TELEMEDICINE IN CHRONIC HEART DISEASE IN HONG KONG- CARE FROM A DISTANCE?

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THE CLOUD REVOLUTION

Uber, the world's largest taxi company, owns no vehicles. Facebook, the world's most popular media owner, creates no content. Alibaba, the most valuable retailer, has no inventory. And Airbnb, the world's largest accommodation provider, owns no real estate. Something interesting is happening.

- Tom Goodwin

WHAT IF PATIENTS DO NOT NEED TO COME/ STAY IN HOSPITAL?

NEW HEALTH CARE ACCESS IN NEW AND NON-TRADITIONAL VENUES

- Convenient care at a lower price than traditional healthcare delivery systems
- Robust consumer mobile health applications that can be easily integrated with existing health solutions
- Enable a cultural shift in healthcare delivery in a convenient and efficient service model

DISRUPTION OF TRADITIONAL HEALTH CARE HAS INTRODUCED NEW MECHANISM FOR THE MEDICAL CONSUMER TO ACCESS HEALTHCARE USING DIGITAL TOOLS…

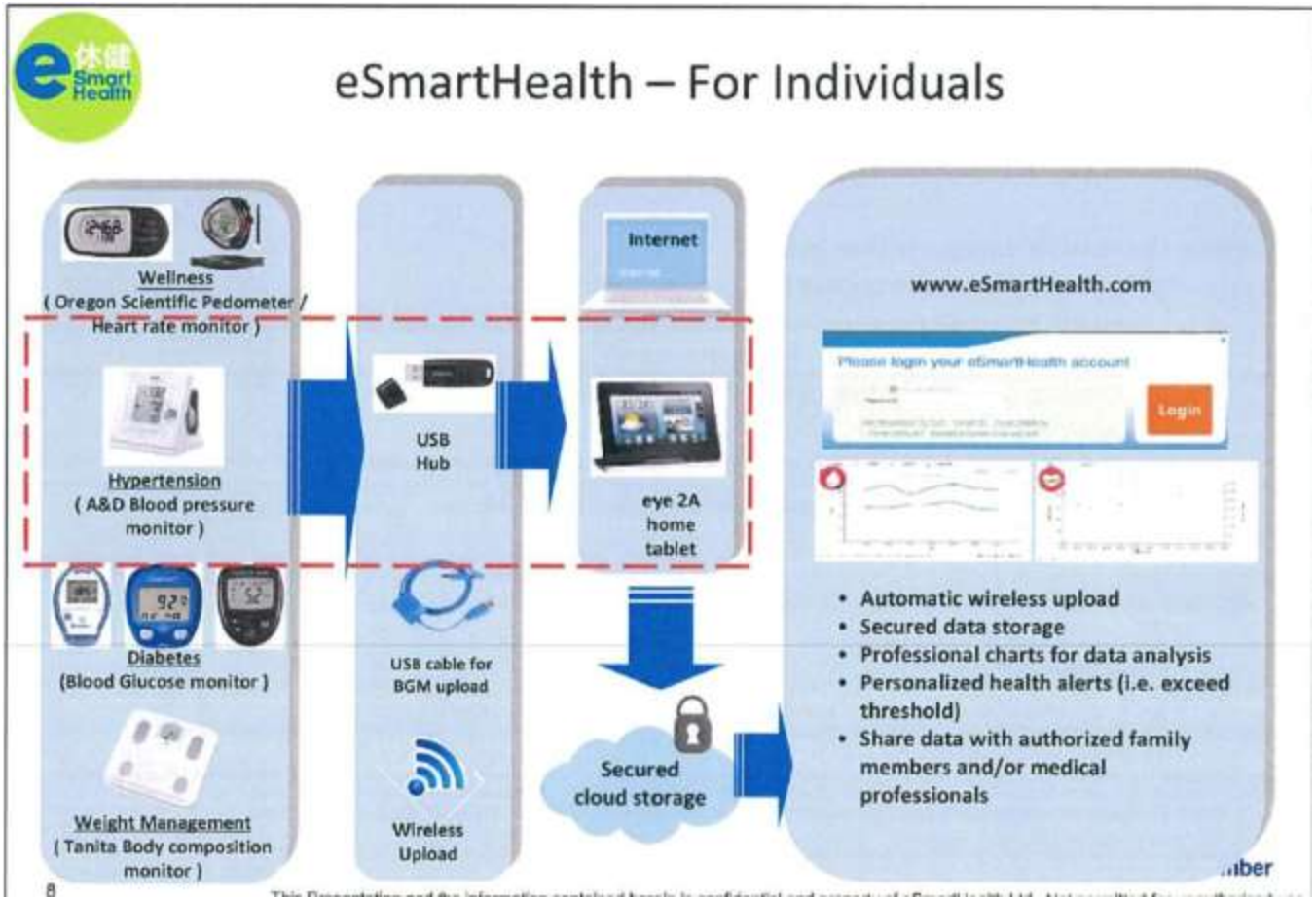
TELEMONITORING IN HK (NGO)

平安手機
Safety Phone

「平安手機®」服務
活躍好動銀齡人士的
貼身支援伙伴

長者安居協會
Senior Citizen Home Safety Association

TELEMONITORING IN HK (TELECOMMUNICATIONS)



INNOVATIVE INSURANCE CONCEPT

- **Fitness trackers are linked online through mobile apps**
- **Allows individuals to monitor activity progress against set goals**
- **Target reached will result in discounts on their insurance premiums**

TELEMEDICINE

- Defined as delivery of healthcare or information at a distance via technology, and includes services such as assessment, monitoring, communications, disease prevention, and education

BOTH PROCESS & OUTCOME OF CARE

- **Providing education- (improve self management)**
- **Enabling information transfer (telemonitoring)**
- **Facilitating contact with health professionals (telephone support and follow-up)**
- **Improving electronic records**

TWO TYPES:

- **Provision of remote clinical services, via real-time two-way communication between the patient and the healthcare provider, using electronic audio and visual means**
- **Store-and-forward transmission of data (asynchronously)**
  - **Monitoring applications** can be entirely automatic or having required the patient to do something

