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Addressing the Challenges of Cardiovascular Patients in Africa Through Innovation.

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04/13/2018

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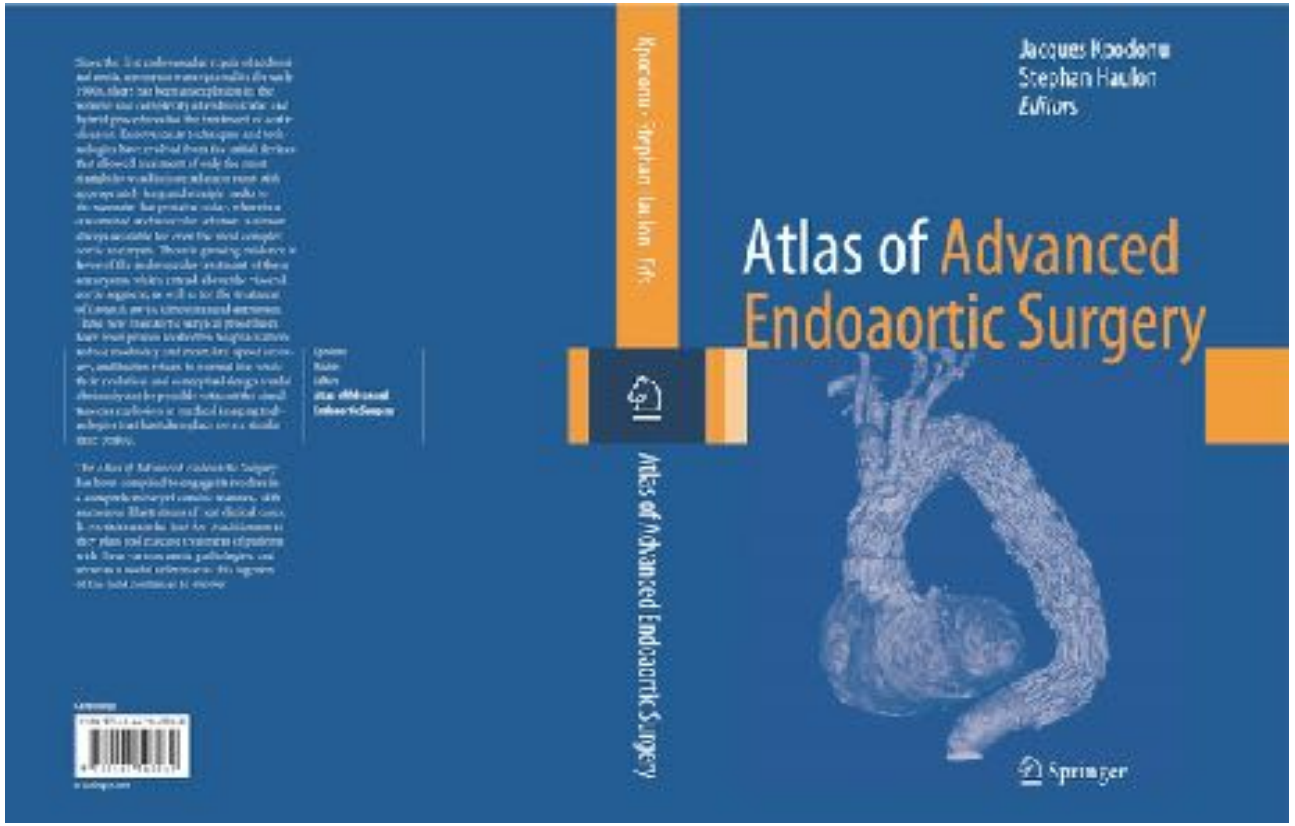
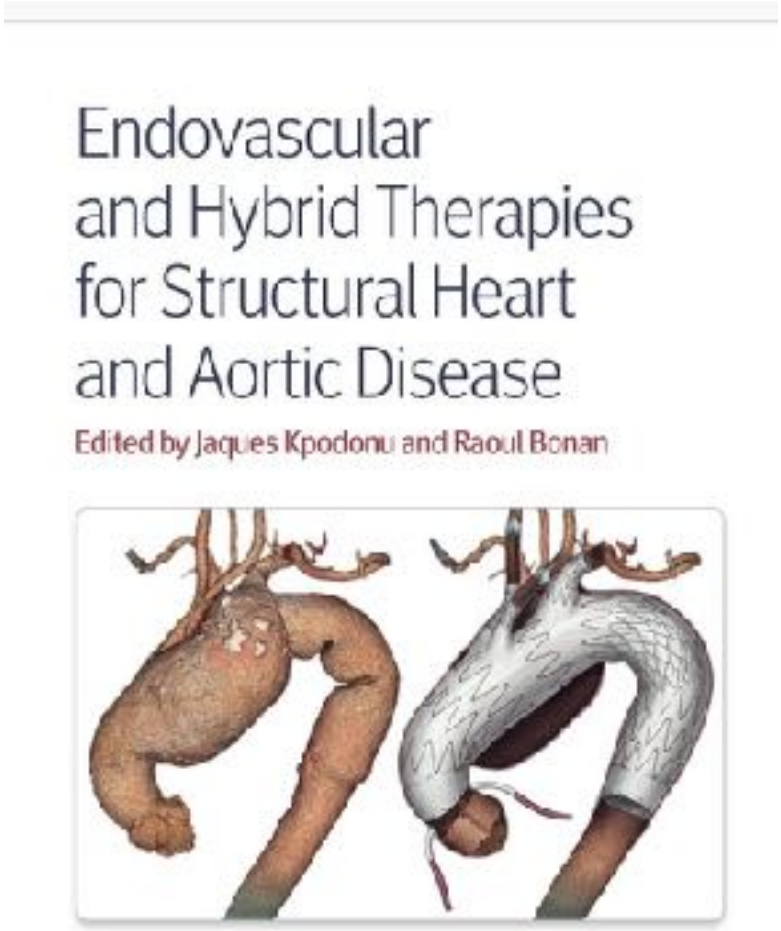
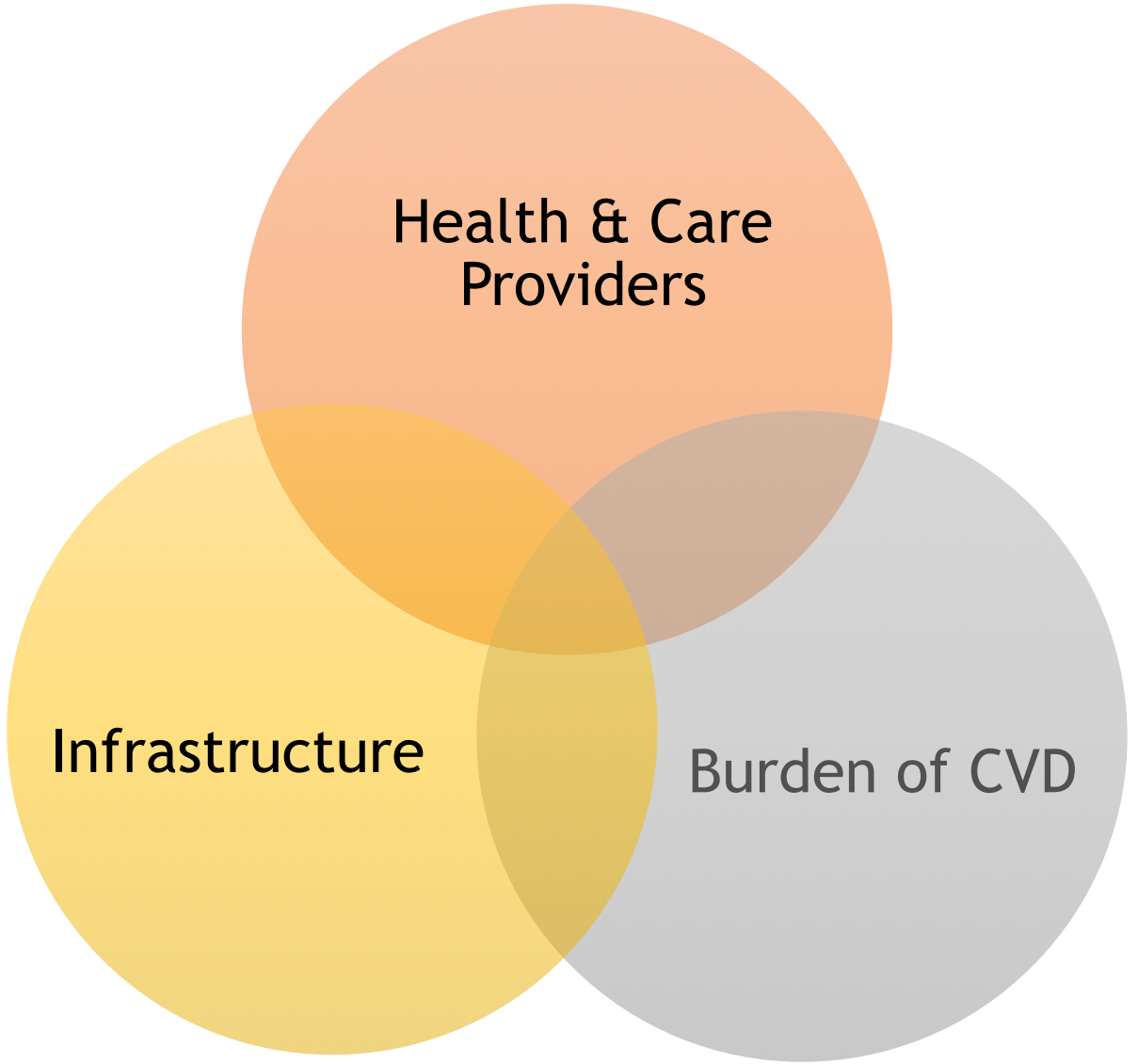
Disclosures

No Disclosures Specific to the Content of this Presentation





Addressing Cardiovascular and Surgery Care in Africa.



Healthcare in Africa:The Problem Compounded.

