (MOH), 2013               |
| Croatia      | HR            | Magiarevic, 2013                    |
| Egypt        | HTA           | Salem, ElSaadany (MOH), 2013        |
| EWH          | HTM           | Malkin, 2013                        |
| EURO-WHO     | HTA, CE-IT    | Pedersen et al (EURO), Kulkarni, 2013 |
| Greece       | HTM, HTP, R&S | Pallikarakis, Stavrianou, 2013      |
| Hungary      | HTA           | Szacsky, 2013                       |
| Israel       | MCH           | Mayaan, 2013                        |
| Italy        | HTM, HTA, CE-IT | Iadanza, Pecchia, Musi, 2013       |
| Jordan       | HTM           | Rahim, Dalou, 2013                  |
| Kuwait        | HR, HTR       | Alzawadhi, 2013                     |
| KSA          | HTA, HTR, CE-IT | Hassanan, Al Tayyar, 2013           |
| Laerdal      | MCH           | Laerdal et al, 2013                 |
| Lebanon      | HTA           | Rihana, 2013                        |
| Netherlands  | HR, HTA       | Hurts/Hansen (MOH), Linnenbank, 2013 |
| Norway       | HTA           | Lauvrak et al, 2013                 |
| Portugal     | HR, HTA, HTR  | Secca, Da Silva, Madureira et al, 2013 |
| Slovakia     | HTA           | Jadud (MOH), 2013                   |
| Spain        | HTA, CE-IT    | Falcon et al, 2013                  |
| Switzerland  | HTM, HTR      | Zaugg, Werlein, Voelksen, 2013      |
| Tunisia      | CE-IT         | Ouhichi, 2013                       |
| Turkey       | HTM, HTA, HTR, R&S | Copur, Demirbas, Turgut/Kuru, Ozturk, 2013 |
| UK           | HTM, HTR, R&S | Murray/Gammie/Wasmuth/McNerney 2013 |
| Yemen        | HTA           | Mujamal (MOH) et al, 2013           |
TABLE 2. 2015 HTM Seminar Participants

| Country           | Position                                      |
|-------------------|-----------------------------------------------|
| Albania           | MOH Health Technology (HT) Director           |
| Argentina         | MOH HT Coordinator                            |
| Argentina         | Private Hospital CE Director                  |
| Australia / Egypt | WHO BME Intern                                |
| Bangladesh        | University BME Professor                      |
| Bangladesh        | University BME graduate student               |
| Bhutan            | MOH Director HT Unit                          |
| Botswana          | MOH Regional HT Director                      |
| Brazil            | MOH HT Manager                                |
| Brazil            | Private CE Company COO                        |
| Canada            | WHO BME Intern                                |
| Colombia          | MOH Director HT Unit                          |
| Colombia          | MOH Laboratory CE Director                    |
| Cuba              | MOH Hospital CE                               |
| Ethiopia          | MOH BME Advisor                               |
| Haiti             | National Hospital CE Director                 |
| Haiti / USA       | Medical Device Consultant                     |
| India             | MOH WHO HT Center Director                    |
| India             | MOH Consultant                                |
| Kenya             | MOH Hospital CE                               |
| Kosovo            | Telecommunications Engineer                   |
| Mexico            | MOH Hospital Coordinator                      |
| Mexico            | University CE Professor                       |
| Mexico            | University CE Professor                       |
| Nigeria           | MOH Director HT Unit                          |
| Peru              | MOH Consultant, University CE Professor        |
| Sierra Leone/USA  | University CE Professor                       |
| Suriname          | MOH Hospital CE Director                      |
| Uganda            | MOH Director HT Unit                          |
| Uganda            | MOH Senior BME                                |
| USA               | NGO BME Leader                                |

- How to enable, using resources & influence to help drive HTM
- WHO needs data from specific case studies to better assist

3. Develop Regional Training Centers (RTC) – Improves HR & HTM
   - Need Key HTM Process Standardization
   - Lessons learned to be applied: (1) create RTC for maintenance; (2) Training that is university-based is more sustainable
   - Incorporate CE/HTM in health care clinical & business courses, such as for physicians and health administrators
   - Share different methods of risk management across countries

4. Develop standard medical equipment procurement documents
   - Incorporate Life Cycle Cost (LCC) Analysis, as World Bank has done for Information and Communication Technologies
   - Make use of WHO resources on Device Specifications
   - Consider central/national Public-Private-Partnership (PPP)