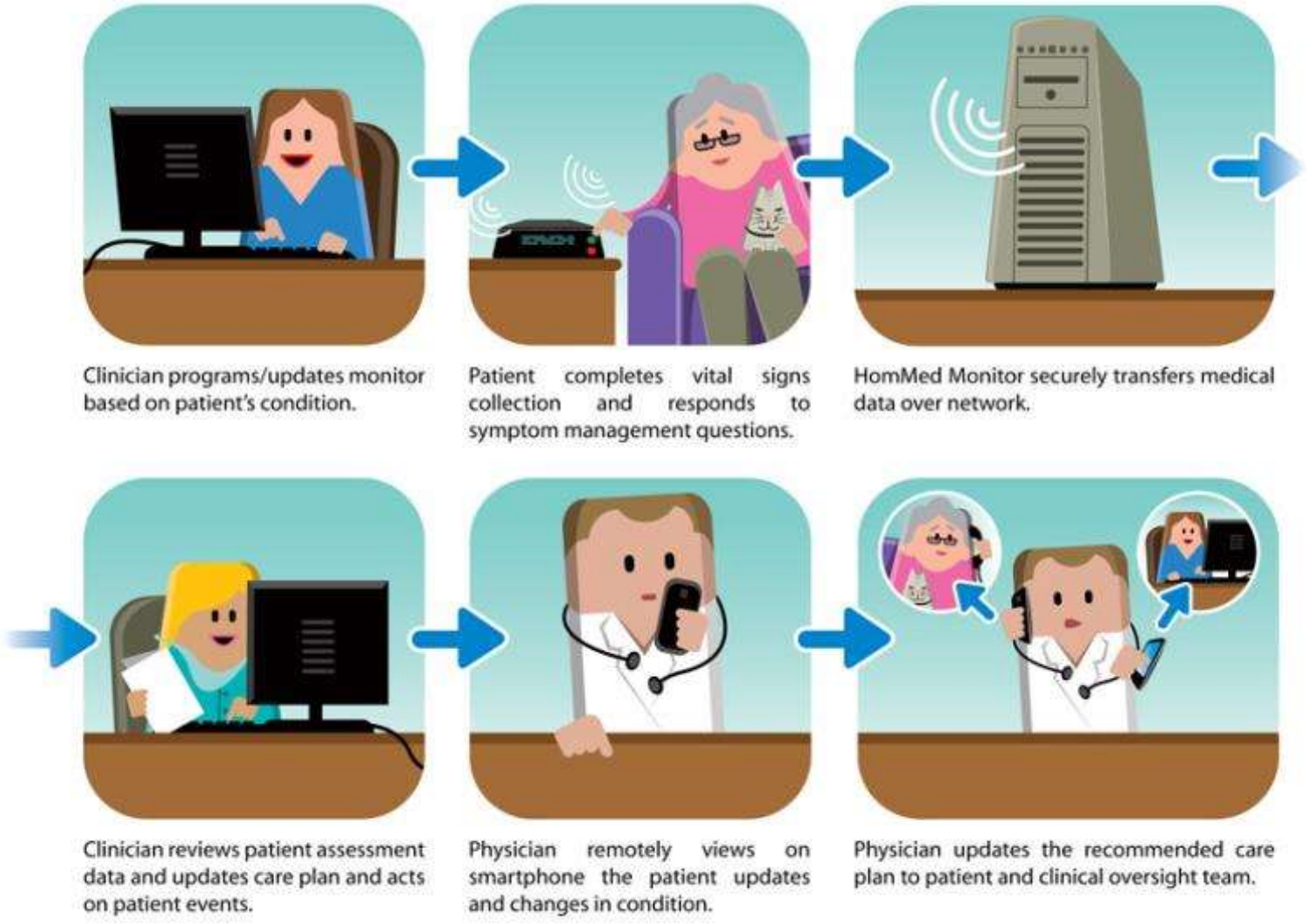
DEVICES USED IN CARDIAC REMOTE MONITORING

Invasive Implants

Care Delivery Innovations:

Non-invasive Sensors

SCHEMA OF CARDIAC TELEMONITORING



Remote Monitoring Using CIEDs

CIEDs with Remote Monitoring capability

Remote Monitoring transmitter

Remote Monitoring system website

Devices send information via wireless radio frequency at scheduled time

Encrypted information upload through household telephone lines

Treatment, detection & record

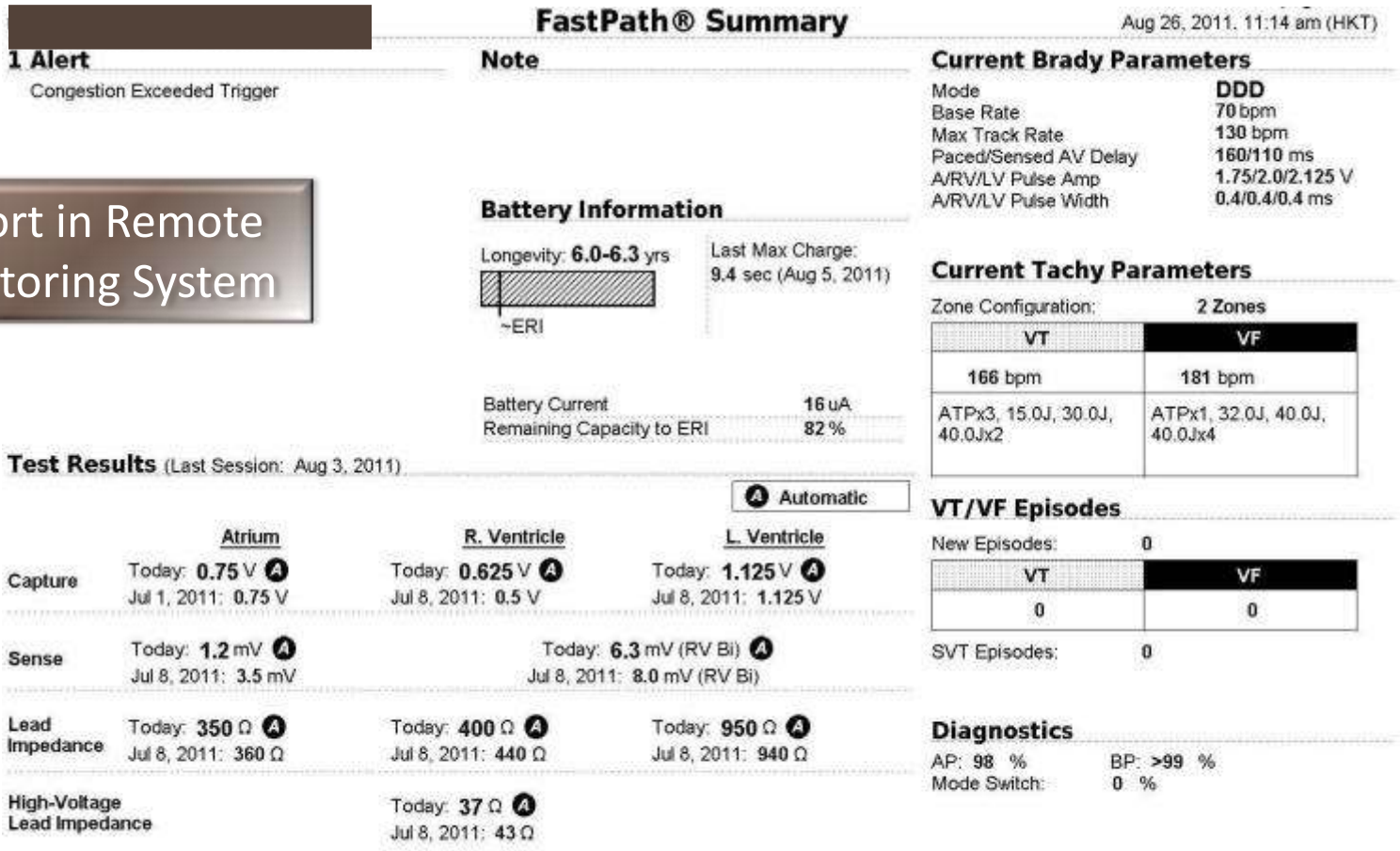
Encrypt the Received information

Authorized personnel access the information by logging into the system with PIN codes

*CIEDS= Cardiac Implantable Electrical Devices

Personnel access the information by logging into the system with Authorized PIN codes

Report in Remote Monitoring System



FastPath® Summary Aug 26, 2011, 11:14 am (HKT)

1 Alert
Congestion Exceeded Trigger

Note

Battery Information
Longevity: **6.0-6.3** yrs
~ERI
Last Max Charge: **9.4** sec (Aug 5, 2011)

Battery Current	**16** uA
Remaining Capacity to ERI	**82** %

Test Results (Last Session: Aug 3, 2011)

Automatic

	Atrium	R. Ventricle	L. Ventricle
Capture	Today: **0.75** V A Jul 1, 2011: **0.75** V	Today: **0.625** V A Jul 8, 2011: **0.5** V	Today: **1.125** V A Jul 8, 2011: **1.125** V
Sense	Today: **1.2** mV A Jul 8, 2011: **3.5** mV	Today: **6.3** mV (RV Bi) A Jul 8, 2011: **8.0** mV (RV Bi)	
Lead Impedance	Today: **350** Ω A Jul 8, 2011: **360** Ω	Today: **400** Ω A Jul 8, 2011: **440** Ω	Today: **950** Ω A Jul 8, 2011: **940** Ω
High-Voltage Lead Impedance		Today: **37** Ω A Jul 8, 2011: **43** Ω	