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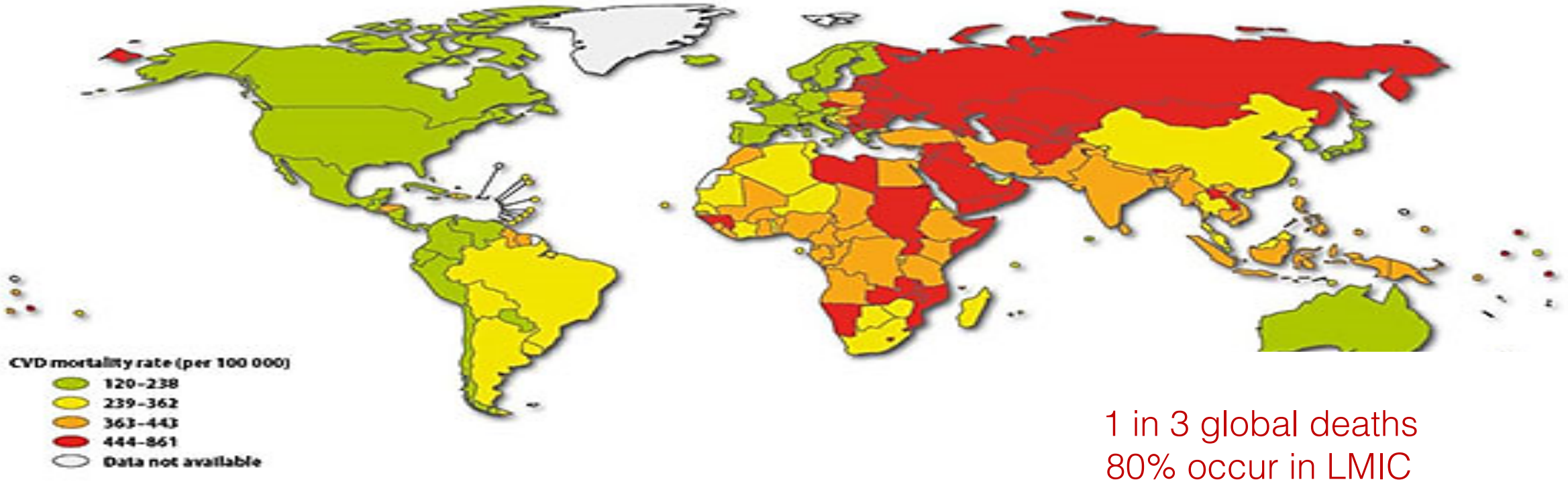
Healthcare Infrastructure

Design Constraints

Medical Device Access

The Burden of Cardiovascular Disease (CVD)



1 in 3 global deaths
80% occur in LMIC

CVD is the leading cause of morbidity and mortality of NCD globally

Rheumatic heart disease

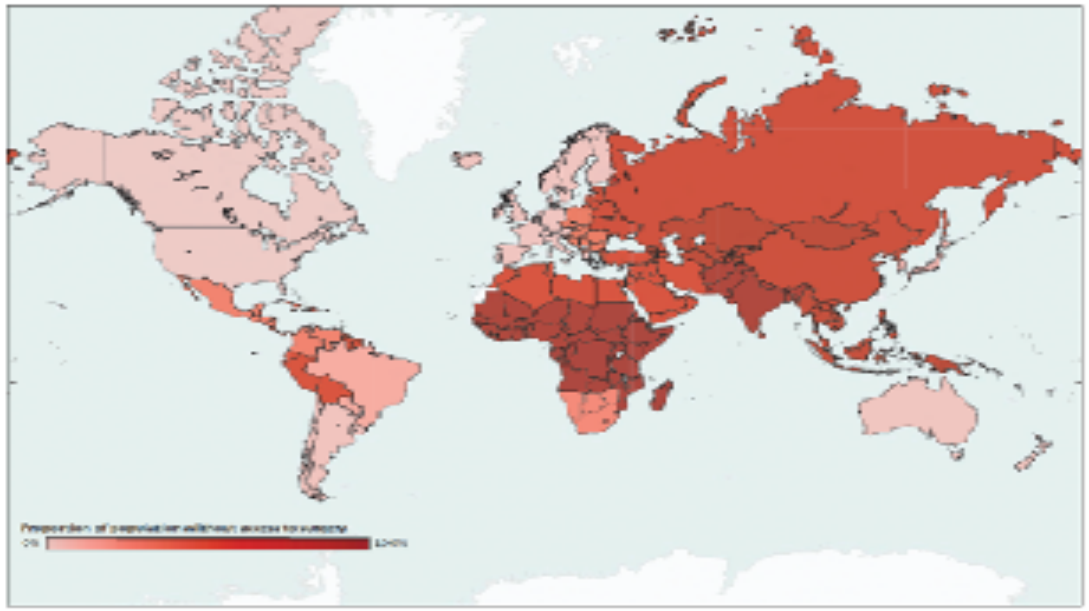
affects 34 million patients globally most in Africa

Hypertension

- **affects over 100 million people in North America**
- **1.5 Billion worldwide**
- **More than 400,000 deaths annually, ~ 1000 people / day**
- **Impacts to the health system cost over $50 Billion per year**

Global Surgery: The Workforce.

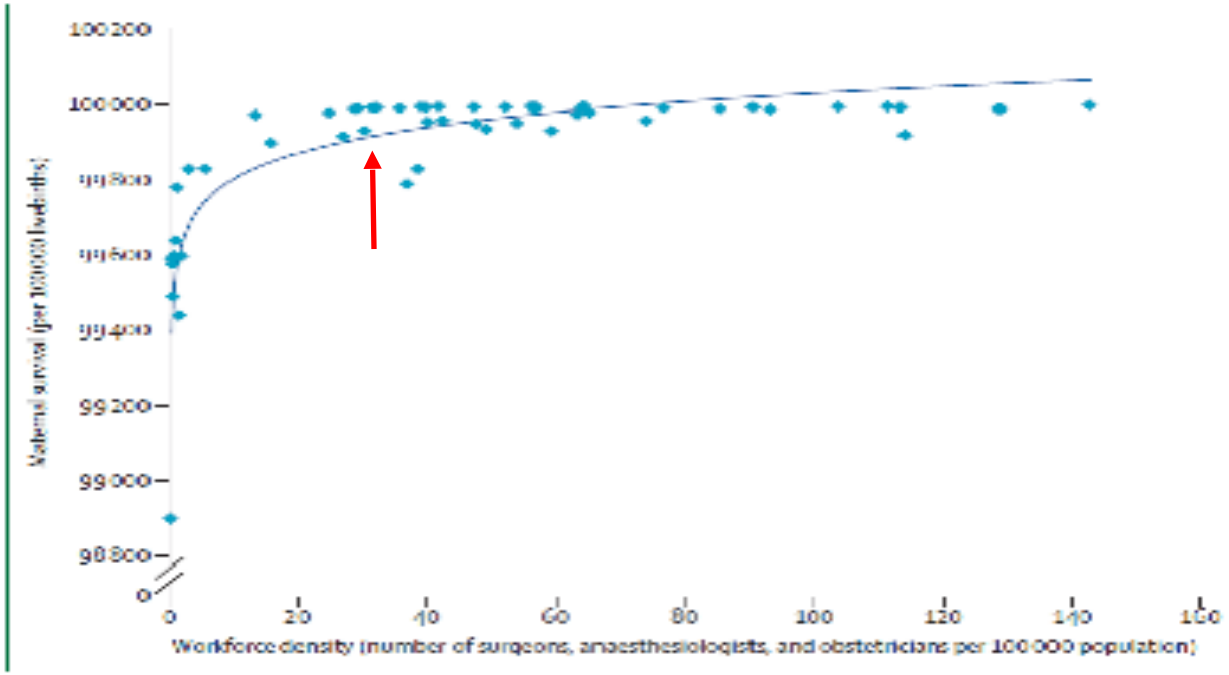
Lancet Commission on Global Surgery



Proportion of the population without access to safe, affordable surgery and anesthesia by Institute for Health Metrics and Evaluation region

5 billion people lack access to safe, affordable surgical and anesthesia care when needed

Specialist surgical workforce density and maternal survival



A surgical workforce density of <20 per 100, 000 specialist surgeons, anesthesiologists, and obstetricians correlates with lower rates of maternal survival

Global Surgery - The Current Challenge.

5 Billion

Patients without access to safe surgery

143 Million

Additional surgical procedures required

2.2 Million

Additional surgical staff are needed

$350,000,000,000

Cost of surgical expansion (2015-2030)

Global Surgery:The Financial Challenge.

"…the total training costs required to achieve surgical scale-up could be substantial."

"Holmer and colleagues projected that by 2030 an additional 600,000–1,600,000 surgeons, anesthesiologists, and obstetricians would be needed in low-income and middle-income countries"

"The training cost per surgeon has informally been estimated to be as high as $75,000 in Mozambique and $150,000 in Haiti."

Taken from "Timing and cost of scaling up surgical services in low-income and middle-income countries from 2012 to 2030: a modelling study"

Global Connectivity: An Opportunity to Innovate in Healthcare ?

