Digital health in LMICs: Digitally enabled healthcare to improve clinical outcomes across WHO regions

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Overview

- Low-and-Middle-Income countries (LMICs) have fragmented resources and pressing needs
  - Digital health tools can help strengthen the health system and meet needs
- GCEA and Pul Alliance Partnership for Impact (MOU)
  - Aligning resources - people, processes and technology
  - Collaboration to transform health and care
  - Innovative models of care
- CEs have valuable skillsets that expand our scope of practice
  - How can CEs help drive use of Digital Health as change agents
- Call to Action
  - Workforce
  - Policy
  - Education

“More people have access to a mobile phone than to clean water, electricity or a toothbrush”

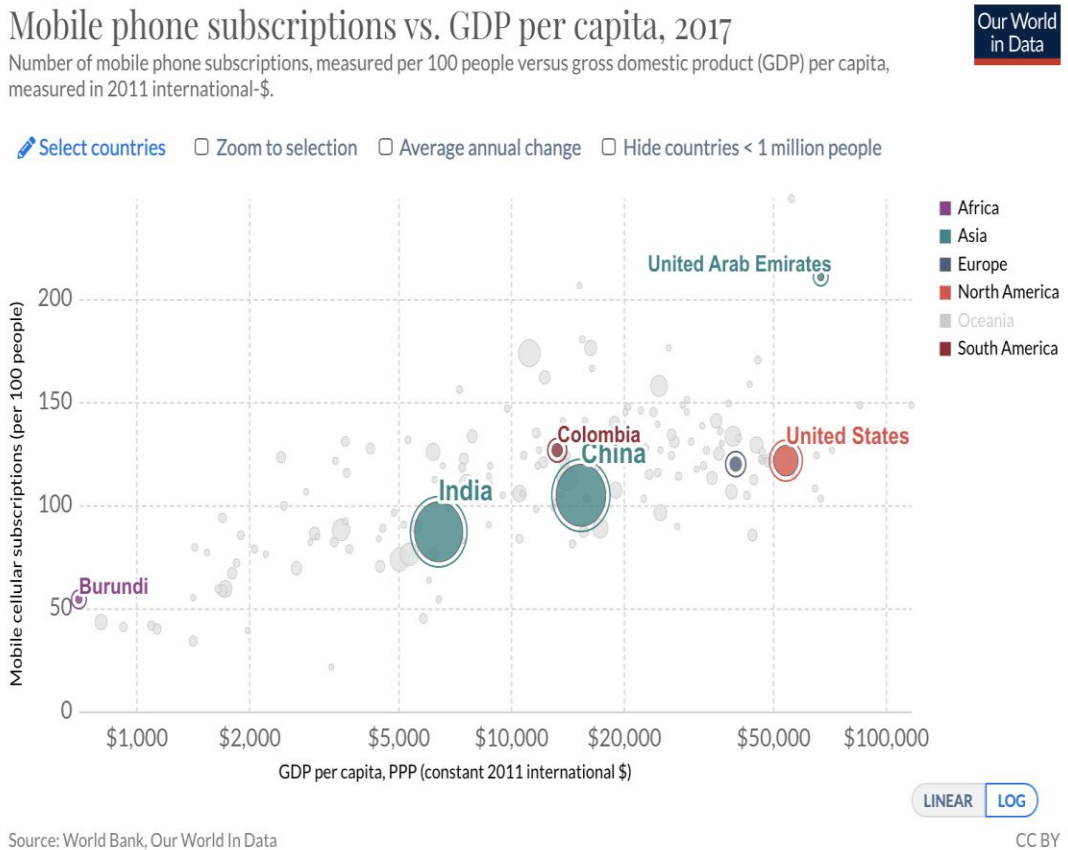
Closing the gap in Health Equity through Technology, Alliance for Health Promotion in collaboration with the ITU, WHO and the Global Health Programme at the Graduate Institute, Geneva Nov. 16, 2015

2022
in subscriptions per 100 people

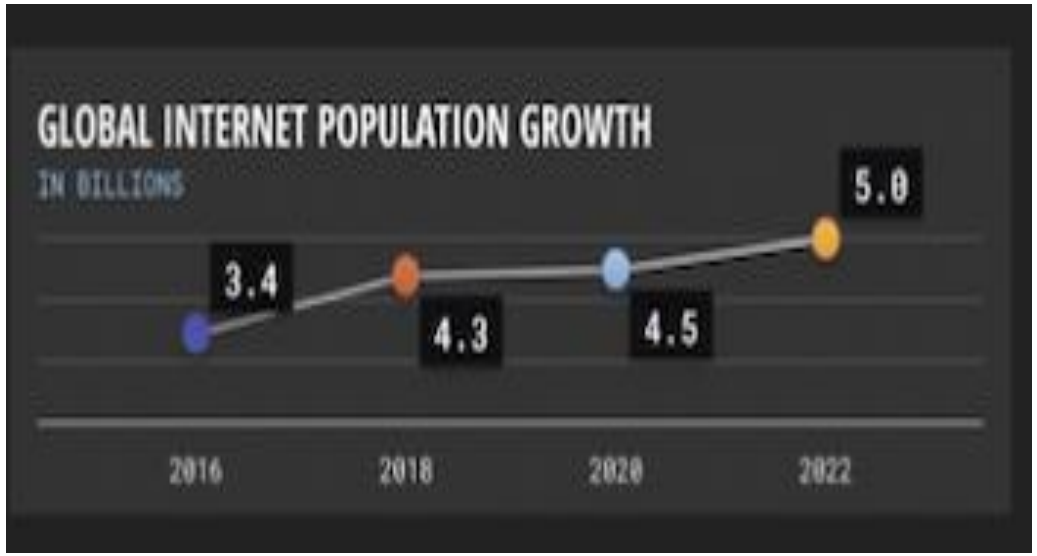
Colombia	155.8
China	124.9
Kenya	121.7
United Kingdom	120.8
United States	110.2
World	108.0
Zambia	99.1
India	80.6
Uganda	70.0
Burundi	58.0

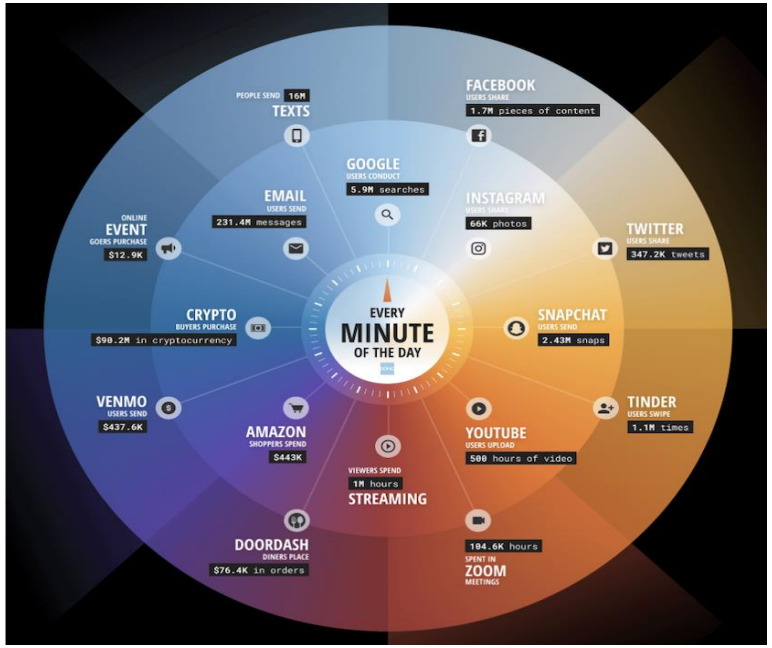
2022
in international-$ in 2017 prices

United States	$64,623
United Kingdom	$47,587
China	$18,188
World	$17,527
Colombia	$15,617
India	$7,112
Kenya	$4,882
Zambia	$3,366
Uganda	$2,280
Burundi	$708