Current Brady Parameters

Mode	**DDD**
Base Rate	**70** bpm
Max Track Rate	**130** bpm
Paced/Sensed AV Delay	**160/110** ms
A/RV/LV Pulse Amp	**1.75/2.0/2.125** V
A/RV/LV Pulse Width	**0.4/0.4/0.4** ms

Current Tachy Parameters

Zone Configuration: **2 Zones**

VT	VF
166 bpm	**181** bpm
ATPx3, 15.0J, 30.0J, 40.0Jx2	ATPx1, 32.0J, 40.0J, 40.0Jx4

VT/VF Episodes

New Episodes: **0**

VT	VF
0	**0**

SVT Episodes: **0**

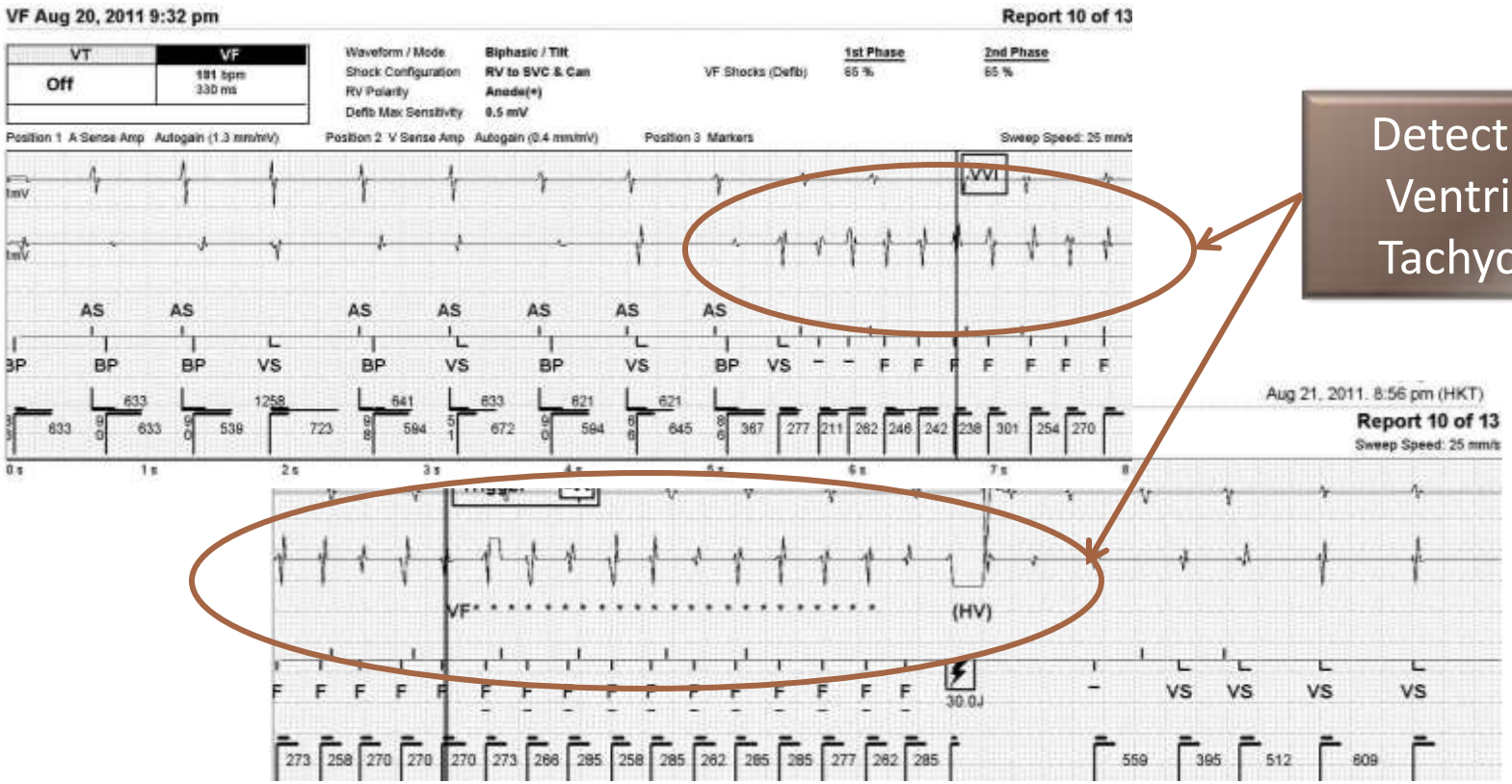
Diagnostics

AP: **98** % BP: **>99** %
Mode Switch: **0** %

REMOTE MONITORING

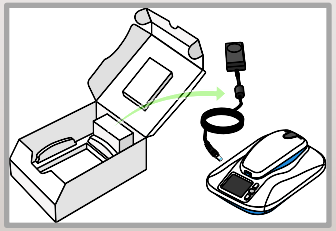
TRANSMISSION OF PRE—SET ALERTS: VT WITH APPROPRIATE SHOCKS

- 68 yrs man with DCM/ NSVT-CRT-D implanted as primary prevention
- Stable condition after ICD shock -did not need to attend ER; patient reassured

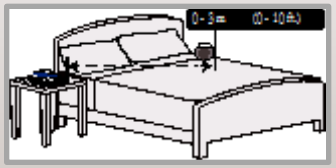


Initial Transmission Overview

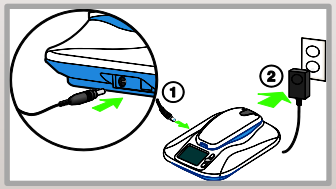
Review the transmission steps. Click to view the monitor animations.



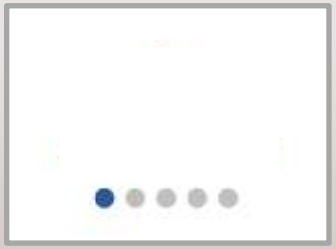
Unbox



Locate

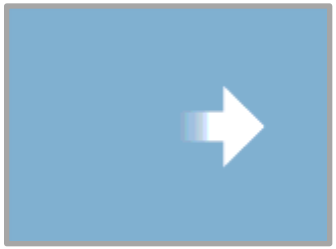


Connect



Boot up

Search for signal



Press Accept

Pick up Reader

Position Reader

Interrogate

Replace Reader

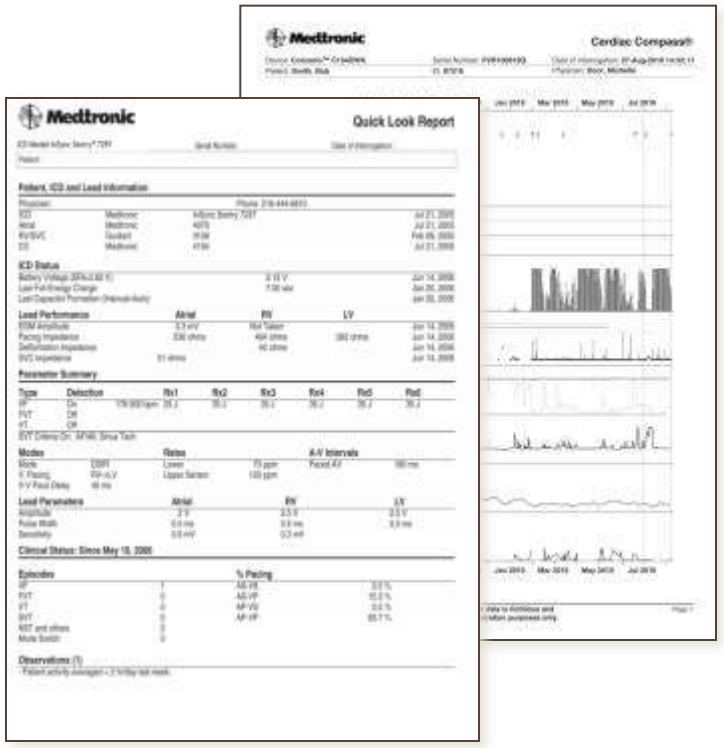
Transmit

Complete

Ready

DEVICE DATA IS CRITICAL FOR PATIENT CARE

System & health status



- Device & lead status
- Arrhythmia episodes (AT/AF)
- Delivered therapies
- AT/AF burden
- Heart rate variability
- % Pacing
- Fluid status
- Activity

Predictive diagnostics for HF hospitalization in the next 30 days[4]

[4] Whellen DJ., et. al. *J Am Coll Cardiol* 2010;55:1803-10.