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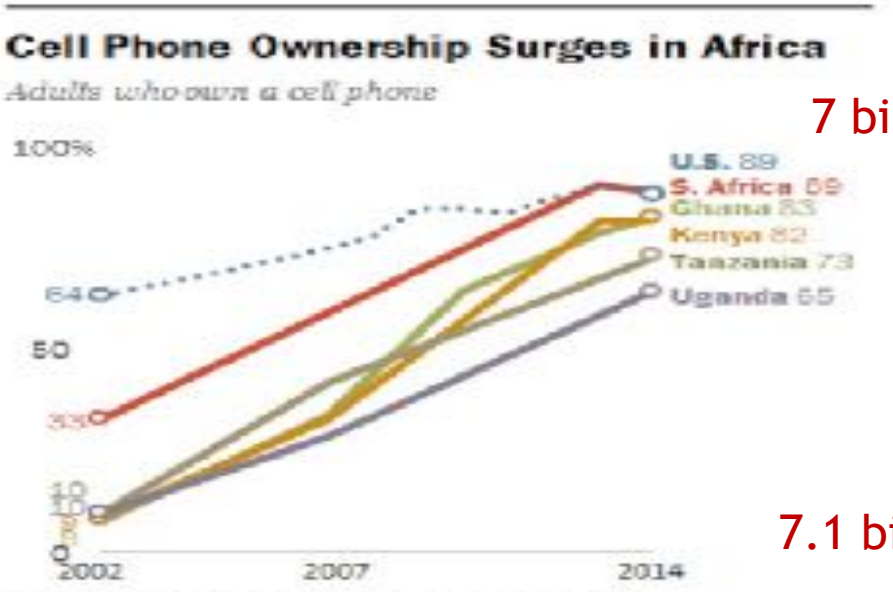
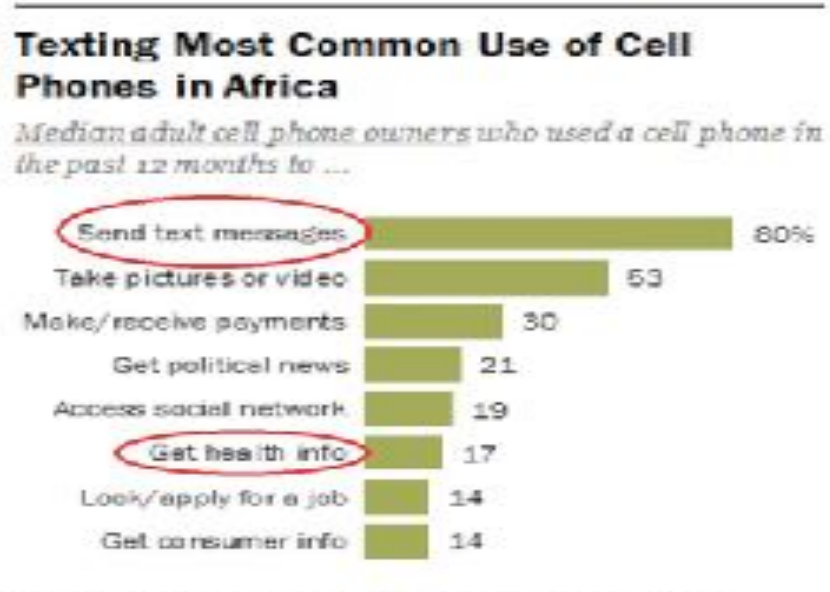
Tanzania	0.03[1]	300[5]
Malawi	0.035[2]	100[6]
Liberia	0.03[3]	420[7]
Ethiopia	0.023[4]	170[8]



7 billion

7.1 billion



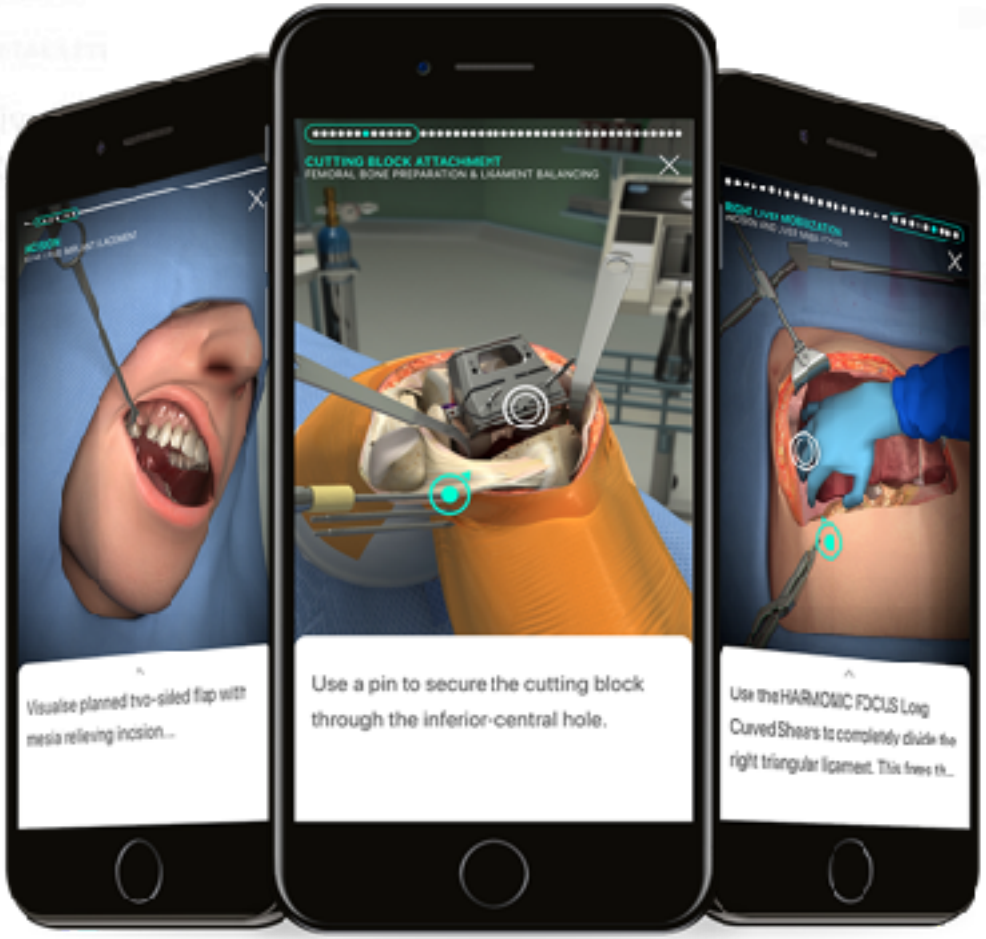
Devlin, Kat. "Cell Phone Ownership Surges in Africa." Pew Research Center's Global Attitudes Project. April 14, 2015. Accessed November 19, 2017. http://www.pewglobal.org/2015/04/15/cell-phones-in-africa-communication-lifeline/africa-phones-7/.

Global Surgery:Addressing Surgery WorkforceThrough Technology.

Touch Surgery: Simulation app based platform already has trained over 2 million people

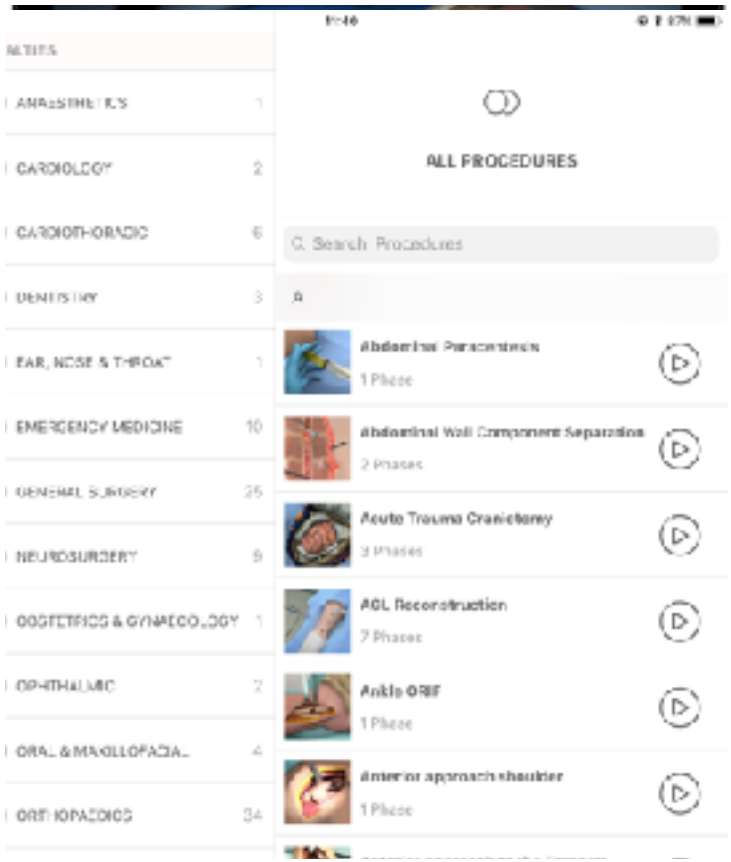
2 Million +
Users Worldwide

Global Surgery:Building Interactive Surgical Education Tools at Infinite Scale.

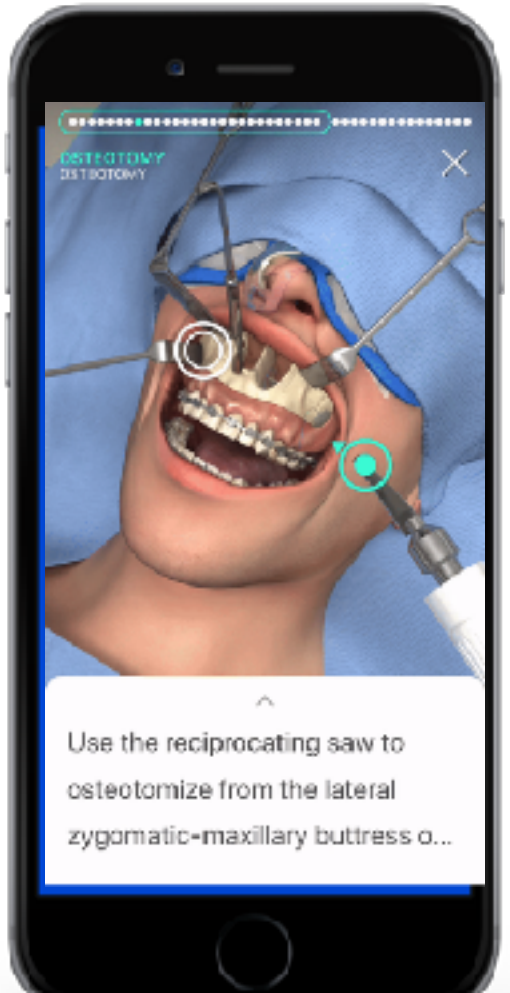


- Build interactive procedures
- Analyze the interactions
- Learn, Prepare, Test for surgical procedures, anytime, anywhere
- Use a library of over 150 cognitive surgical simulations
- Validated for training by the academic literature
- Touch Surgery is free to download