Data is Pervasive… and Underutilized for Informed Decision Making

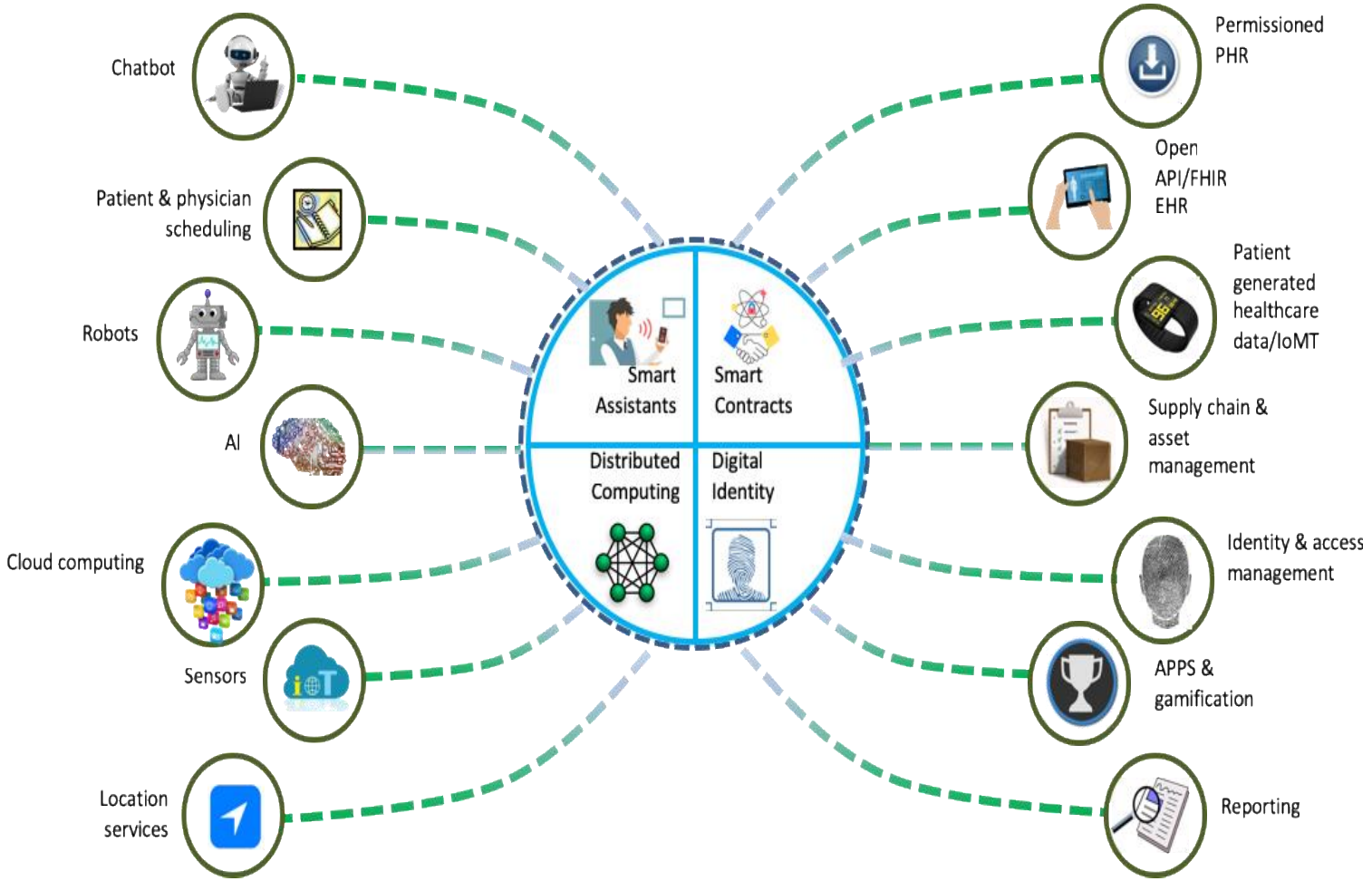




Healthcare Has Highest CAGR for Data: 36%

Notable Trends

- Increased Digital Consumption
- Consumerism
- Mobility
- Telehealth
- Wearables
- Precision Medicine



Safety and Quality: We have a lot of work ahead…

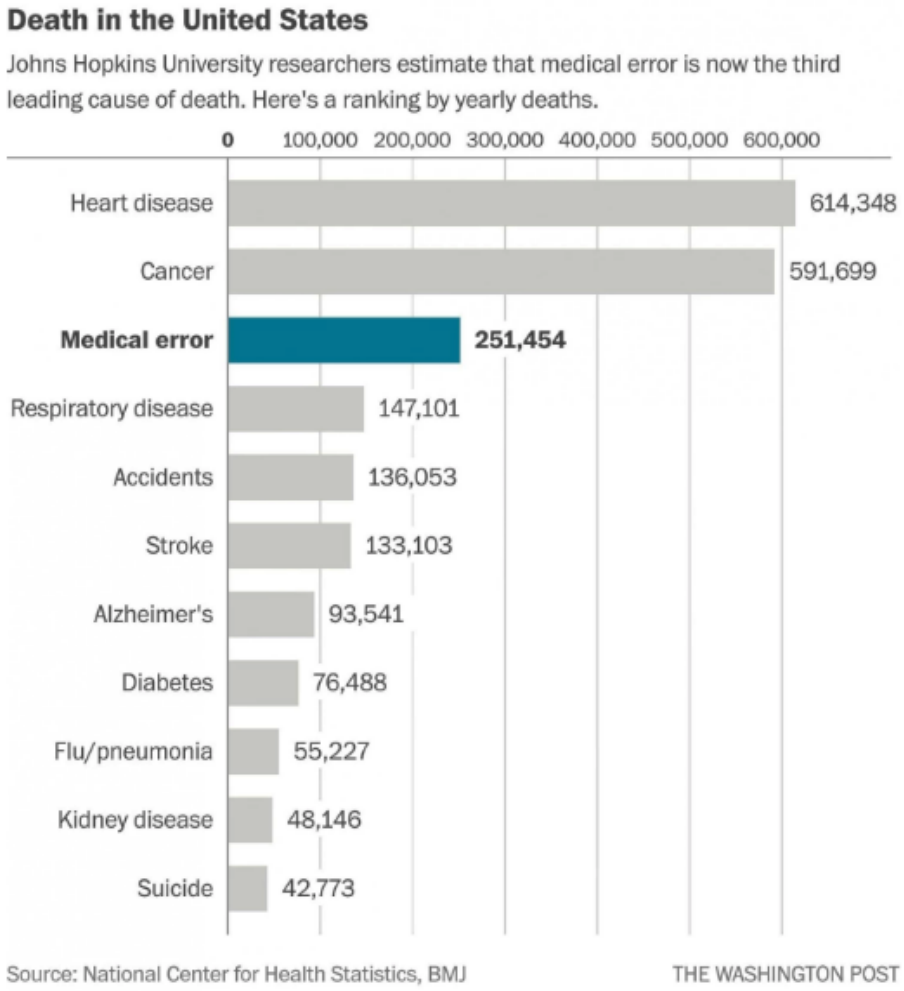
"1:10 admissions leads to an adverse event;
1:300 admissions leads to death"

World Health Organization

http://timesofindia.indiatimes.com/articleshow/8032059.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

"5.2M deaths annually due to medical errors in India"

"More than **43 million people are injured** worldwide each year due to unsafe medical care, according to a new study from ***Harvard School of Public Health*** (HSPH). These injuries result in the **loss of nearly 23 million years of "healthy" life."**



Workforce Shortages

- Global shortage:18M health professionals
- Upto **13M** of nurses will be needed to fill the global nurse shortage gap in the future
  - Existing deficits in nursing workforce plus retirement due to aging and **burnout**
  - 89% of these nurse shortages concentrated in LMIC
  - **76 countries** with less than 1 MD/1000
- **3 billion** people <u>without</u> access to a health professional