5. Consider how to best facilitate “our group” ongoing communications and networking – e.g., INFRATECH and WHO Listservs

6. Maintenance Management
   - Need inventory management system on line with history (CMMS); such as, basic inventory, then layers
   - India is working on a national CMMS that can be made available on line for free

7. WHO & Medical Equipment Manufacturers
   - How to improve interactions?
   - WHO: Has created a Forum for manufacturers

8. Improve Domestic production of Medical Devices
   - Affects HTM, making best use of Technology Transfer

9. Organize professional societies to extend influence
   - Many benefits to join locally, nationally, regionally, globally
TABLE 3. Summary of Participant Gains/Challenges [A-Y]

| Country (Pop. in M) | Key Gains                  | Key Challenges |
|---------------------|----------------------------|----------------|
| Albania (2.9)       | HTM, HTP, HTR              | HR, CE-IT      |
| Argentina (43)      | HTM, CE-IT                 |                |
| Bangladesh (157)    | HTM, HTA, HTP, CE-IT       | HR             |
| Bhutan (0.74)       | HTM, HTA                   | HR, HTP, HTR   |
| Botswana (2.2)      | HTM                        | HR, HTP, HTR   |
| Brazil (202)        | HTM, CE-IT                 |                |
| Colombia (48)       | HTM, CE-IT                 | HTP, HTR       |
| Cuba (11)           | HTM, HR                    | CE-IT          |
| Ethiopia (92)       | HTM, HTP                   | Wider HTP, HTR |
| Haiti (10)          | HTM                        | HR, HTP, HTR   |
| India (1,250)       | HTM, HTA, HTP, CE-IT       | Wider CE-IT    |
| Kenya (44)          | HTM, HR                    | HTP, HTR       |
| Kosovo (1.9)        | HTM, CE-IT                 | HR, HTP, HTR   |
| Mexico (122)        | HTM, HR, HTP, HTA, HTR, CE-IT | Wider CE-IT |
| Nigeria (140)       | HTM                        | HR, HTP, HTR   |
| Peru (30)           | HTM, HR, CE-IT             | HTP, HTR       |
| Suriname (0.57)     | HTM                        | HR, HTP, HTR   |
| Uganda (40)         | HTM                        | HR, HTP, HTR   |

CASE STUDIES / SUCCESS STORIES

Ghana

Improved HTM and HR: In 2009, 2 HTM Seminars were organized by ACCE in collaboration with WHO, International Aid, and the Ghana Health Service. Essential HTM topics were covered. The curriculum for the HTM workshop was based on the WHO-adopted “How to Manage” series for HT. The seminars were well attended, with 135 at the first and 83 at the second. Participants identified a number of HTM challenges including: (1) A lack of training on HTM topics. (2) Inadequate tools and test equipment. (3) Poor availability of spare parts. (4) A lack of communication between government policy makers and HT stakeholders affected by policies (HTP).

This indicates a need for future seminars to include more content for government policy makers.

Results

Professional Society: At the conclusion of the second seminar, the attendees initiated the Ghana Biomedical Engineering Society (GBES). An email listserv was set up to facilitate communication among workshop attendees.

Global Partnerships: In addition, the faculty members from Canada initiated a formal partnership between the Canadian Medical and Biological Engineering Society (CMBES) and GBES. There is also opportunity for CMBES and GBES to partner more closely with WHO via regional African societies under development and through joint WHO and IFMME CED global initiatives.
The CMBES-GBES partnership has resulted in the successful application for a research grant to examine medical equipment donation practices in Canada, and the experiences of recipients of such donations in Ghana. Members of the 2 societies are in frequent communication. Such ongoing partnerships are considered an important factor in the strengthening of HTM programs.

**ALBANIA**

*Improved Access and HTM:* Before September 2014, MOH Albania had no maintenance strategy for its hospitals’ highest technology diagnostic equipment – linear accelerators, magnetic resonance imaging, computed tomography scanners and angiography – resulting in higher costs, significant downtime, and poor vendor relationships. They then implemented a new approach based on global best practices: full risk, 2-year service contracts via negotiation; vendor meetings to present our new approach and for authorized distributor confirmation; then open tender procedures for international participation, to avoid speculation of monopoly.

**MEXICO**

*Role Model:* Established MOH Unit in 2004, CENETEC; has become a global CE-HTM role model with countrywide HTP, HTM, HTA, HTR, HR, and Practice Guideline development.