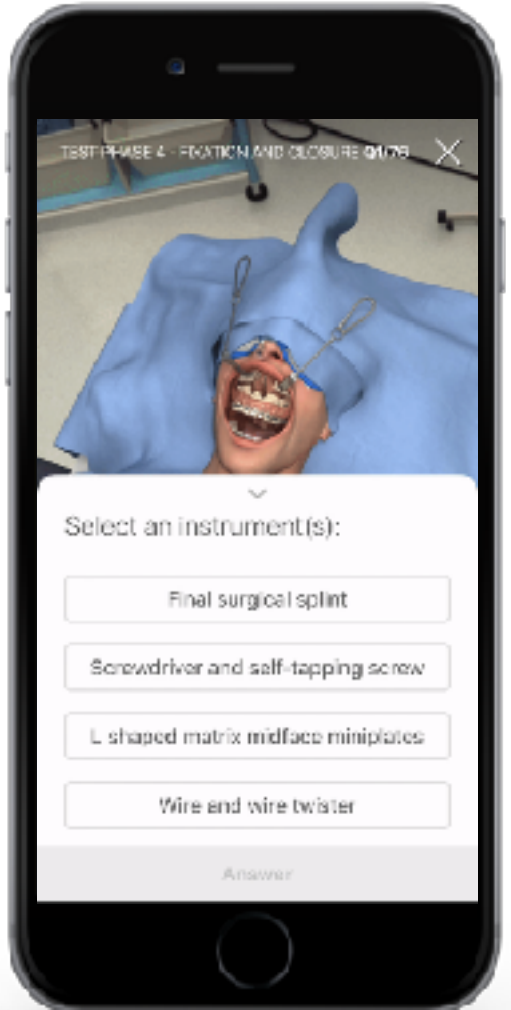
Global Surgery:Start by Learning Measure Comprehension by Testing.



Learn



Test



Evolution of Global Healthcare: Going Digital Provides Value.

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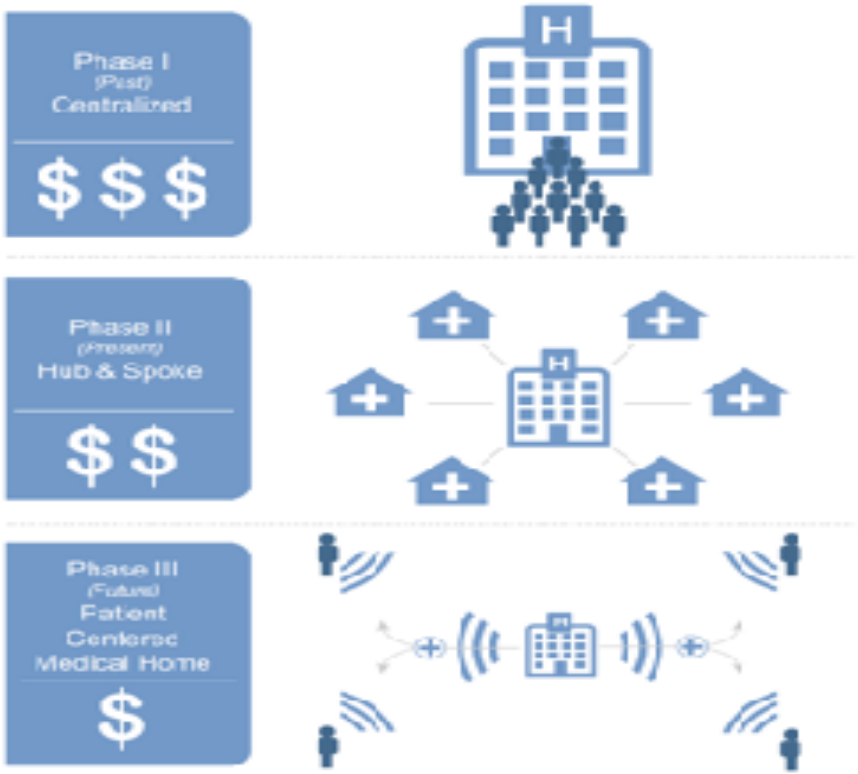
Centralized care facilities increase costs exponentially. Digital health could enable hospitals of the future to transition to the connected home.



Paper records

↓

Digital records

↓

Patient Monitoring & AI

"Beyond the revenue opportunity associated with digital health technologies, potential systems savings represent a major incentive to adoption – we peg the total savings opportunity (TSO) at $305 billion."

Goldman Sachs

Healthcare At a Crossroad. The Future of Connected Care.

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Partners HealthCare, New England's largest hospital network, lost $108 million; the Cleveland Clinic witnessed a 71% decline in operating income; and MD Anderson, the nation's largest cancer center, dropped $266 million.

Forbes Pharma & Healthcare

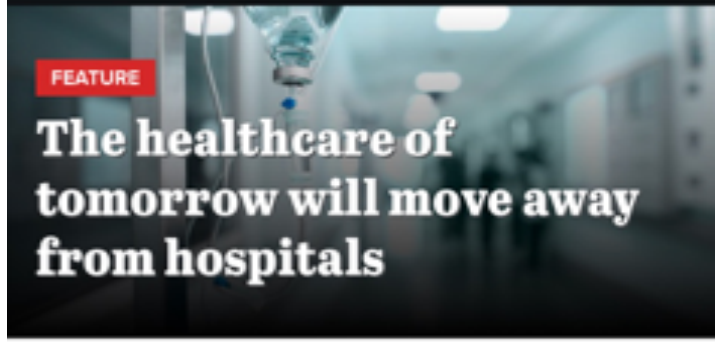
Why Major Hospitals Are Losing Money By The Millions

Robert Pearl, M.D., CONTRIBUTOR
Nov 7, 2017 7:50 AM 47,331

Large hospital systems throughout the country are struggling [+]

A strange thing happened last year in some the nation's most established hospitals and health systems. Hundreds of millions of dollars in income suddenly disappeared.

HealthcareDIVE MENU



FEATURE

The healthcare of tomorrow will move away from hospitals

By **Jeff Byers**, **Shannon Muchmore** • Nov. 6, 2017

ECONOMY

In Health Care, Republicans Could Learn From Rwanda

An American pediatric specialist during a radiology teaching session with pediatric residents in Kigali, Rwanda. In the past 15 years, Rwanda has worked to build a near-universal health care system.

MARTINA BACIGALUPO FOR THE NEW YORK TIMES

Transforming Cardiovascular Care in Africa Through Innovation.

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Smart Phone Hospital Symptoms → Diagnostics → Laboratory Testing

Blood pressure iBP

Oxymetry iO2

Activity Monitor 6 MWT

Pocket Echocardiography

iECG

Point-of-Care BNP

Leveraging Smart Devices, Machine Learning Tools and BIG DATA .

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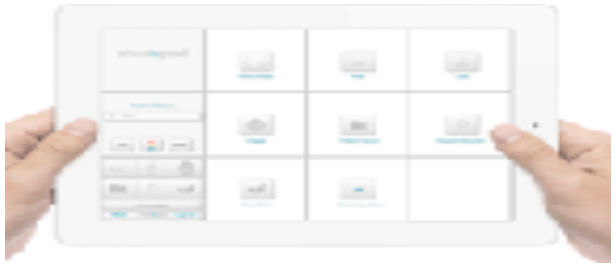
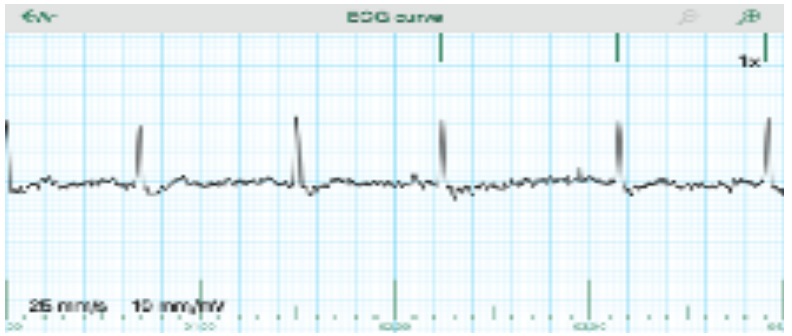
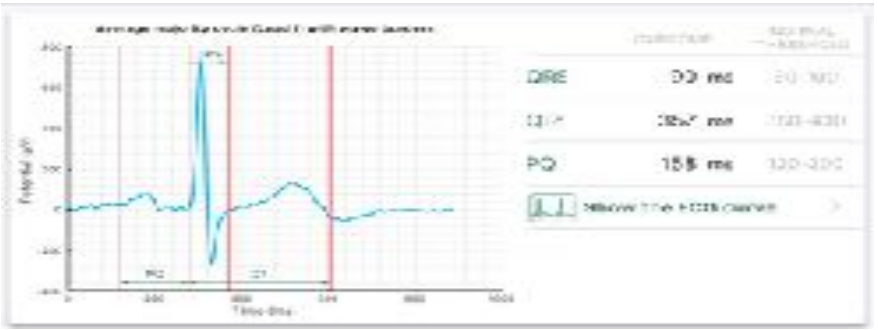
Phone app

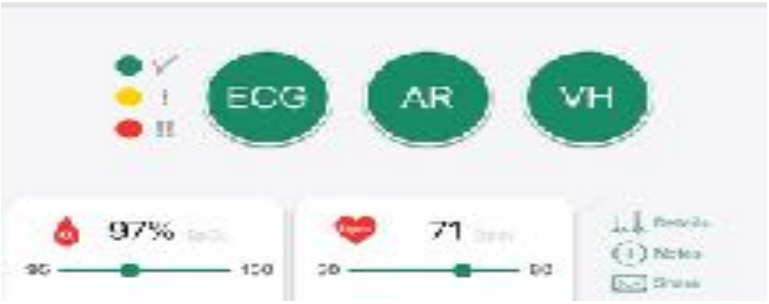


Wireless EKG/Oxygen sat device

EKG recording







Phone as a Lab Device: Can My Phone Diagnose a Heart Attack ?