WHO, World Medical Association, ICN

Cost and Opportunity Costs

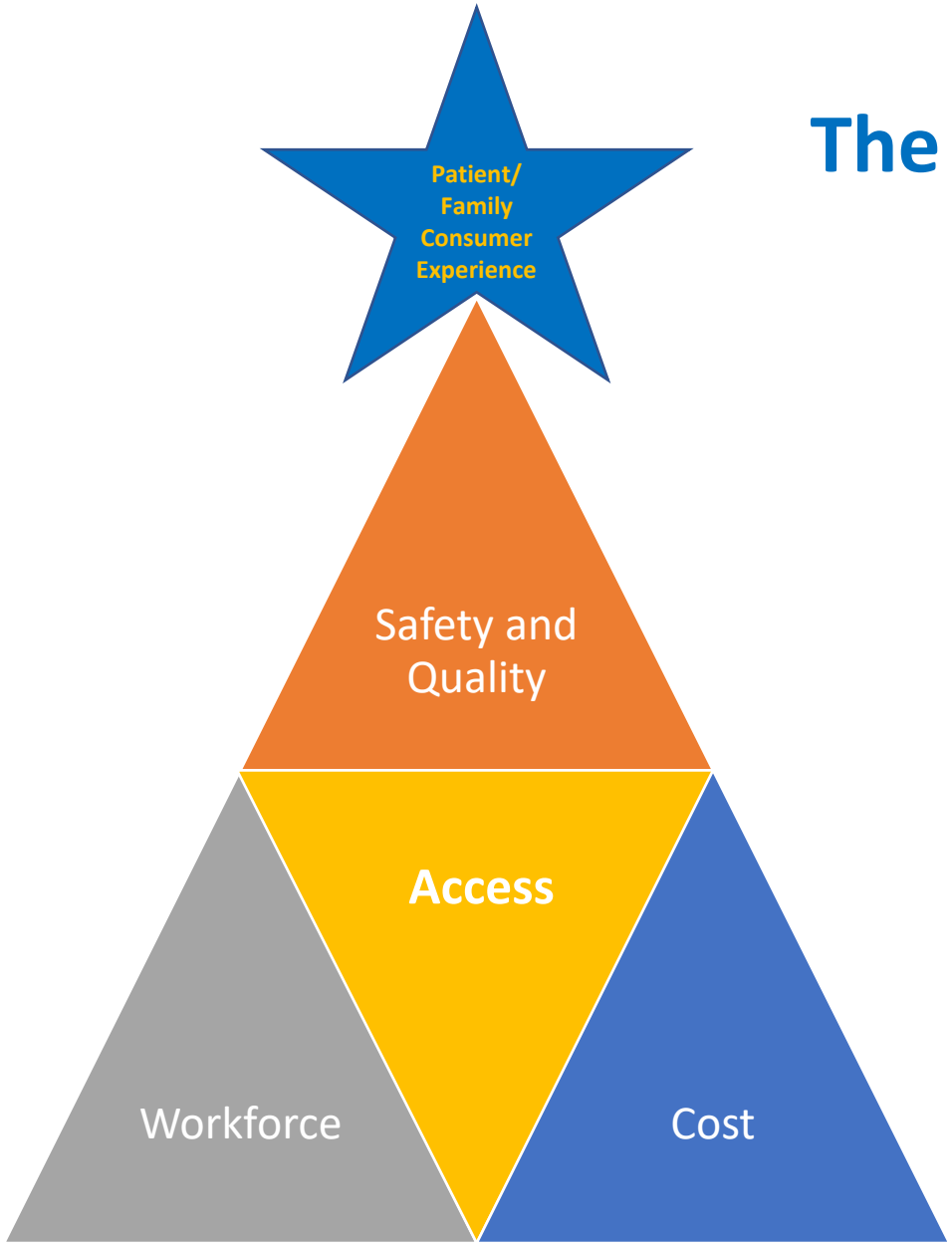
*Overall: **10%** of Global GDP*
(~$10 trillion, 2022)

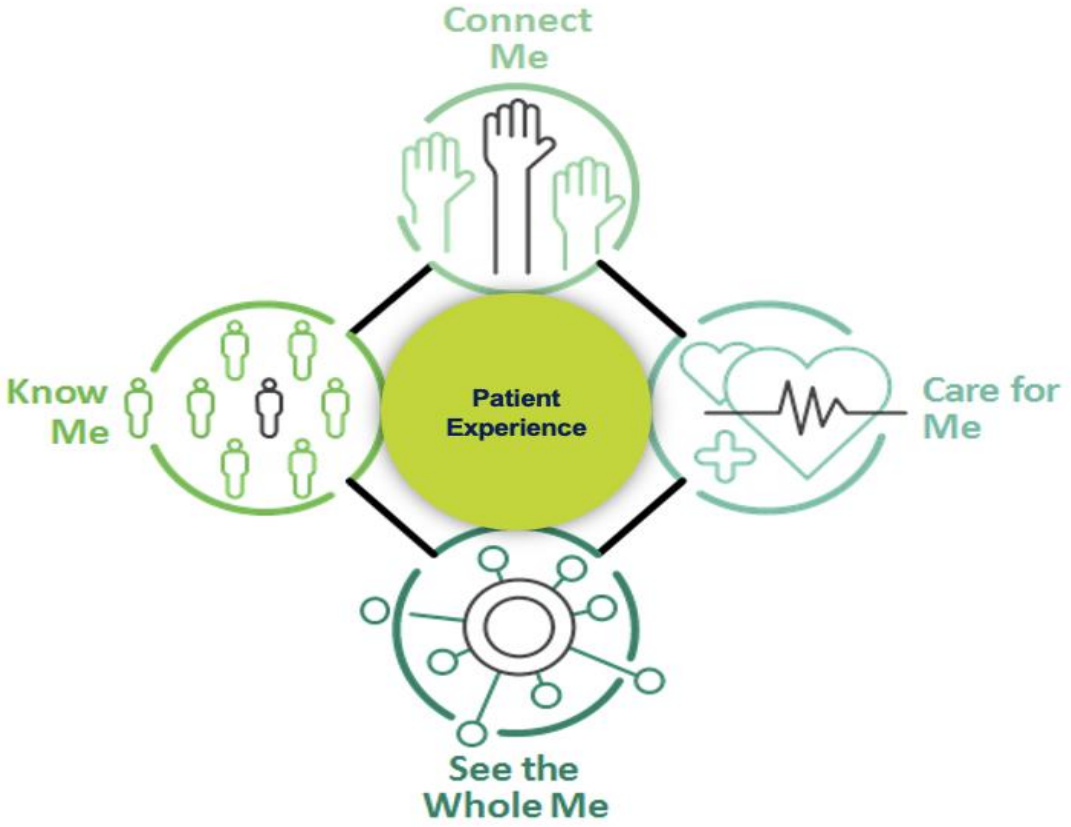
- *High Income countries: **14.02%***
- *LMIC: **5.61%***
- *China: **5.59%***
- *Colombia: **8.99%***
- *Ecuador: **8.48%***
- *India: **2.96%***
- *Zambia: **5.62%***