REDUCE HEALTHCARE UTILIZATION

Up to **1 in 4** CRT-D/ICD device patients may visit the Emergency Room[1]

35%[2] potential reduction in ER visits

Baseline | Remote Monitoring

Up to **1 in 2** CRT-D/ICD device patients may require a hospitalization [1]

20%[3] potential reduction in all-cause 3y rehospitalization

18%[1] potential reduction in hospital length of stay

[1] Crossley GH, et al. *J Am Coll Cardiol.* 2011;57:1181-1189.[2] Landolina M, et al. *Circulation*. 2012;125:2985-2992. [3] Akar J, et al. LB03-03 Presented at HRS 2014.

SIMPLIFIES ROUTINE FOLLOW-UP

Routine in-office visits may be replaced by remote visits resulting in **45% fewer**[1] in-office visits

58% less time[2] for remote vs. in-office follow-up

Remote monitoring **improves patient compliance**[1] to follow-up

[1] Varma N. *Am Heart J.* 2007;154:1029-1034. [2] Cronin EM, et al. *Heart Rhythm.* 2012;9:1947-1951.

Remote Monitoring “Big Data”

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The Relationship Between Level of Adherence to Automatic Wireless Remote Monitoring and Survival in Pacemaker and Defibrillator Patients

Niraj Varma, MD, PhD,* Jonathan P. Piccini, MD, MHSc,† Jeffery Snell, BA,‡ Avi Fischer, MD,‡ Nirav Dalal, MS,‡ Suneet Mittal, MD§

CONCLUSIONS RM is associated with improved survival, irrespective of device type (including PMs), but demonstrates a graded relationship with the level of adherence. The results support the increased application of RM to improve patient outcomes. (J Am Coll Cardiol 2015;65:2601-10) © 2015 by the American College of Cardiology Foundation.

J Am Coll Cardiol 2015;65:2601–10

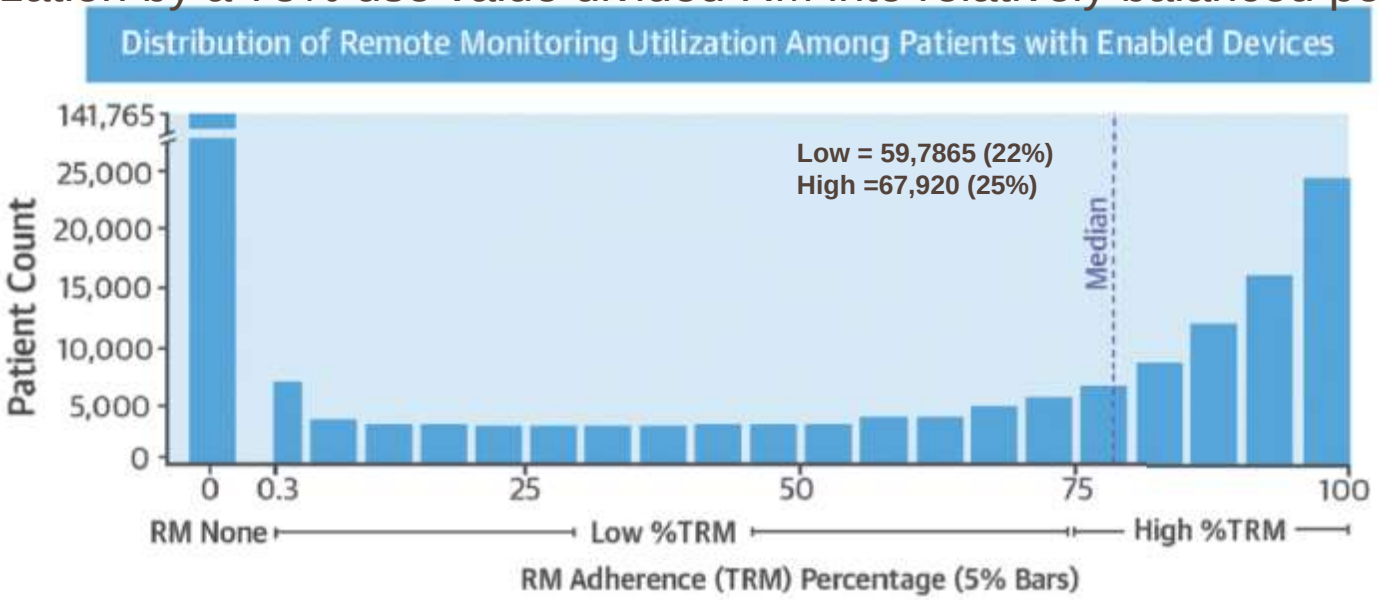
Patient Adherence to RM

- "Big data" to assess
  - –RM is associated with improved survival
  - –Type of cardiac device
  - –Degree of use
- N=269,471 consecutive pts implanted with automatic RM capable devices between 2008-2011
  - –Mean age 71±13.5 yrs; 64.8% male
  - –Mean FU 2.9±1 yrs

RM adherence per patient was defined as the proportion of total follow-up weeks having at least 1 status transmission or percentage of time in RM (%TRM)

53% patients never used RM

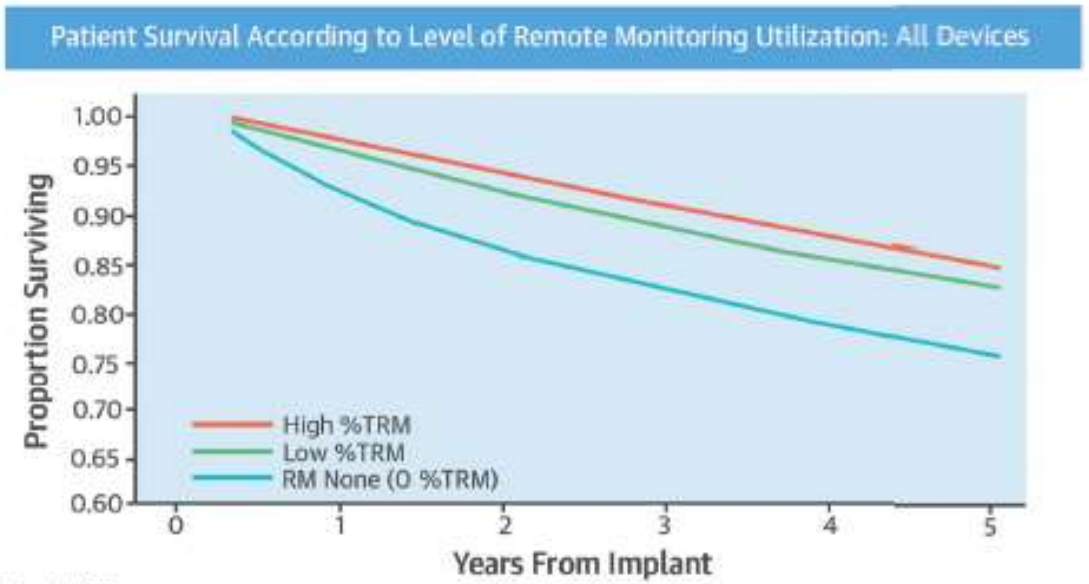
Dichotomization by a 75% use value divided RM into relatively balanced populations