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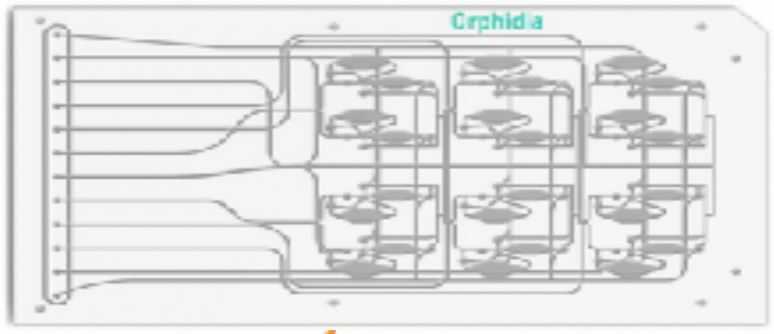
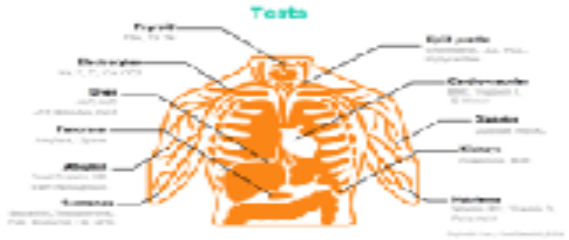
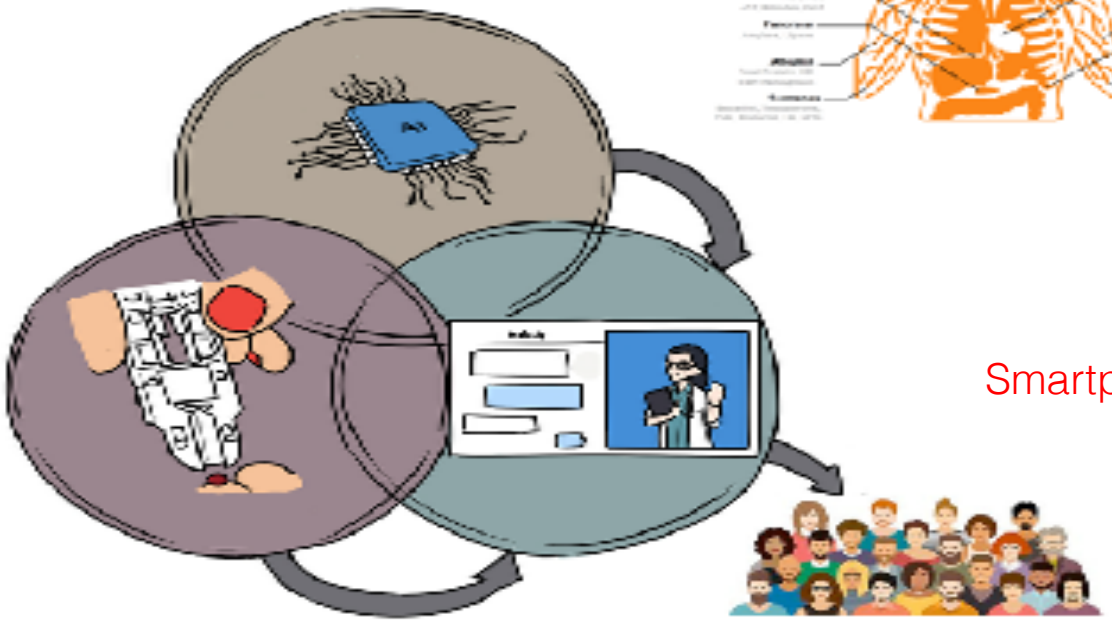
Machine Learning to predict patients risk factors







Smartphone test reader & real-time monitoring AI app

HS Cardiac OTC test Cassette
+ Biomarker Combo

Phone Ultrasound Device: Revolutionizing Structural Heart Disease Care in Africa.

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Cloud Based Echo Reporting

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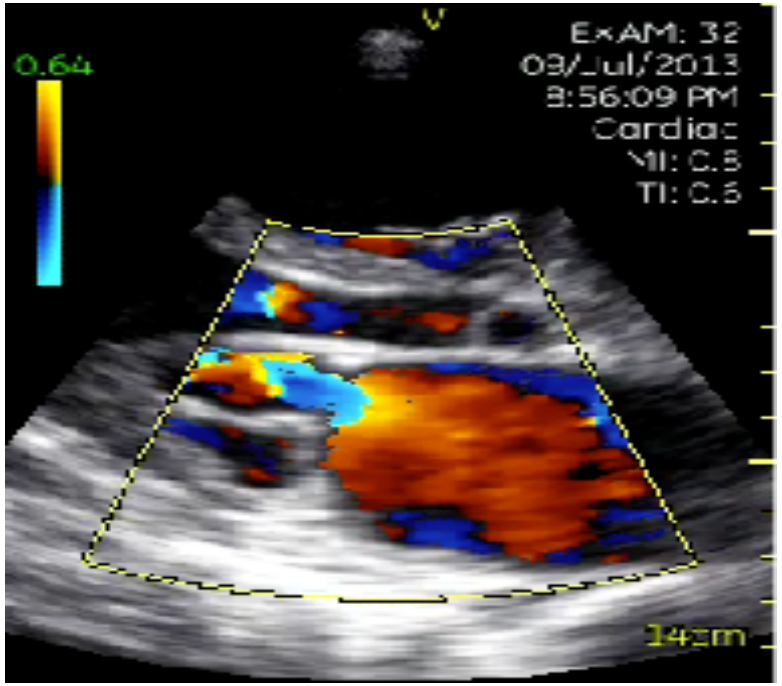
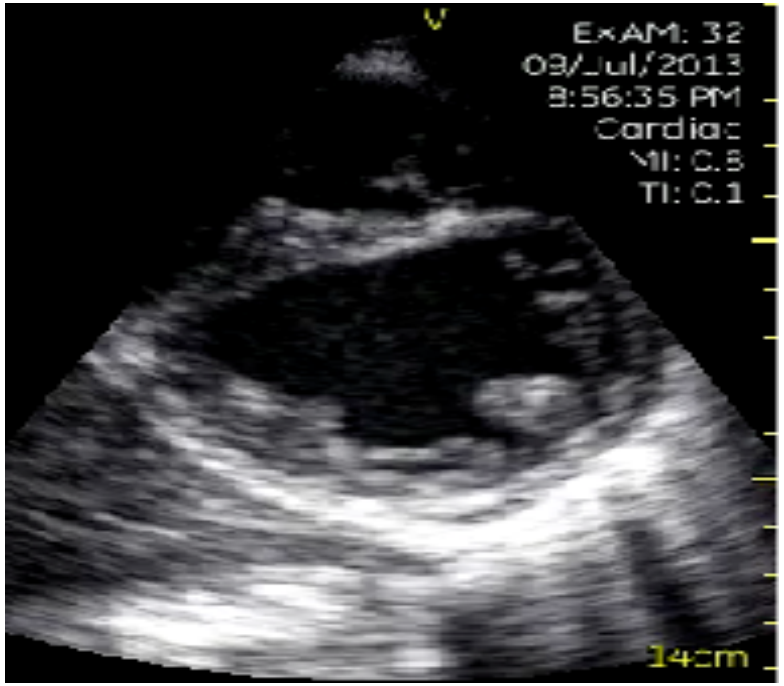
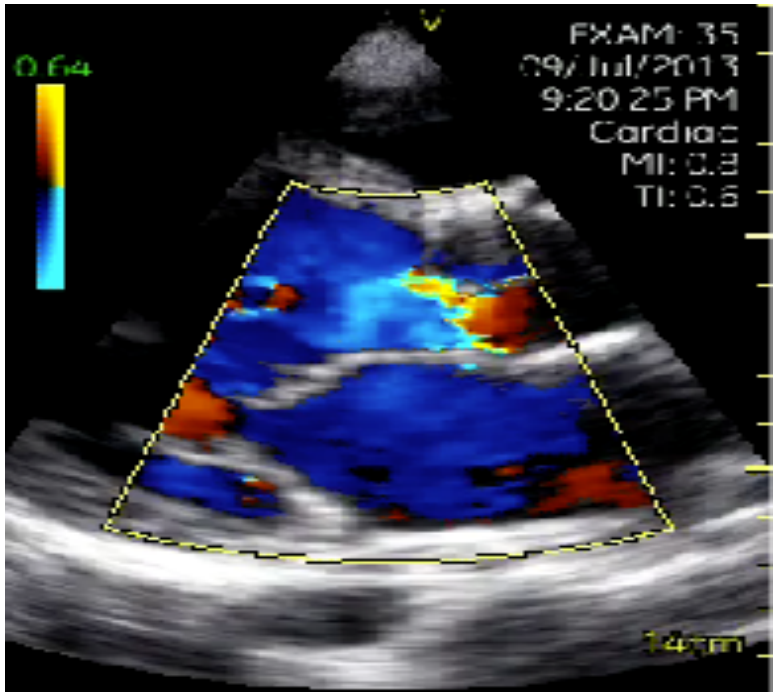
Smart phone Ultrasound.



Rheumatic Mitral Valve Disease



Pulmonary Hypertension and Right Ventricular Dysfunction



Mixed Rheumatic Mitral and Aortic Valve Disease

Could m-Health Impact Outcomes in Resource Limited Areas? Randomized Trial.