Up to 30% waste

JAMA 2019 Oct 15;322(15):1501-1509
doi: 10.1001/jama.2019.13978

The Perfect Healthcare System



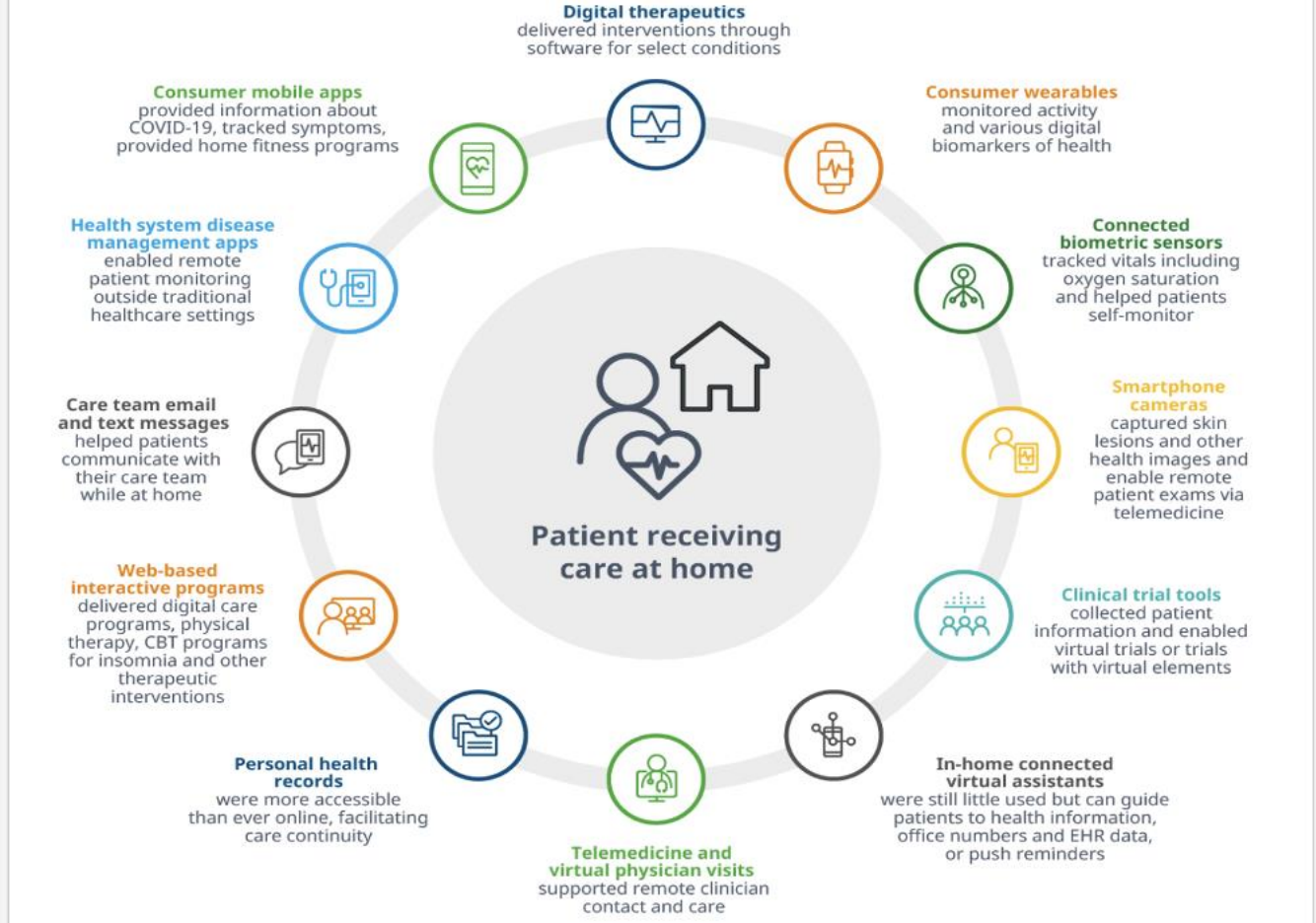


Build Trust with Patients

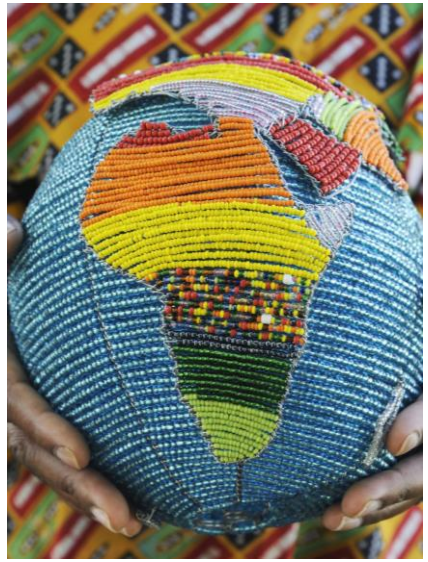
Our World is now different…

- Increasingly, we must do more with less
- Adapt to rapid, continuous change
- Digital penetration
- Consumerism

There is an accelerated the need for innovative models that leverage digital tools and technologies- to make **Access to Care easier and equitable**



Pul Alliance
DIGITAL HEALTH & EQUITY



Vision

Help create empowered, and resilient communities through “digital bridges” that lead to more equitable pathways for access to quality healthcare, educational opportunities and better livelihoods.

Mission

Strengthen frontline partner organizations globally that are serving to bridge disparities and inequities amongst the vulnerable.

Pul Alliance's integrated framework to build capacity and capability

Knowledge and Best Practices	Workforce Development	Digital Health and Medical Technology	Execution Management	Fundraising
• **Knowledge and Know How** • **Evidence and Best Practices** • **Outcomes Definition and Transformation**	• **Capacity, Capability and Competency building** • **Curriculum Design** • **Learning and Development** • **Competency Assessment**	• **Infrastructure and Devices** • **Software and Services** • **Digital Transformation**	• **Planning, Coordination and Project Management** • **Resource and Change Management** • **Project Delivery and Stabilization**	• **Identify and Mobilize funding for Initiatives globally, regionally and locally** • **Donor/Funder engagement**

India: Case Study

Indian Public Healthcare System - Challenges

Over **500 million** without access to health coverage

Medical costs are **2nd Leading cause of impoverishment** in India

`60 million individuals into poverty every year due to catastrophic health expenditures push around

30% of Rural population **travels > 5 km** for healthcare

Approx **70% of rural primary care by informal providers**

60% of deaths are caused by NCDs like heart disease, diabetes, cancer, mental health and chronic disease have become the biggest causes of illness and death

Only **0.68 Doctors for 1000 people** (vs the WHO benchmark of 1 & OECD average of 3.4)

0.4 beds/1,000 people (vs OECD benchmark of 4.7)

Up to **60% of infra in urban covering** -28% of India's population

Burden Of Diseases Statistics

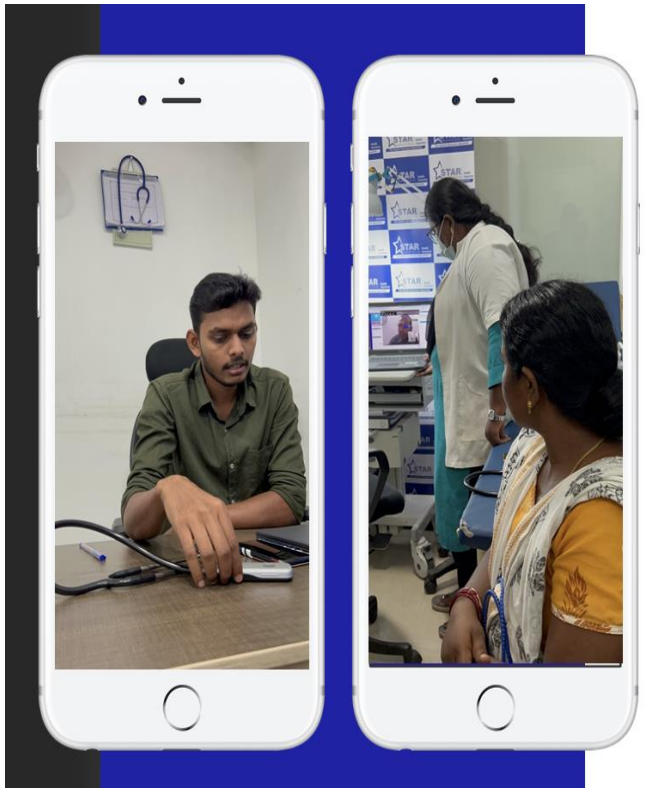
24.8%
CARDIOVASCULAR DISEASES

10.2%
RESPIRATORY DISEASES

10.1%
TUBERCULOSIS DISEASES

9.4%
MALIGNANT & OTHER TUMOURS

Case Study: India (2022)



Digitally enabled primary care in LMIC

- Proliferation of Digital Health tools and of technology at the Point of Care created an opportunity
- A demonstration of how low-cost innovation with appropriate technical support and joint training for healthcare workers resulted in improved patient care
- There was a re-allocation of workforce skills that impacted patient outcomes
- A new paradigm for workforce development is needed to support such innovation

This pilot resulted in improved clinical outcomes for Diabetes and Hypertension

The Growing CE Role: *Overview*

- Who are Clinical Engineers and what is the Global CE Community?
  - Clinical Engineers are *Biomedical Engineers who serve at the Point of Care* (WHO)
  - Global CE Community Defined
    - The 5th ICEHTMC was a key joint Community activity in 2023, followed by the WHO Innovation Forum
  - The Global CE Community Worldwide Footprint
  - CE-BME Capacity Building Framework
  - Body of Knowledge & Practice (BOK-BOP) in the Global CE Community, December 2022 Survey
- Stories from the Global CE Community
  - Global and Regional CE/Health Technology (HT) Priorities Identified in 2022 Survey
  - Call for Action[1]
  - Digital Health Impact on Workforce Examples[2]

1. https://www.nationalacademies.org/news/2022/05/the-growing-role-of-clinical-engineering-merging-technology-at-the-point-of-care
2. https://www.globalce.org/index.php/GlobalCE/article/view/84/48

CEs can Play a Key Role in Digitation of Healthcare

- **The USA has projected that over 1 million nurses are needed to replace retiring nurses, and globally this number is closer to 13 million[1].** *[1]https://nursejournal.org/articles/post-pandemic-nursing-shortage/*
- Clinical Engineering assistance with EHR-related tools can mitigate Nursing burnout
- By removing silos between CE and Nursing, new skillsets can emerge:
  - Examples: CEs can assist by setting up medical devices in surgical rooms, infusion pumps, surgical equipment, etc. CEs and nurses can also work together to optimize clinical workflows.
- Health systems such as USA's Kaiser Permanente (KP) have had CEs working successfully with physicians & nurses in clinical workflow design and care delivery, using digital health tools
  - One presenter has been part of that story for the past 15 years.

Healthcare Technology and Workforce Challenges

WHO, Medical Devices and the Pandemic

- The global pandemic demanded a huge demand for mechanical ventilators (2020) and medical oxygen (2021), noted at the World Health Organization (WHO) World Health Assemblies
- As a result, WHO engaged Clinical Engineers (CEs) globally for managing Health Technologies such as medical devices, PPE, medical oxygen sources and delivery, and digital health tools in LMICs.
- GCEA was also engaged by WHO (2020-2022) to evaluate emerging Health Technology Innovations, drawing from the expertise of 100 CE colleagues around the world.

Growth of Medical Devices and Digital Health Tools; Workforce Implications

- Global medical device sales are projected to reach $658 USD billion by 2028; these will need to be optimally managed in LMICs and elsewhere.