J Am Coll Cardiol 2015;65:2601–10

Survival in all Patients (PPM, ICD, CRT)

Survival was greater in patients in all device types



Patients at Risk

High %TRM	67,920	66,096	60,519	29,812	7,726	533
Low %TRM	59,786	57,221	52,473	30,715	10,236	1,042
RM None	141,765	129,137	115,230	62,720	18,032	1,735

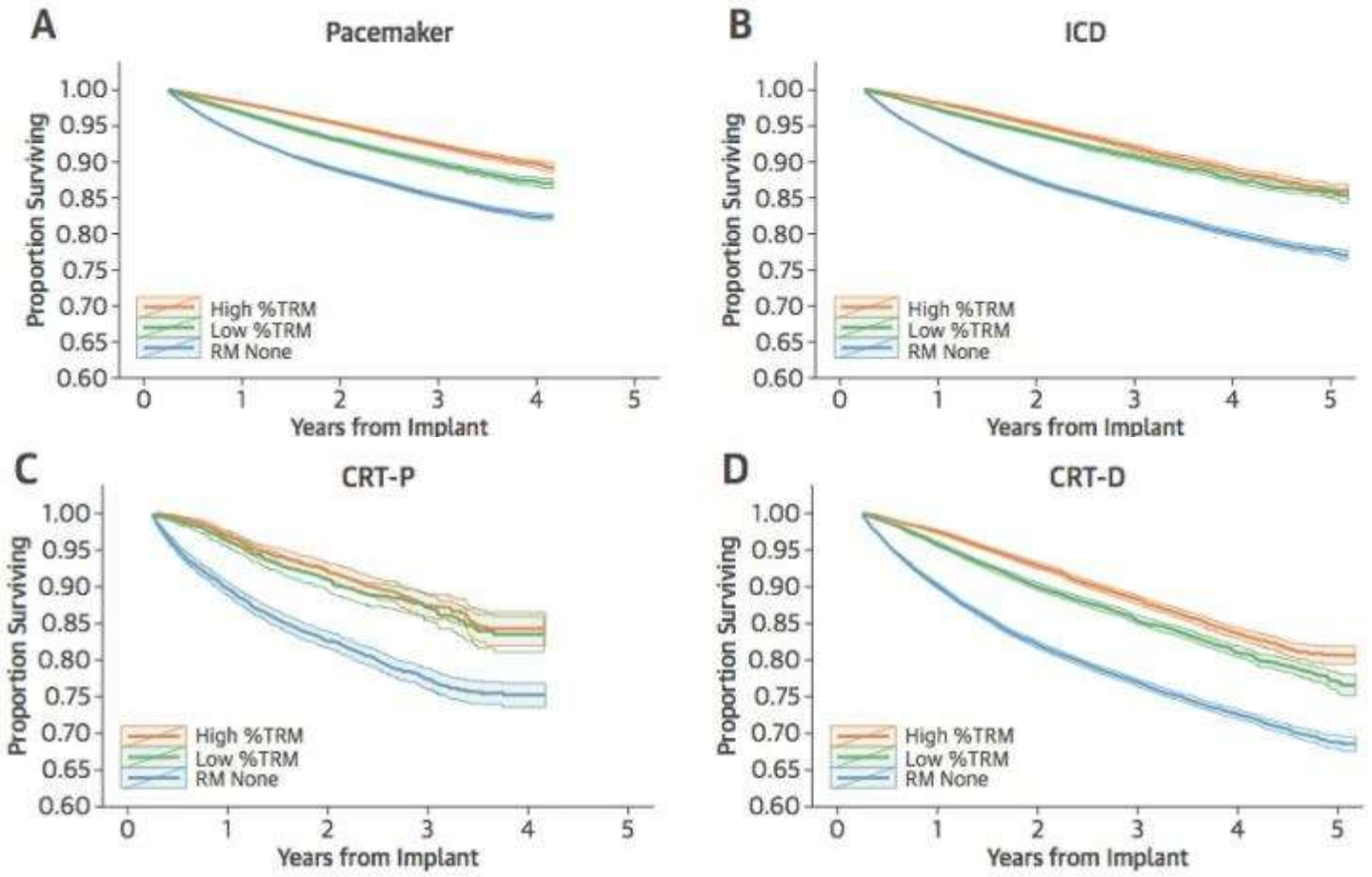
Cox Survival

High %TRM vs RM None	HR: 2.10 (2.04-2.16) p <0.001
Low %TRM vs RM None	HR: 1.58 (1.54-1.62) p <0.001
High %TRM vs Low %TRM	HR: 1.32 (1.27-1.36) p <0.001

Mean Follow-Up: 2.87 (1.03) Years

J Am Coll Cardiol 2015;65:2601–10

OUTCOMES WERE SUPERIOR IN HIGH %TRM AND LOW %TRM FOR ALL DEVICE TYPES



The degree of adherence correlates with the magnitude of survival gain, suggesting a gradient of effect

Critical impact of adherence: for maximal benefit of RM:

Earlier activation and then maintenance of consistent transmissions were associated with best outcomes

TELEMONITORING FOR HEART FAILURE DISEASE MANAGEMENT IN HONG KONG

HEART FAILURE – A GROWING GLOBAL CONCERN

Prevalence and Incidence

Overall 2.1% prevalence: 5.1M heart failure patients in 2010[1]

825,000 people ≥ 45 years of age are newly diagnosed each year with HF.[1]

15 M heart failure patients in the European countries[2]

- Overall 2-3% prevalence[2]

Mortality

For AHA/ACC stage C/D patients diagnosed with HF:

- 30% will die in the first year.[3-5]
- 60% will die within 5 years.[5]

HF prevalence in the US is projected to increase 46% from 2012 to 2030, resulting in > 8M people ≥ 18 years of age with HF.[6]

1. AHA 2014 Statistics at a Glance, 2014
2. The European Society of Cardiology, ESC HF Guideline, 2008
3. Curtis et al, Arch Intern Med, 2008.
4. Roger et al. JAMA, 2004.
5. Cowie et al, EHJ, 2002.
6. Heidenreich PA et al. Circ Heart Failure 2013.

HEART FAILURE IS ASSOCIATED WITH HIGH HOSPITALIZATION AND READMISSION RATES

In 2010, there were 1 million hospitalizations in the US with HF as the principal diagnosis.[1]