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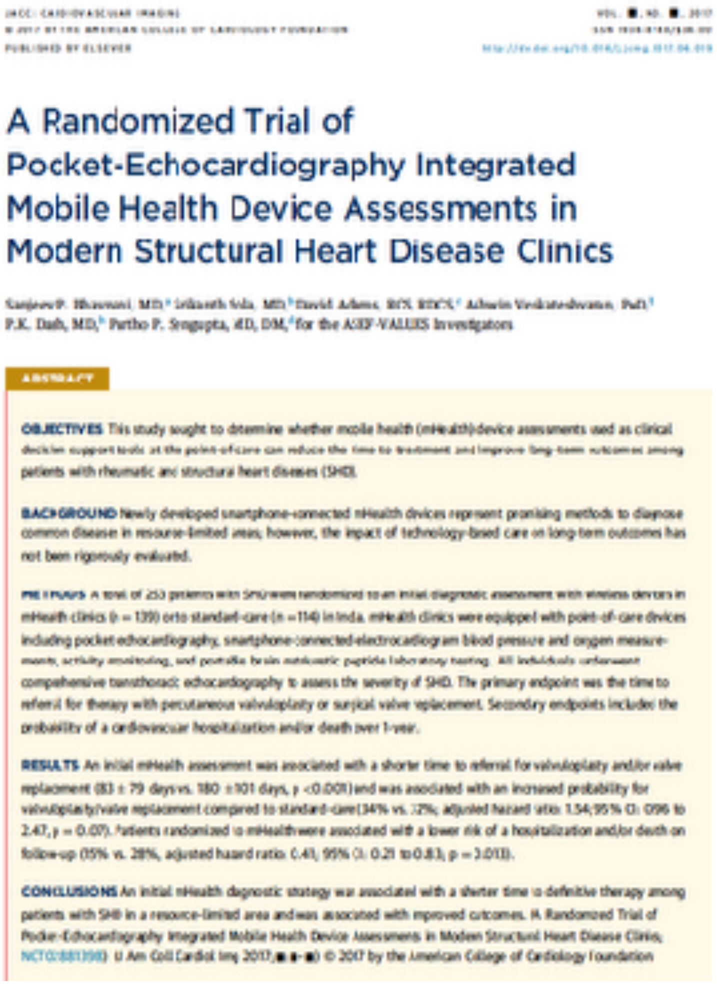
JACC: CARDIOVASCULAR IMAGING
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PUBLISHED BY ELSEVIER

A Randomized Trial of Pocket-Echocardiography Integrated Mobile Health Device Assessments in Modern Structural Heart Disease Clinics

Sanjeev P. Bhavnani, MD, Srikanth Sola, MD, David Adams, RCS, RDCS, Adwin Venkateshvaran, PhD, P.K. Dash, MD, Partho P. Sengupta, MD, DM, for the ASEF-VALUES Investigators

ABSTRACT

OBJECTIVES This study sought to determine whether mobile health (mHealth) device assessments used as clinical decision support tools at the point-of-care can reduce the time to treatment and improve long-term outcomes among patients with rheumatic and structural heart diseases (SHD).

BACKGROUND Newly developed smartphone-connected mHealth devices represent promising methods to diagnose common diseases in resource-limited areas; however, the impact of technology-based care on long-term outcomes has not been rigorously evaluated.

METHODS A total of 253 patients with SHD were randomized to an initial diagnostic assessment with wireless devices in mHealth clinics (n = 139) or to standard-care (n = 114) in India. mHealth clinics were equipped with point-of-care devices including pocket echocardiography, smartphone-connected electrocardiogram, blood pressure and oxygen measurements, activity monitoring, and portable brain natriuretic peptide laboratory testing. All individuals underwent comprehensive transthoracic echocardiography to assess the severity of SHD. The primary endpoint was the time to referral for therapy with percutaneous valvuloplasty or surgical valve replacement. Secondary endpoints included the probability of a cardiovascular hospitalization and/or death over 1-year.

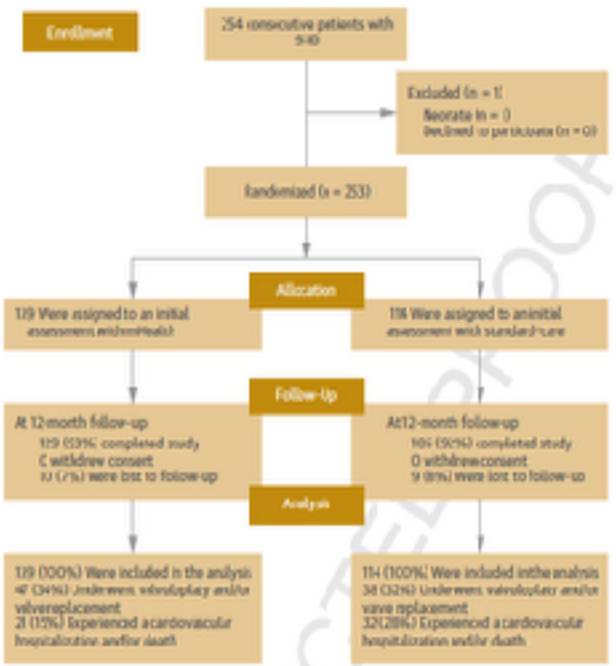
RESULTS An initial mHealth assessment was associated with a shorter time to referral for valvuloplasty and/or valve replacement (83 ± 79 days vs. 180 ± 101 days, p < 0.001) and was associated with an increased probability for valvuloplasty/valve replacement compared to standard-care (34% vs. 12%, adjusted hazard ratio: 1.54; 95% CI: 0.96 to 2.47; p = 0.07). Patients randomized to mHealth were associated with a lower risk of a hospitalization and/or death on follow-up (15% vs. 28%, adjusted hazard ratio: 0.41; 95% CI: 0.21 to 0.83; p = 0.013).

CONCLUSIONS An initial mHealth diagnostic strategy was associated with a shorter time to definitive therapy among patients with SHD in a resource-limited area and was associated with improved outcomes. (A Randomized Trial of Pocket-Echocardiography Integrated Mobile Health Device Assessments in Modern Structural Heart Disease Clinics; NCT02881398) (J Am Coll Cardiol Img 2017;■:■-■) © 2017 by the American College of Cardiology Foundation.

eFigure 2: mHealth devices
Smartphone connected wireless blood pressure and oxygen monitor (panels A and B), pocket- echocardiography (panel C), activity monitor (panel D), smartphone iECG (panel E), point-of-care fingerstick BNP test (panel F). Refer to text for device descriptions.

created wireless m-Health clinics equipped with pocket ultrasound #iECG, #activity, #BP, #lab testing

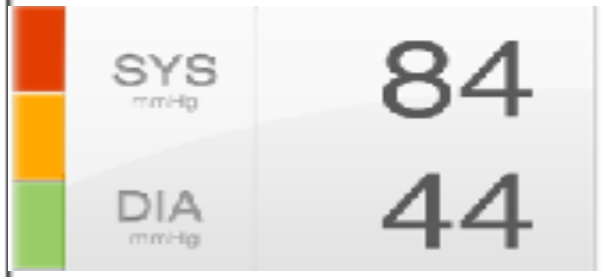
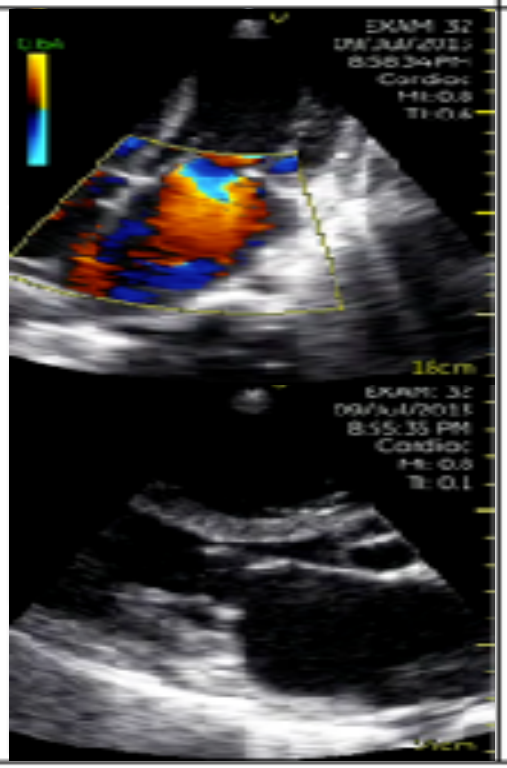
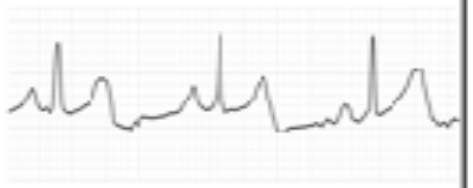
FIGURE 1 CONSORT Diagram



Enrollment, randomization, and follow-up of the study population. SHD = structural heart disease.

Randomized 253 patients in 72 hours to an initial assessment with #m-Health or to standard-care

Identifying Individual Risk with m-Health

Clinical History	6 Minute Walk Test	Mobile Blood Pressure	Handheld Echocardiogram	iECG	Point-of-Care BNP
29 year old woman No medical history Mild exertional dyspnea NYHA I-II	**Duration** 4.3 minutes **Symptoms** Dyspnea **Activity** 364 steps 277 meters 2.4 mph **Resting** 71 bpm 96% O2 **Peak Exercise** 94 bpm 92% O2 **NYHA** reclassified to class III				126

29 year old woman
NYHA I-II reclassified to NYHA III
Moderate rheumatic mitral stenosis and severe mitral regurgitation
Sinus rhythm
Referred for mitral valve replacement

Could m-Health Impact Outcomes in Resource Limited Areas? Randomized Trial.