CE-BME *Capacity Building* Framework

Clinical Engineers:

- **Manage** *Health Technologies (HT)* through their lifecycle, according to WHO methodologies
- **Innovate** to create new models and tools for healthcare delivery including Digital Health approaches
- Ensure ***Appropriate*** HT selection and deployment initially & ***Sustainability*** during use
- Work through ***National CE-BME Societies*** to assist ***Capacity Building*** at country and regional levels
- Have measurably improved healthcare ***Safety, Quality*** and ***Clinical Outcomes***

Status	Low	Middle	High
KNOWLEDGE			
Education (Academia)	2-4 year Academia	Academia: 4 year undergraduate & graduate	Graduate CE
Training (Academia - CPD, CEU & Industry)	Limited	Ongoing	Ongoing for typical devices plus more for high tech devices
Internships (part of Academic studies or independently in hospitals)	Absent	Limited	Available through different sources
Credentialing (Certification & Registration)	Absent	Limited	<50% Certified
Digital Health & Innovation (Knowledge used to improve devices and clinical & business workflows, etc.)	Absent	Limited	Beginning involvement
INVESTMENT			
Investment Drivers Externally (NGOs, Industry) versus internally (MOH, Universities)	Externally driven	Ministry of Health (MOH) directed	MOH driven, aligned well with University & Industry partners
Device Sources Majority Donations versus Majority Central Health Leader-driven	Majority Donations	MOH-led device planning, selection, & management	Extensive central planning, selection, & management through MOH
CE Department **Staffing**, Facilities & Test Equipment	Limited	Full range for typical devices & growing staff to meet needs	Extensive facilities & wide range of test systems with mature staff size matching needs
Inventory Management Manual versus CMMS	Manual	CMMS	CMMS includes Digital Health & Cybersecurity information, with ability to share data with decision makers & colleagues across hospitals
Added Value: Quality & Safety Measurement, monitoring, improvement, and risk management	Absent	Limited	Extensive
COMPETENCIES			
Scope of CE-HT Management Activities	Minimal set of devices	Full range of typical devices	Typical plus high-tech devices + Digital Health tools & Cyber
Device Preventive Maintenance & Repair	Limited PM & Repair of typical devices	Full range for typical devices	Full range PM & repair typical + high tech specialty devices
Clinician & Healthcare Team Relationships	Absent	Limited	Strong partnerships
National CE / BME Society (Bringing HT colleagues together to share best practices and training)	Absent	Beginning	Mature and able to assist other nearby countries
Leadership Development (Developing & Mentoring CE practitioners/Influencers)	Absent	Limited	Key country CE leaders mentored externally, They train & mentor others; become Influencers
Policy, Regulation, Legislation (Raising HT issues to national level in Political context)	Absent	Limited	Extensive

WHO:

- Measured 800K+ existing CE practitioners in 2018 from 130+ countries; the Global CE community efforts now show **over 1M in 200+ countries**
- Global CE Community 90+ best practice webinars with WHO **were attended by 160 countries** 2020-2023
- The Global CE Community joined a WHO evaluation team in 2020-2022 to create ***WHO's 2021-2022 Compendia of innovative health technologies for low-resource settings***
- WHO Medical Device Unit created the **STAG MEDEV** in 2022 to lead global HT improvement efforts, with many CE-BME on the team

CE Competency Priorities from the 2022 Survey

GCEA-CED 2022	BOK-BOP Survey	Priorities shown:	Scored 85-90% of ...	High & Moderate Importance ...	Aggregate Scores
Global Survey High Priorities	*LA&C Survey High Priority Competencies*	*China Survey High Priorities (WPRO)*	*Africa AFRO Survey High Priorities*	*SEARO Survey High Priorities*	*Europe EURO Survey Priorities*
1. Maintenance Management (medical devices)	1. HTA	1. Regulation	1. Maintenance	1. Maintenance	1. Maintenance
2. Quality (Management)	2. Hospital Engineering	2. Maintenance	2. Quality	2. CE-IT	2. Data & Cybersecurity
3. HTA (Health Technology Assessment)	3. Maintenance	3. Quality	3. Patient Safety / User Training	3. Presentation Skills	3. HTA
4. Risk Management	4. Regulation	4. Data & Cybersecurity	4. CE-IT	4. Engineering Asset Management	4. Engineering Asset Management
5. CE-IT (Computers, Networking, Information Technology)	5. Patient Safety / User Training	5. Risk Management	5. Hospital Engineering	5. HTA	5. Quality
6. Engineering Asset Management	6. Quality	6. CE-IT	6. Leadership/Exec. Skills Coaching	6. Leadership/Executive Skills Coaching	6. Risk Management
7. Data Analysis & Cybersecurity	7. Data & Cybersecurity	Also strongly representative of the WPRO Region of 10 countries' priorities, the other 9 with a total of 34 more responses (total of 214 from all WPRO)	7. Project Management	7. Health Facilities Planning & Design	7. CE-IT
8. Project Management	8. Imaging		8. Regulation	8. Risk	8. Presentation Skills
9. Regulation	Others		9. Risk	9. Project Management	9. Patient Safety / User Training
10. Hospital Engineering	9. Innovation		10. Presentation Skills	10. Patient Safety / User Training	10. Project Management
	10. Digital Health (including CE-IT)		11. Data & Cybersecurity	*EMRO Survey High Priorities*	
				1. HTA	
				2. Hospital Engineering	
				3. Maintenance	
				4. Project Management	
				5. Risk	
				6. Quality	
				7. Procurement Strategies	
				8. CE-IT	
~~Countries:~~ 127	LA&C: 30 countries – excluding USA & Canada	China: 21 provinces; WPRO: 10 countries	AFRO: 29 countries' responses	SEARO: 9 countries/EMRO: 16 countries	EURO: 31 countries' responses
Sample Size Respondents: 870	160	180	237	SEARO: 93; EMRO: 48 responses	EURO: 78

The Global CE Community

The Global Clinical Engineering Community = GCEA & IFMBE CED

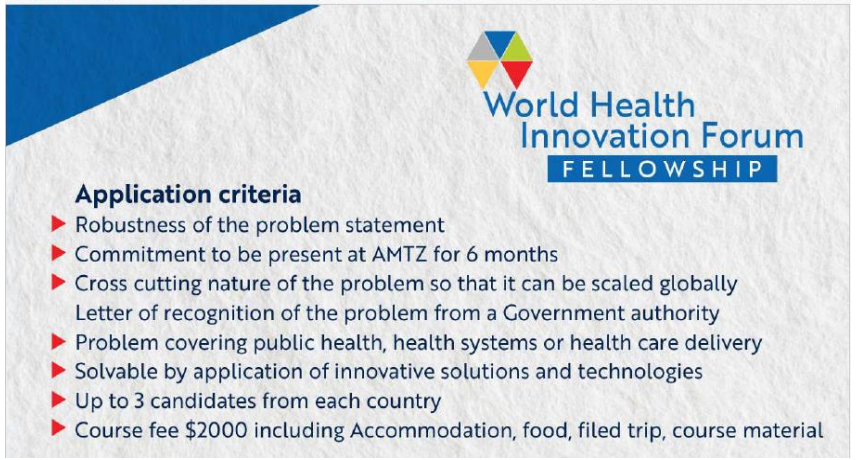
Global Clinical Engineering Alliance https://www.globalcea.org/home
IFMBE Clinical Engineering Division https://ced.ifmbe.org/
Global CE Community Collaborators https://ced.ifmbe.org/who-we-are
See Live Streaming for 5th ICEHTMC Nov 10-13, 2023 https://www.globalcea.org/icehtmc-2023;
followed by the World Health Innovation Forum Nov 14-16, 2023: https://www.youtube.com/watch?v=peCZy-_8laU

A Key Joint Activity was the 5th ICEHTMC;