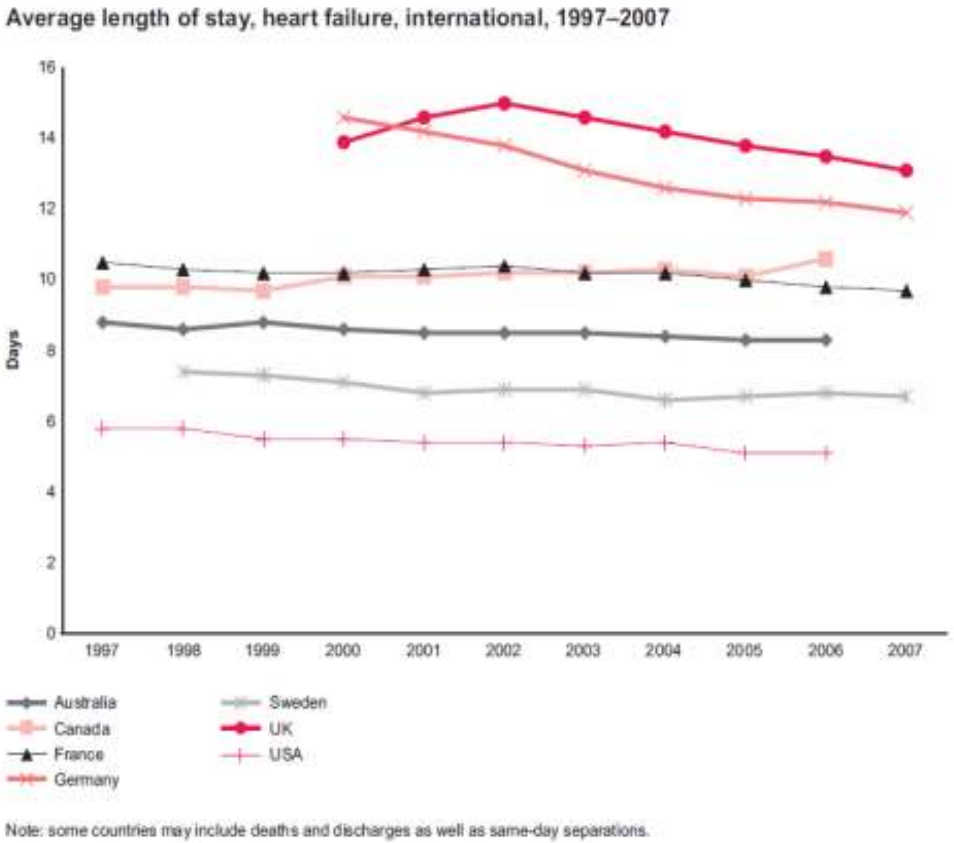
- Hospitalization rate did not change significantly from 2000.[1]

Average length of hospital stay

- Approximately 5 days (US)[2]
- 11 days (Europe)[3]

<u>HF is associated with high readmission rates:</u>

- ~25% all-cause readmission within 30 days[4] and ~50% within 6 months[5]

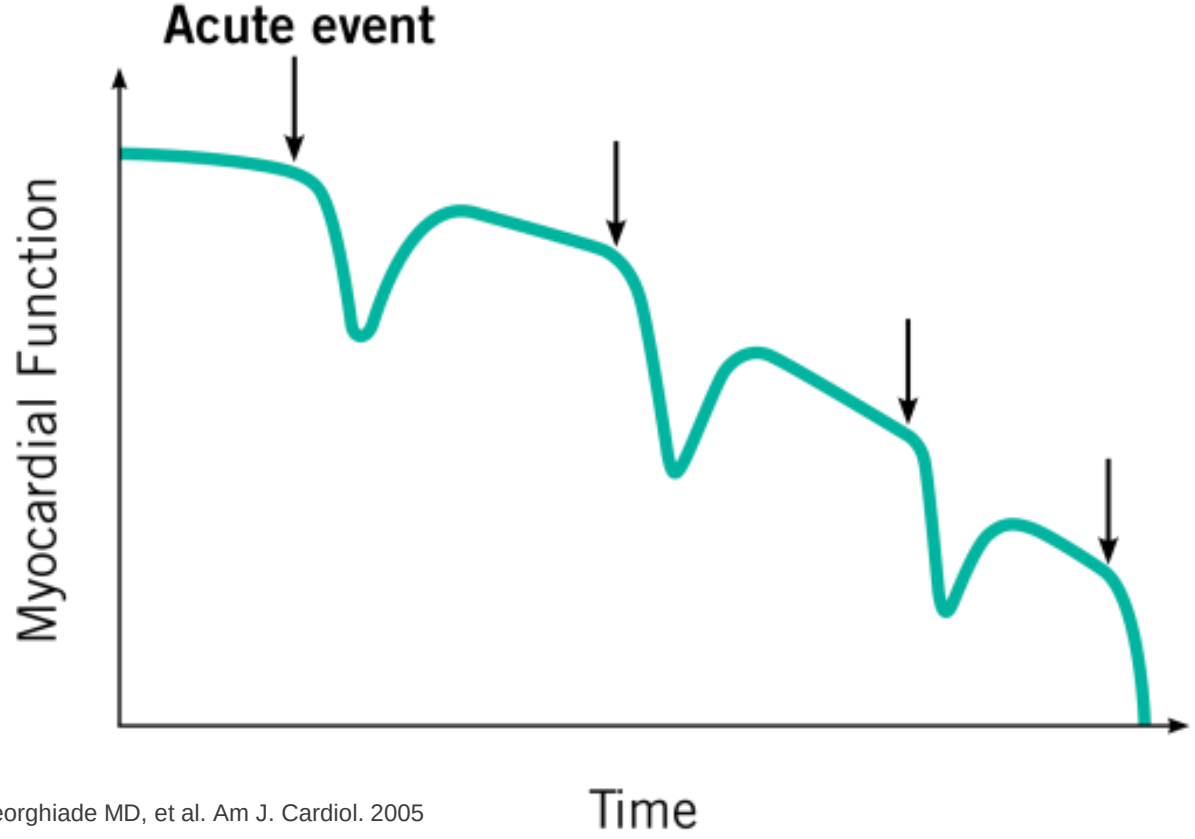


1. CDC NCHS National Hospital Discharge Survey, 2000-2010
2. Yancy et al. JACC, 2006.
3. Cleland et al. EuroHeart, 2003.
4. Krumholz HM, et al. Circ Cardiovas Qual Outcomes 2009.
5. Wexler DJ, et al. Am Heart J 2001.

Graph from www.health.org.uk. Bridging the gap: Heart Failure, 2010.
Data from Organization for Economic Cooperation and Development, 2009.

WORSENING HEART FAILURE LEADING TO HF-RELATED HOSPITALIZATIONS CONTRIBUTES TO DISEASE PROGRESSION

With each subsequent HF-related admission, the patient leaves the hospital with a further decrease in cardiac function.



Graph adapted from: Gheorghiade MD, et al. Am J. Cardiol. 2005

CURRENT HF MANAGEMENT IS INADEQUATE FOR IDENTIFYING AND MANAGING CONGESTION LEADING TO DECOMPENSATION

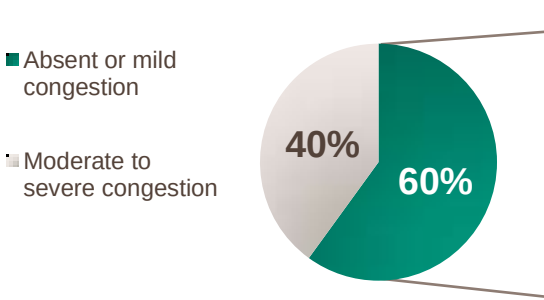
Identifying congestion early will lead to early treatment, prevent hospitalizations and slow the progression of HF.