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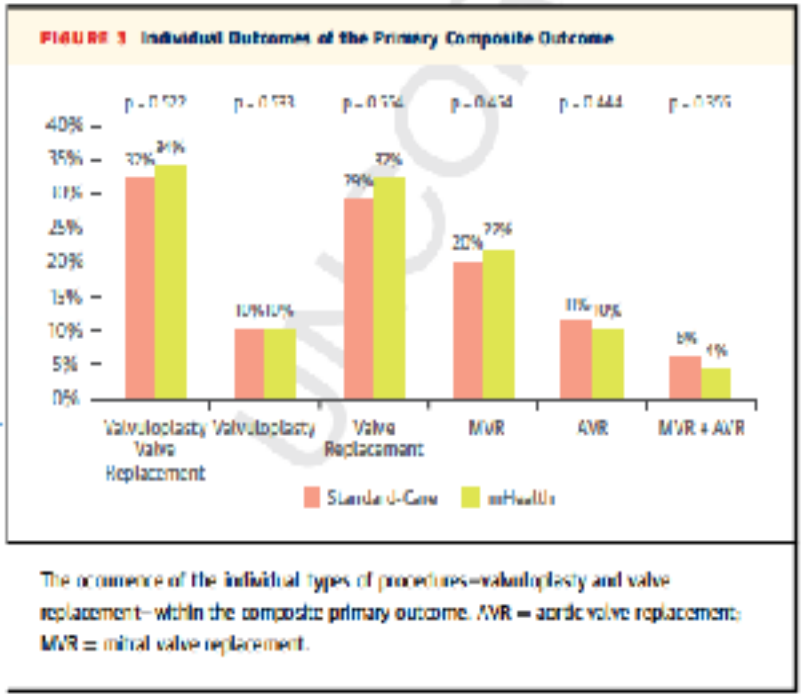
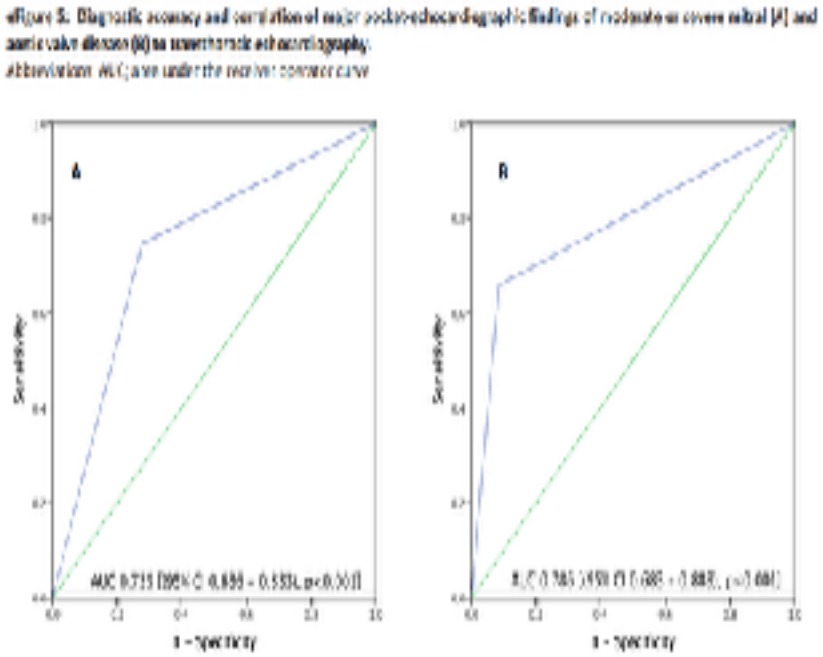
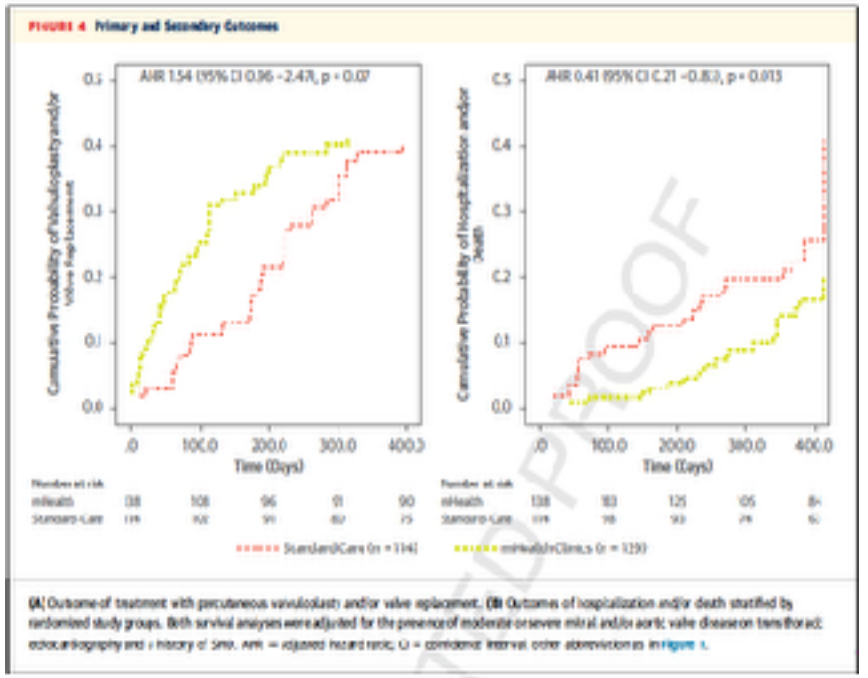


The occurrence of the individual types of procedures—valvuloplasty and valve replacement—within the composite primary outcome. AVR = aortic valve replacement; MVR = mitral valve replacement.





34% of study population underwent treatment with valvuloplasty or valve replacement on follow up; total number of procedures 119

96% of #V scan graded as good image quality & diagnostic certainty to trans-thoracic echo AUC 0.74 & 0.79 for mitral & aortic disease

Compared to standard-care #m-Health associated with shorter time to treatment (180 vs 83 days) with 2x referral rate at 90 days with #m-Health

Addressing Cardiovascular Device Market Innovation in Africa .

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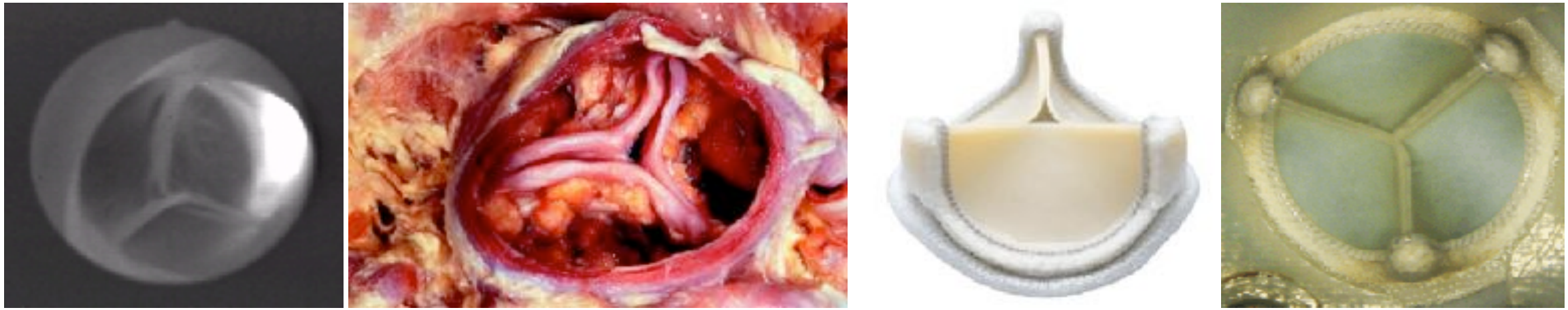
- 200,000 aortic valve replacements
  - 5% prevalence in the US population, growing at 7% per year
- ~ $2 Billion market in US and EU
  - 65% are surgically implanted tissue valves
- Huge untapped market in developing world – 34 million rheumatic heart valve disease patients



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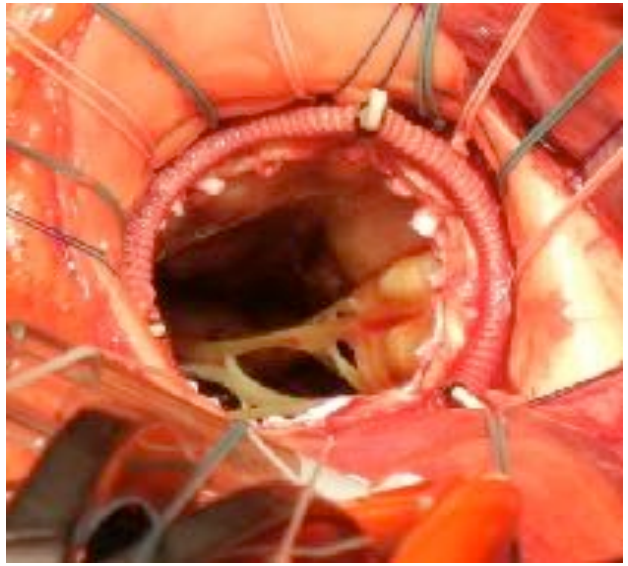
Innovation: Development Low Cost Heart Valve

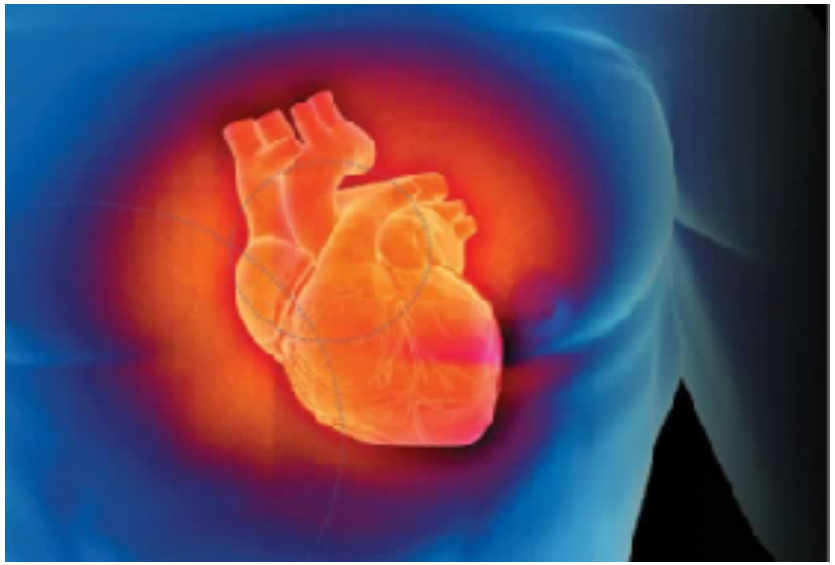
addressing the uniqueness of rheumatic heart disease patients

Conventional bioprosthesis

Implanted base of Vitality

Two-step implant of Vitality





Rapidly Exchangeable LeafletsTechnology Platform.