There were …

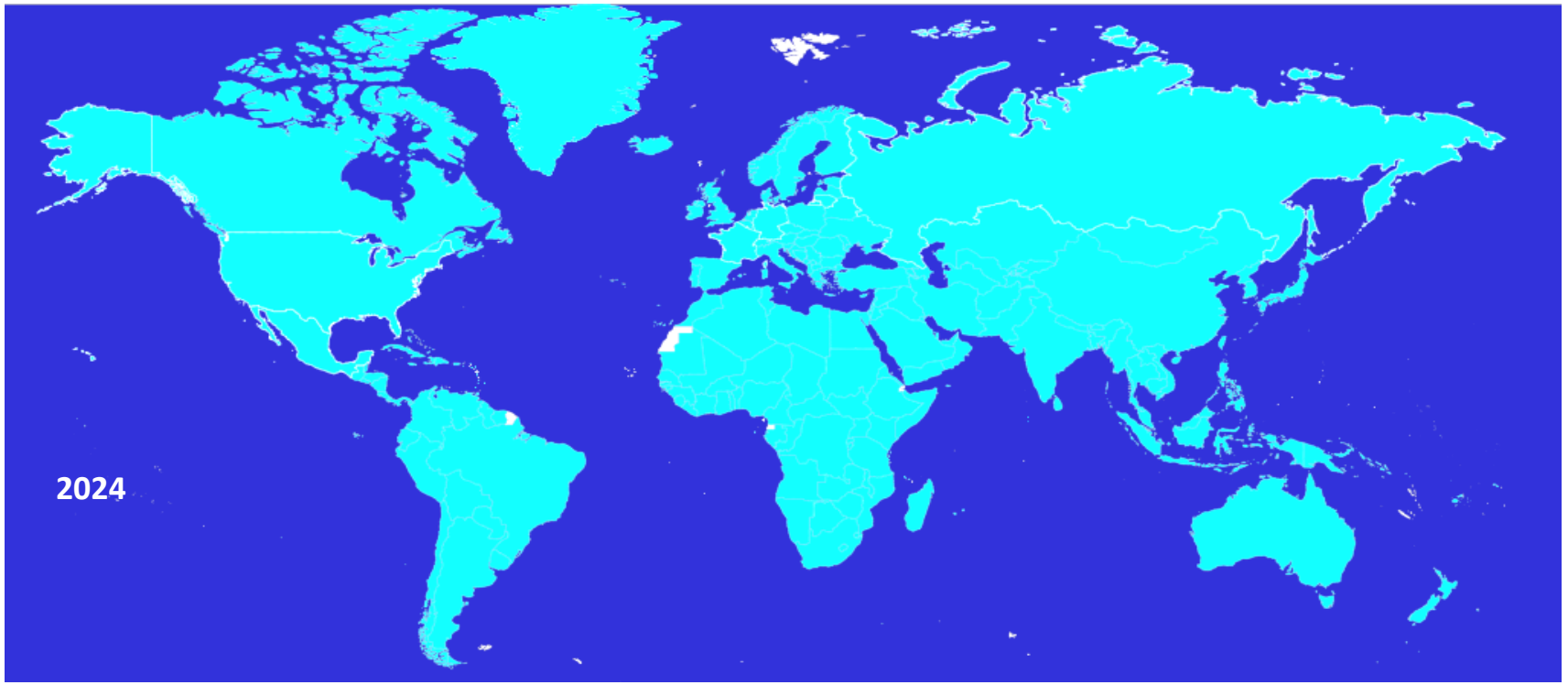
Over 200 presenters from 110 countries!

2024 Innovation *Fellow* Opportunity



For the 1st year of this program and as of August 2024, there are 26 Fellows at AMTZ that have begun their locally & globally mentored Innovation projects. All have their course fees sponsored, and there is room for 50 Fellows in 2025. Find out more from the GCEA-WHIF webinar in May this year: https://www.youtube.com/watch?v=tD2yAFQIzU4

The Global CE Community Worldwide Footprint



Now over 1100 Collaborators from 210+ Countries

These individuals include current & former Ministers of Health, Physician & Health System leaders, Engineers, Medical Physicists, Technologists, Technicians, Professors, WHO representatives, all religions, all races, and 1/3 women. Half of these countries are defined by the World Bank as LMIC. Clinical Engineers are Biomedical Engineers who typically serve at the point of care in healthcare settings.

Themes for Clinical Engineering Collaboration- USA Example: Kaiser Permanente (KP) EHR driving better Outcomes

1. Meeting USA EHR Meaningful Use requirements (using EHR & devices to improve clinical outcomes)
2. EHR CPOE (Computerized Practitioner Order Entry), best practice alerts/alarms drive EBM care
3. Social media interfaces driving Patient Engagement
4. Interactive patient care at Point of Care (as well as Point of Care - POC testing/measurement devices)
5. Data mining for Clinical Decision Support (CDS) tools (from device information)
6. Medical Device Integration (MDI) in hospitals and clinics
7. Patient data from mobile device applications for chronic disease management
8. Wireless infrastructure/RTLS (real time location systems & RFID) improves clinical workflows
9. Emerging Genomic patient evaluation
10. Facilitating Telehealth for improved access & e-Consult (using mobile medical devices tools)

Global Clinical Engineering Stories

1. **Tazeen Bukhari & Fiza Shaukat, Clinical Engineers, Pakistan**
   - Tazeen beginning service as MOH/WHO consultant during COVID-19
   - Fiza starting an EMR LMIC company after family tragedy

2. **Ministers of Health at WHO World Health Assembly**
   - During COVID years 2020-2021 had to be virtual for MOHs and government leaders from WHO 194 member states
     - Key issue in 2020: where are the **Ventilators?**
     - Key issue in 2021: where are the **Oxygen sources?**
   - WHO has increased responsibilities of its ***Medical Device Unit*** *(MDU)*
     - WHO MDU led by colleague CE/BME **Adriana Velazquez Berumen**
     - Scope increased from medical devices to also include PPE, Oxygen sources and delivery tools, & Digital Health tools

3. **Dr. Jitendra Sharma, Managing Director at AMTZ, India**
   - Created a MedTech Center to develop and manufacture medical devices in India and have deeply influenced national HT policy
   - An amazing track record serving internally & beyond during COVID-19
   - Host of the 2023 5th ICEHTMC & World Health Innovation Forum; GCEA Member & CED Board Member

Tazeen

Fiza

Adriana

Jitendra

Global Clinical Engineering Journal

Received February 20, 2020, accepted May 8, 2020, date of publication May 19, 2020

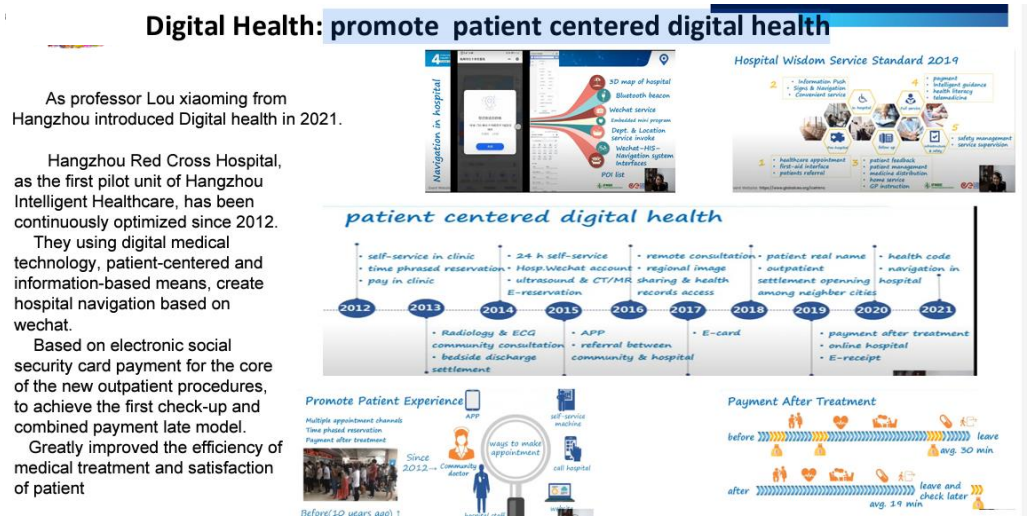
A Model for Priority Setting in Health Technology Innovation Policy

By J. Sharma[1,2]; J. Bunders[2]; T. Zuiderent-Jerak[2]; B. Regeer[2]

[1] CEO, AP Med Tech Zone & Executive Director, Kalam Institute of Health Technology, Visakhapatnam, India.
[2] Athena Institute, Vrije Universiteit Amsterdam.

CE Digital Health
Global Innovation Stories

Part 1

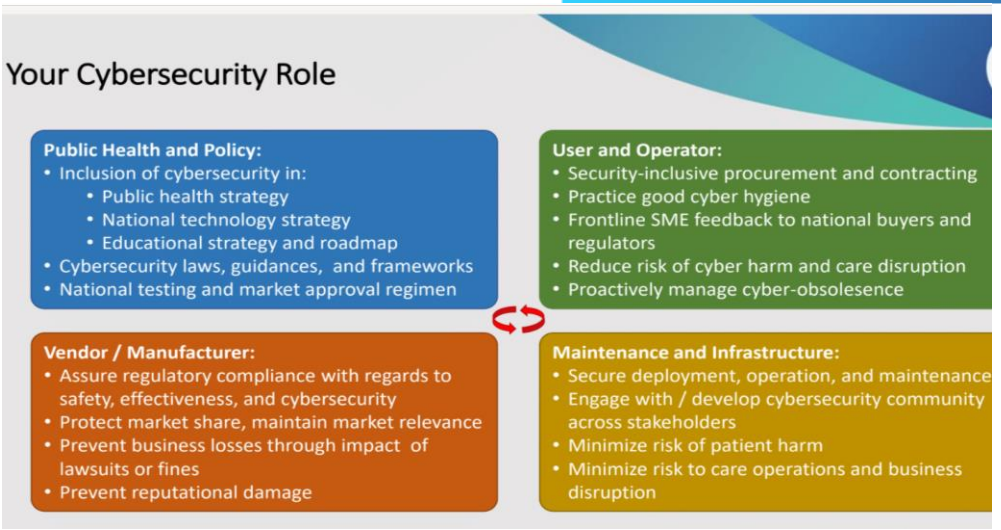


Lou Xiaomin, Red Cross Hospital, Hangzhou, China, 2022

	Country	Author	Digital Health Tools/Focus	Key Results
1.	Paraguay	**Pedro Galvan**	MOH AI Screening for COVID patients	Patient risk stratification driving care next steps
2.	Pakistan	**Fiza Shaukat**	Developed private LMIC-capable EMR	Provided needed continuity of care in LMIC settings
3.	China	**Lou Xiaomin**	Patient-centered hospital digital health	Piloting *Intelligent Care* processes since 2012, see above
4.	India	**Jitendra Sharma**	Provided Oxygen Concentrators country-wide	Staged @ 80 warehouses, leased $5 USD/day by Uber
5.	UK	**Dan Clark, OBE**	Accurate digital pulse oximeters for COVID	Used NHS-wide re early declining oxygen levels warning
6.	Kenya	**Stephen Wanyee**	Country-wide COVID Surveillance system	EMR, mobile app, and labs connected for MOH system