90% of HF hospitalizations present with symptoms of pulmonary congestion.[1,2]

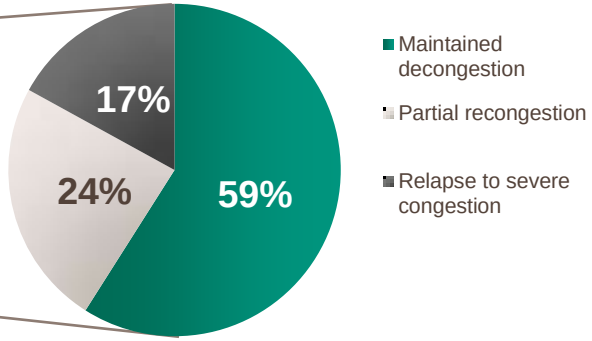
Post hoc analysis of 463 acute decompensated HF patients from DOSE-HF and CARRESS-HF trials showed:

- 40% of patients are discharged with moderate to severe congestion.[3]
- Of patients decongested at discharge, 41% had severe or partial re-congestion by 60 days.[3]

Congestion state at discharge

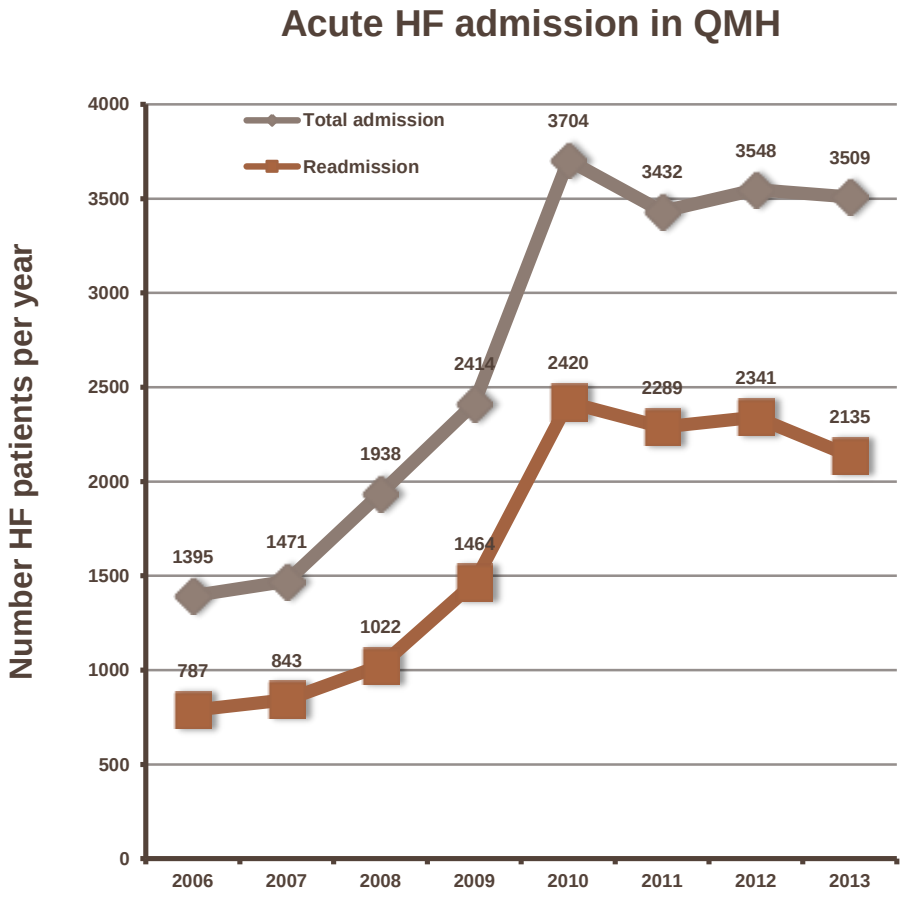


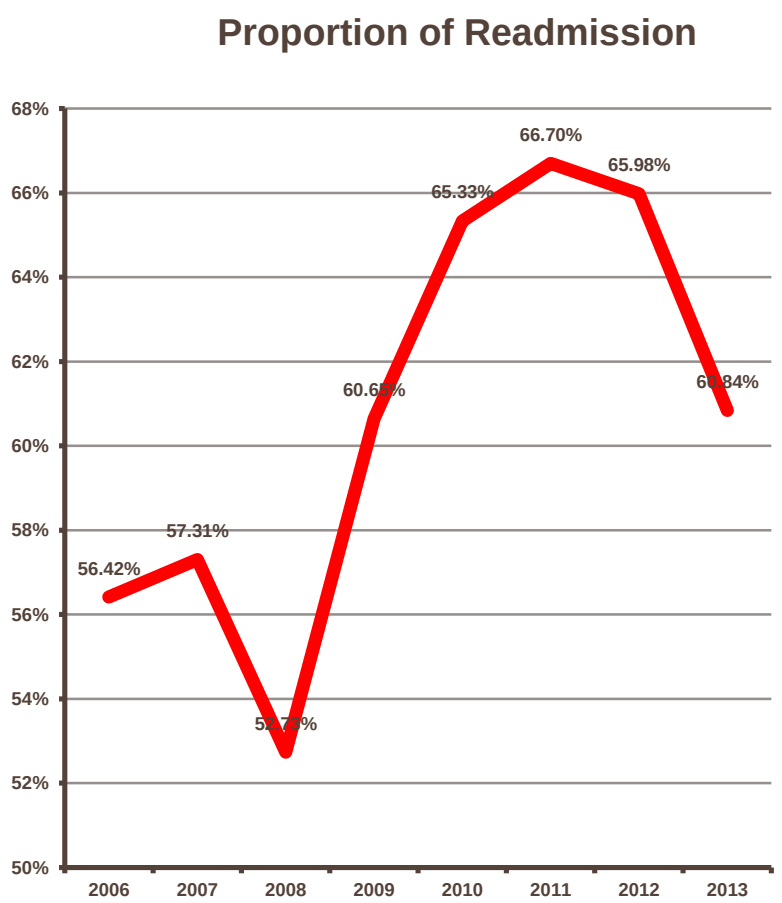
Congestion state of patients discharged without congestion at 60 day follow-up[3]



1. Adams KF, et al. Am Heart J. 2005
2. Krum H and Abraham WT. Lancet 2009
3. Lala A, et al. JCF 2013

LOCAL ACUTE HF ADMISSIONS DATA





In 2013, there were ***3,509 acute admissions*** (out of total 23,085 admissions, i.e. **15.2%**), i.e., ***10 HF admissions/day,*** and the means ***LOS: 4.8 days*** in QMH, ***estimated total cost in QMH = HKD$72,931,056*** (3,509 admission x 4.8 days x HKD$4,330)