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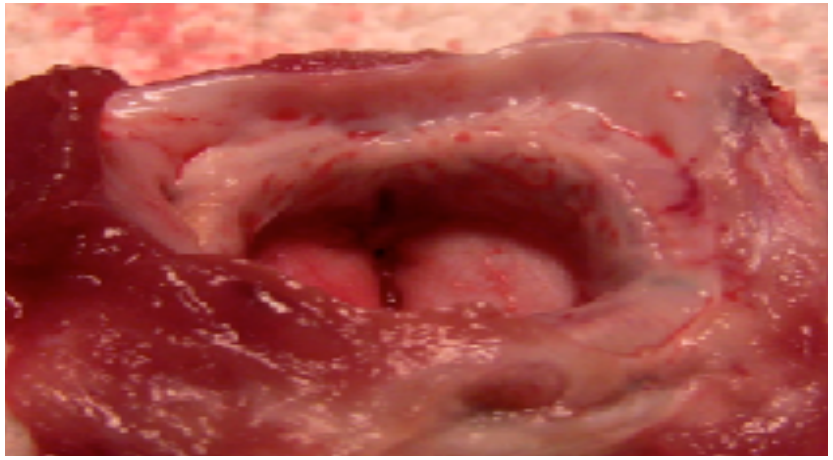
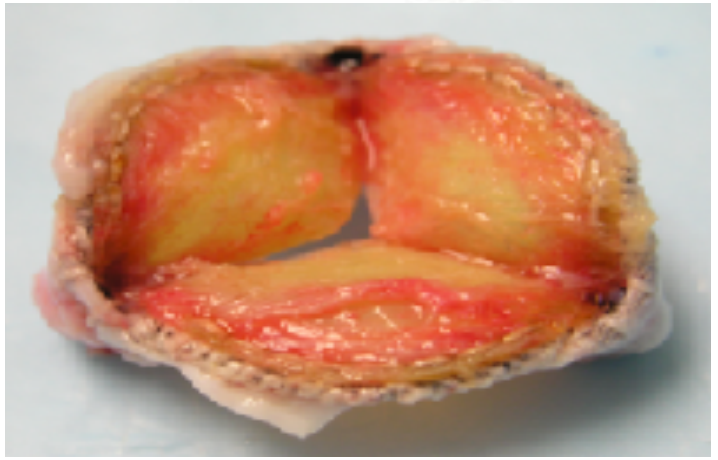
- Leaflet Exchange demonstrated in Animal Models
  - Pannus overgrowth tears as Leaflet Set is separated from Base.
  - Reduces redo pump time from > 60 minutes to ~ 5 minutes
  - Drives tissue valve indications to younger patients (RHD)





Funding A Low Cost Heart Valve .Is There a Future?

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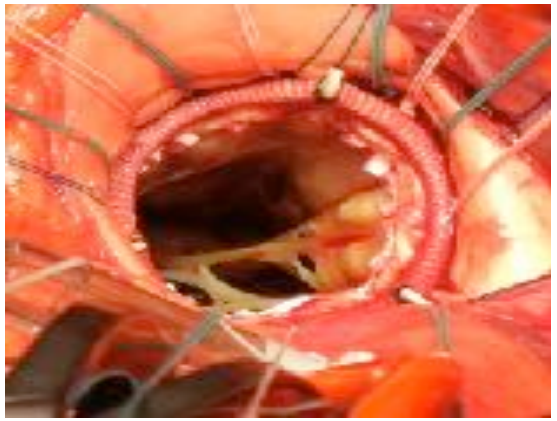
Edwards

Vitality valve

Total Cost	S550 (estimated)	$250 after molding implementation
Assembly labor	8 hours per valve	6.5 hours per valve
Tissue	$150 per valve	S50 per valve
Valve Frame	$35-50	S8 after molding implementation

Injection molded parts offer low unit cost, faster assembly, less training of assembly technicians
Automated pericardium selection improves utilization and reduces costs




FUTURE
PAST
PRESENT

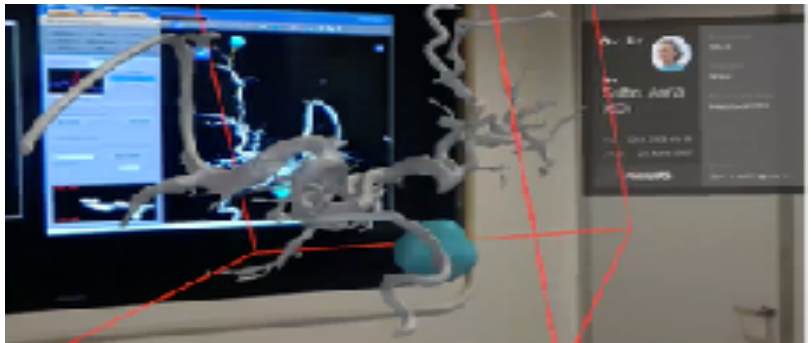
Connecting the Dots: Preparing For The Fourth Industrial Revolution.

67TH International Congress of the European Society of Cardiovascular and Endovascular Surgery
ESCVS
12-14 APRIL 2018 STRASBOURG

(a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres," could significantly improve the quality of life for billions around the world) Irving Wladawsky-Berger

Immersive Reality

Long Distance Tele-Robotic-Health



Connecting the Dots: Building a Scalable Global Cardiac Care Surgery Delivery Platform.

The Operating Room of The Future Will Leverage Augmented Reality ,Robotics and Tele-presence Technology.

Cloud Computing Replaces Hardware; Automated Image Guided Surgical Protocols Could Be Made Available to emerging economies.

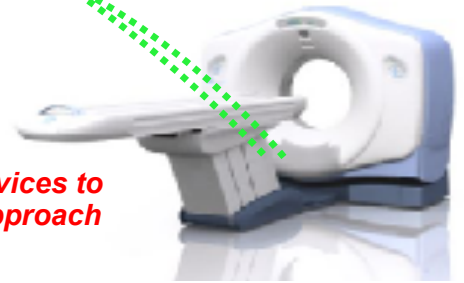
medopad

Virtualized surgery

Data is transmitted through secured health cloud

The relevant images and report are sent to the customer site.

A heart surgeon in the US, for example, could use Internet-controlled devices to virtualize an operation in Africa. While the practical application of this approach remains in the future, there have already been demonstration trials.



Patient imaging /digital health data from'Anywhere'

Computer Vision and Holographic Image Guided Surgery:Building a Scalable Platform for Global Surgery.

Data and reports sent to Center of Excellence.

3D Printing of Heart Valves From Ideation to Concept .

Bridging the North-South Divide Through Innovation: The Future

The Cape Town Declaration calls for a global cardiac umbrella organization built from existing societies to oversee cardiac care development in LMICs.

Digital health platform could connect cardiac specialists from all over the world through a collaborative platform for training, research, education, patient care, and global surgery.

Innovation

Expedites information sharing and service coordination to create a practical pathway for the delivery of cardiac care in developing countries.

Creates a coalition of stakeholders: cardio-thoracic surgeons, cardiologists, industry, governments and donors

67TH INTERNATIONAL CONGRESS OF THE EUROPEAN SOCIETY OF CARDIOVASCULAR AND ENDOVASCULAR SURGERY
ESCVS
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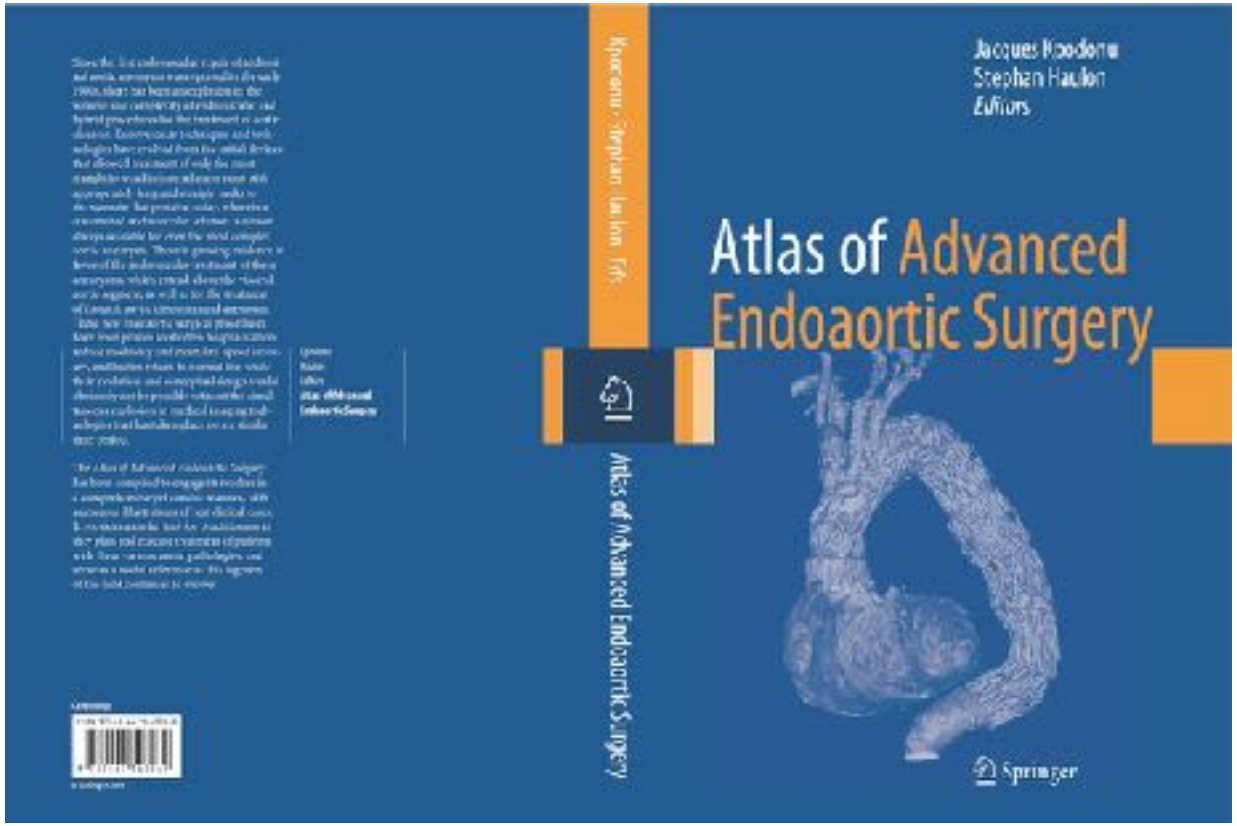
Thank You



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