CE / Health Technology Digital Health Innovation Stories

Part 2



Axel Wirth, MedCrypt Cybersecurity, 2022

	Country	Author	Digital Health Tools/Focus	Key Results
1.	Colombia	**Medellin Universities**	Consortium developing AI system for Sepsis, etc.	Encouraging intra- & entrepreneurship
2.	Mexico	**Luis Fernandez**	Provided freeware asset management to MOH	Allowed tracking of EUA ventilators country-wide
3.	Global	**Axel Wirth**	Global audience, Cybersecurity management	LMIC trained, adopting best practices as able
4.	Global	**Carla Gallegos**	Digital App increasing access to global specialists	AI-driven telehealth access to Providers global App
5.	Global	**Ricardo Silva**	Developing CE-IT certification process, content	**Community assists LMIC Academic Digital Health certification**
6.	Global	**Manish Kohli, MD**	NGO creates Digital Runway for LMIC patient RPM	UAV/telehealth allows remote areas to be served 24/7

Call for Action:

How Can CEs transition to meet Emerging Health System Needs

- **Education of the workforce**
  - With demonstrated competencies and internationally coordinated professional credentialing, CEs will be prepared to be complementary partners with others, participating in new clinical roles and workflows to free physicians and nurses for direct patient care.
- **National health technology policy**
  - To address priority national challenges.
- **National and international alliances and partnerships**
  - To share expertise and lessons learned.
  - To build capacity and capability at the front lines.

Partnerships to Drive Adoption Use of Digital Health Tools

- How can GCEA and Pul Alliance help do this?
  - It takes a village to drive use adoption and use
  - How technology can be used to improve patient care

- CEs have valuable skillsets to expand scope of practice
  - We CEs and partners can drive this as change agents
  - How can we partner better with other health professionals, community-based workers, and other resources? Ask the Panel.

Questions?

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Tom Judd judd.tom@gmail.com

Pul Alliance
DIGITAL HEALTH & EQUITY

www.pulalliance.org

Appendix

Global Context of Digital Health

Clinical Engineering – Information Technology (CE-IT)

- **EMR/EHR:** Access to patient information plays a vital role in the provision of effective clinical care by health professionals. Diagnosis and treatment can be improved if health professionals have easy access to accurate and comprehensive medical records of patients ... Many countries are now introducing Electronic Medical Records / Electronic Health Records (EMR / EHR) to improve the management of patient information, enhance health care services, and allow for rapid communications between health care providers.[1]
- **Health IT** (Health information technology): Enables substantial improvements in health care quality and safety, compared to paper records. Yet health IT can only fulfill its enormous potential if risks associated with its use are identified, if there is a coordinated effort to mitigate those risks, and if it is used to make care safer."[2]

1. World Health Organization (WHO, 2014) http://www.who.int/ehealth/events/standardization_forum_2014/en/

2. USA Institute of Medicine: *Health IT & Patient Safety*, 2011 www.iom.edu/Reports/2011/Health-IT-and-Patient-Safety-Building-Safer-Systems-for-Better-Care.aspx

Key CE-IT Concepts

Workflows, Data Capture, Alarms

A. How devices are used in EHR Workflows

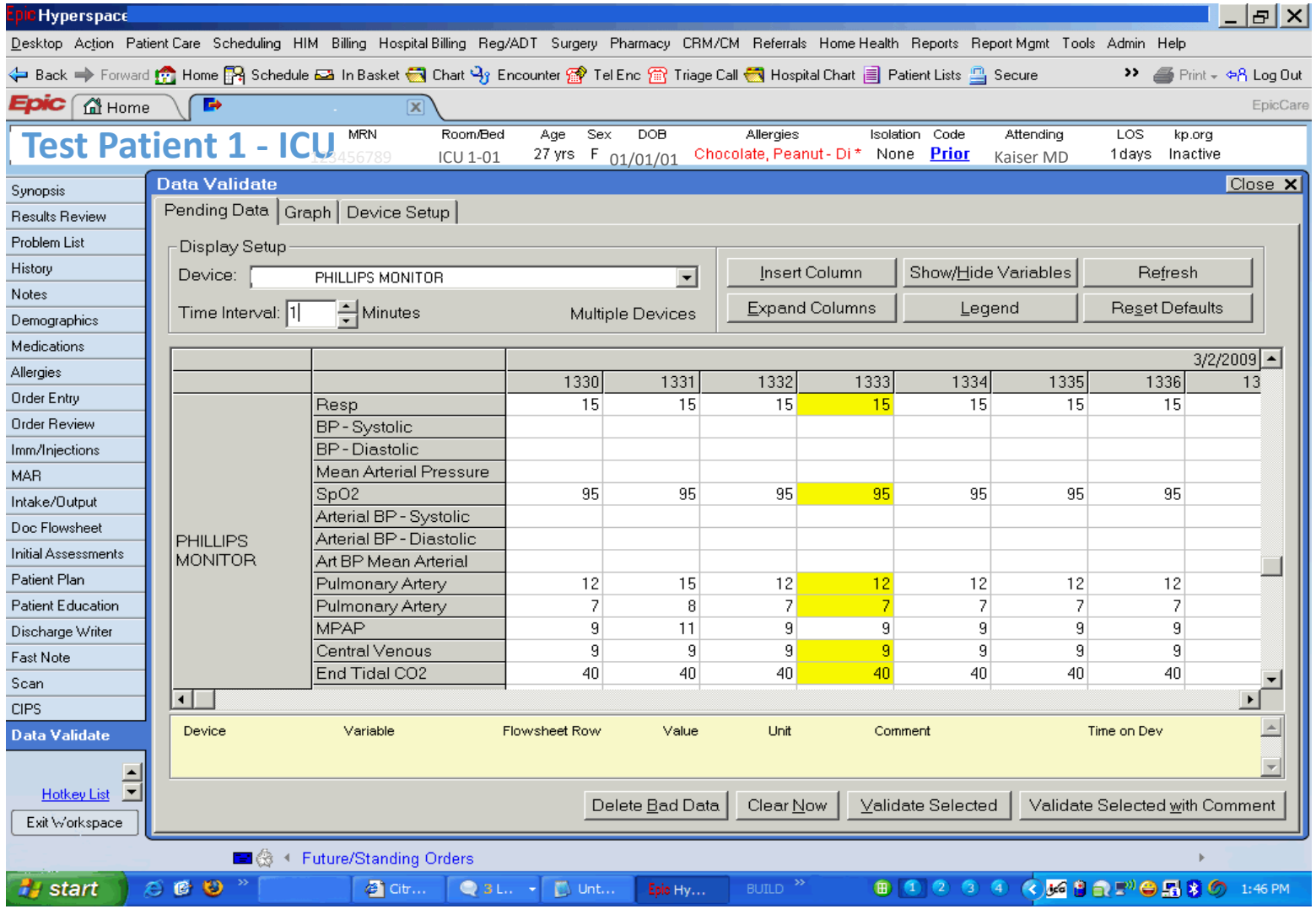
- Patient Management
- Patient Context
- Scheduling
- Order Workflow
- Data acquisition
- Data analysis
- Clinical documentation
- Surveillance
- Messaging
- Data management
- Report generation
- Device specific workflows

B. Medical Device Interoperability

the ability for clinical medical devices to communicate in a consistent, predictable and reliable way, allowing for the exchange of, and interaction with, data from other medical devices and with patient data sources and repositories, such as electronic health records (EHRs), in order to enhance device and system functionality.