**BRAZIL**

*First MOH Unit* – established at São Paulo state level in 1980s. Key leader in global HTP, HTM, HR, and CE-IT.

**FUTURE: 2015–2020**

What is needed for CE/HTM profession?\(^\text{10}\)

- **CE-IT:** need education for MDI seamlessly into EHRs\(^\text{7}\)
- Technical, Management, Leadership, Health IT (CE-IT) Standards, and Regulatory (HTR) framework
- Global Drivers: eHealth, Patient Safety & Risk Management, Medical Device Cybersecurity, Patient & Population Health Outcomes
- Clinical workflows: CE/HTM leaders provide improved design
- Leading edge initiatives: CE/HTM leading telehealth, smartphone/mHealth, in their countries and regions to improve quality, safety, access and affordability.
- Maternal and Child Health (MCH), e.g., Neonatal and Newborn Care, using WHO-vetted Evidence-Based Interventions & Practice Guidelines
- Influence: Stronger leaders, with wider impact on decision makers

**CONCLUSIONS**

This study showed steady improvements globally in most indicators for Health Technology. Health Technologies will play an increasing role in global health care delivery with the emerging spread of CE-IT (EHR-enabled care) to improve quality and continue to make care affordable.

**ACKNOWLEDGMENT**

The authors wish to acknowledge the invaluable contribution made by dozens of volunteers from less-developed countries who provided information and suggestions in various means. They also want to apologize to countries from which no information was obtained, mostly due to their limited knowledge of those countries and their key stakeholders.

**CONFLICT OF INTEREST**

The authors declare that they have no conflict of interest.

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APPENDIX

The following listing is the country-level presentations made during the 2015 HTM Seminar in Denver, CO USA, and Toronto, Canada. They can be obtained from the authors and or the presenters.

A. Picari L, Albania HTM Seminar Country Update, & MOH HT Unit Maintenance of Medical Devices (high technology systems), 2015
B. Giles G, Lencina M, Argentina HTM Country Update, 2015
C. Abir AR, Rabbani KS, Bangladesh HTM Seminar Country Update, 2015
D. Penjore T, Bhutan HTM Seminar Country Update, 2015
E. Thomelang B, Botswana HTM Seminar Country Update, 2015
F. Contó M, Katz Z, Brazil HTM Seminar Country Update, 2015
G. García Ibarra AR, Rojas Morales JM, Colombia HTM Seminar Country Update, 2015
H. Castro Medina J, Cuba HTM Seminar Country Update, 2015
I. Mideksa M, Ethiopia HTM Seminar Country Update, 2015
J. Valliere M, Chery J, Haiti HTM Seminar Country Update, 2015
K. Sharma Dr. JK, Arora P, India HTM Seminar Country Update, 2015
L. Anyango Amoko P, Kenya HTM Seminar Country Update, 2015
M. Abazi N, Kosso HTM Seminar Country Update, 2015
N. Cardenas Alanis C, Leon de Alba F, Orencio E, Moreno ME, Mexico HTM Seminar Country Update, 2015
O. Bukola E, Nigeria HTM Seminar Country Update, 2015
P. Rivas R, Peru HTM Seminar Country Update, 2015
Q. Jie G, Suriname HTM Seminar Country Update, 2015
R. Mulepo S, Edward K, Uganda HTM Seminar Country Update, 2015
S. Castañeda M, Business Opportunities in Health Technology Projects, 2015 (outcomes of August 2013 ACCE HT Seminar, Barranquilla, Colombia)
T. Clark T, Lemgruber A & Caccavo F (PAHO), Molina Velasquez T (Universidad CES Colombia), Graciá F (Universidad National Tech. Argentina), Rivas R & Vilcahuaman L, (Universidad PUCP Peru), Biomedical Technology Online Courses for the Americas, 2015
U. Hernandez A, Trends on IT and Health Technology (CE-IT), 2015
V. Painter F, Risk Management, 2015 (outline of device Risk & Safety issues)
W. Quintero Dr. V, IHE Colombia Crash Course on Interoperability (CE-IT), from Universidad Simón Bolívar, Barranquilla, Colombia, 2015
X. Sloane Dr. E, Medical Device and ICT Convergence (CE-IT), 2015
Y. European Network for Health Technology Assessment. Common Questions. What is Health Technology Assessment (HTA)? Accessed Dec. 1, 2015 at: http://www.eunethta.eu/about-us/faq#t287n73