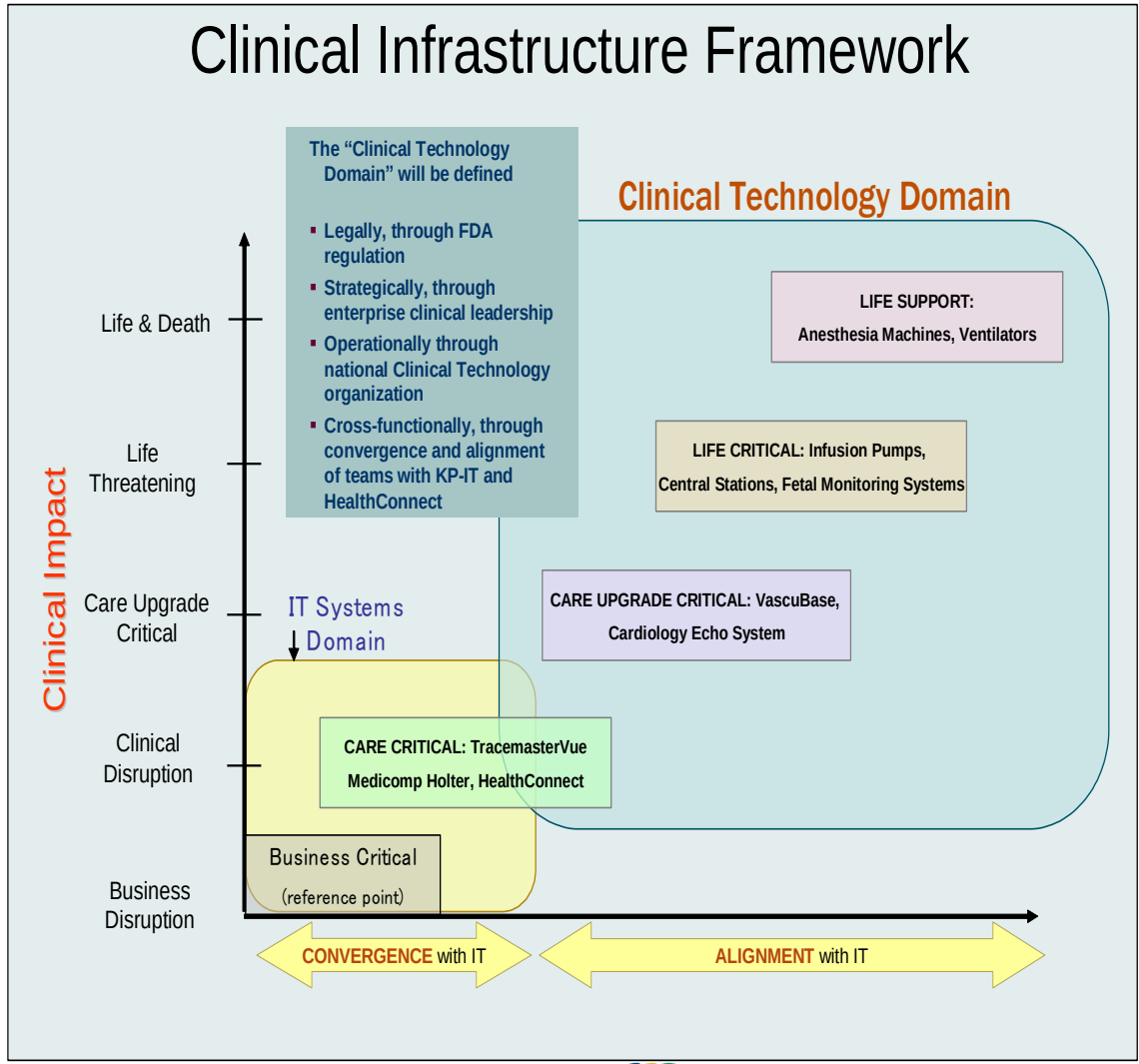
C. MDI issues

- **EHR Device Data Capture**
  - Patient Flowsheets for monitoring trends
  - Validated & Unvalidated clinical data
- **Forwarding device Alarms to central communication systems & mobile devices** (SmartPhone, pager)
  - Nursing Alarm Fatigue



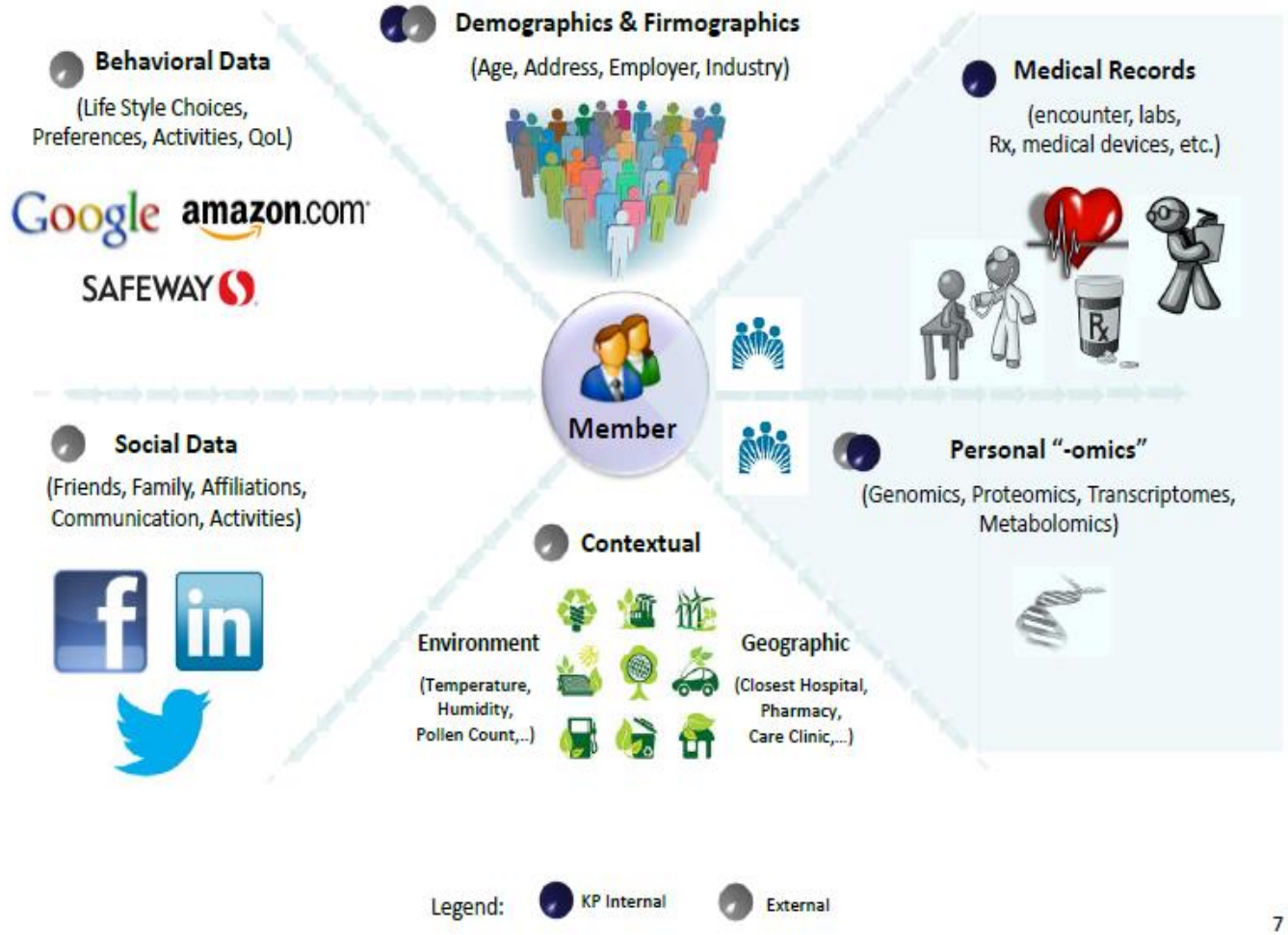
Kaiser Permanente (KP) CE-IT Case Studies & Outcomes

1. Physiologic Monitor
2. Ventilator
3. LVP = Large Volume Infusion Pump
4. ECG / Holter
5. Cardiac Implant Management
6. Sleep Lab
7. Fetal Monitor
8. Mobile Vital Signs
9. Anesthesia Machine
10. EEG
11. Dialysis
12. Pulmonary Function Testing=PFT
13. Visible Light Image Management
14. Point of Care (POC) Testing
15. Nursing Communication & Alarm Management
16. Mobile (m) Health
17. Wireless / RFID / RTLS
18. Telehealth



KP EHR Genomic & Big Data

- **Panarome**: genome, transcriptome, proteome, metabolome, lipidome, epigenome (iPOP)
- **Metagenome/microbiome:** 10/100
  C. Dif, Autism, MS, Obesity (twins)
- **Phenome**: EHR and related data
- **Socialome**: Public exhaust and authorized feeds
- **Exposome**: Fixed and mobile sensors
- **Personal Sensoromes**: wearable devices exhaust
- KP-CalIT2 Collaboration



KP CMIO John Mattison, MD, 2013