REMOTE MONITORING VS REMOTE DISEASE MANAGEMENT

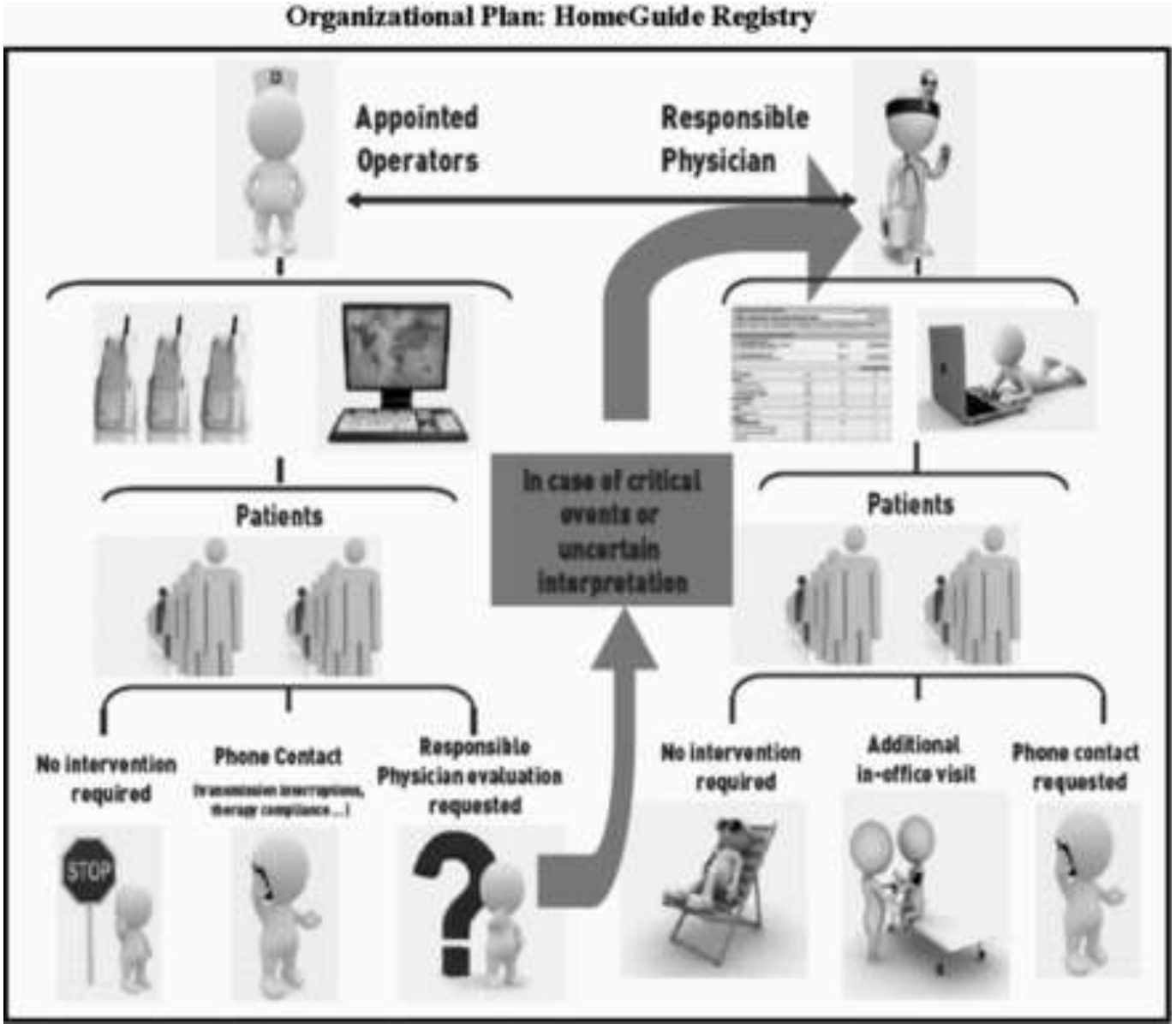
Paradigm shift

Access to information in a more timely fashion allowing a more pro-active approach

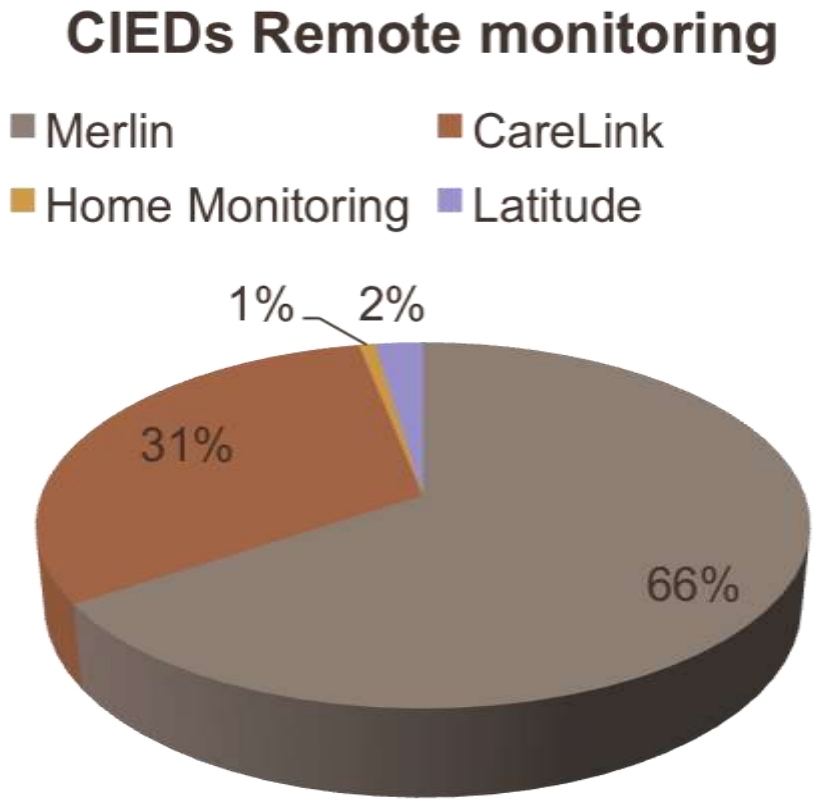
Can we use devices as disease management tools?

- Can we provide better heart failure care?
  - ***Can HF hospitalization be prevented by remote monitoring?***

WORKFLOW AND PATHWAY OF HOME MONITORING FOR HEART FAILURE PATIENTS WITH IMPLANTABLE DEVICES

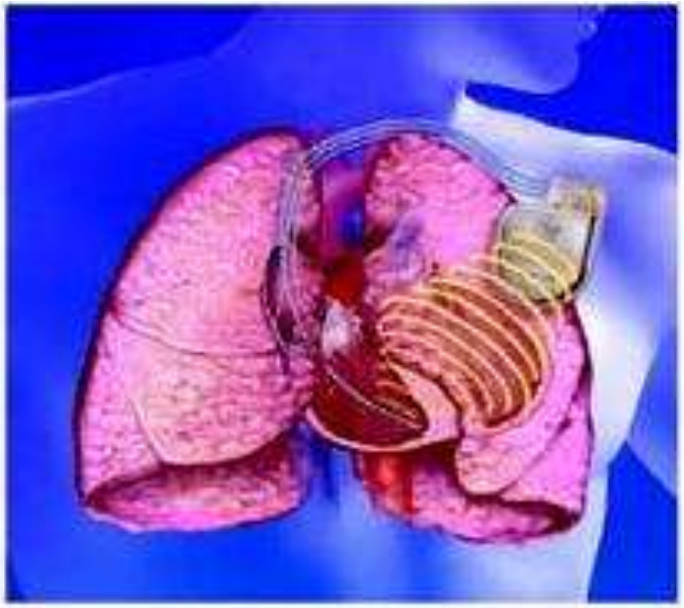


CIEDS REMOTE MONITORING IN GH



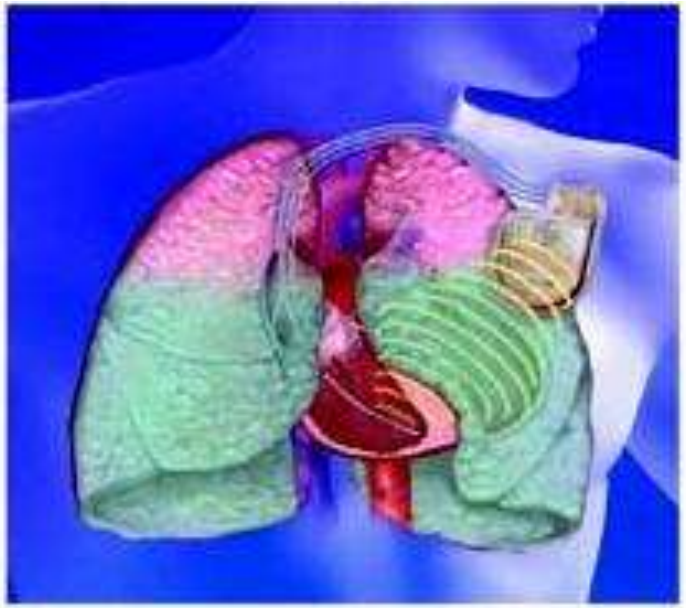
- From 2010-2015
- 128 patients implanted with RM-capable devices joined RM program in GH
- Total 3495 transmissions (average 27.3 /pt)
- 154 episodes requiring interventions= 5.8% of total transmissions

CONCEPTS OF INTRATHORACIC IMPEDANCE CORRELATING WITH HEMODYNAMIC STATUS



Drier lungs means the transthoracic impedance is higher

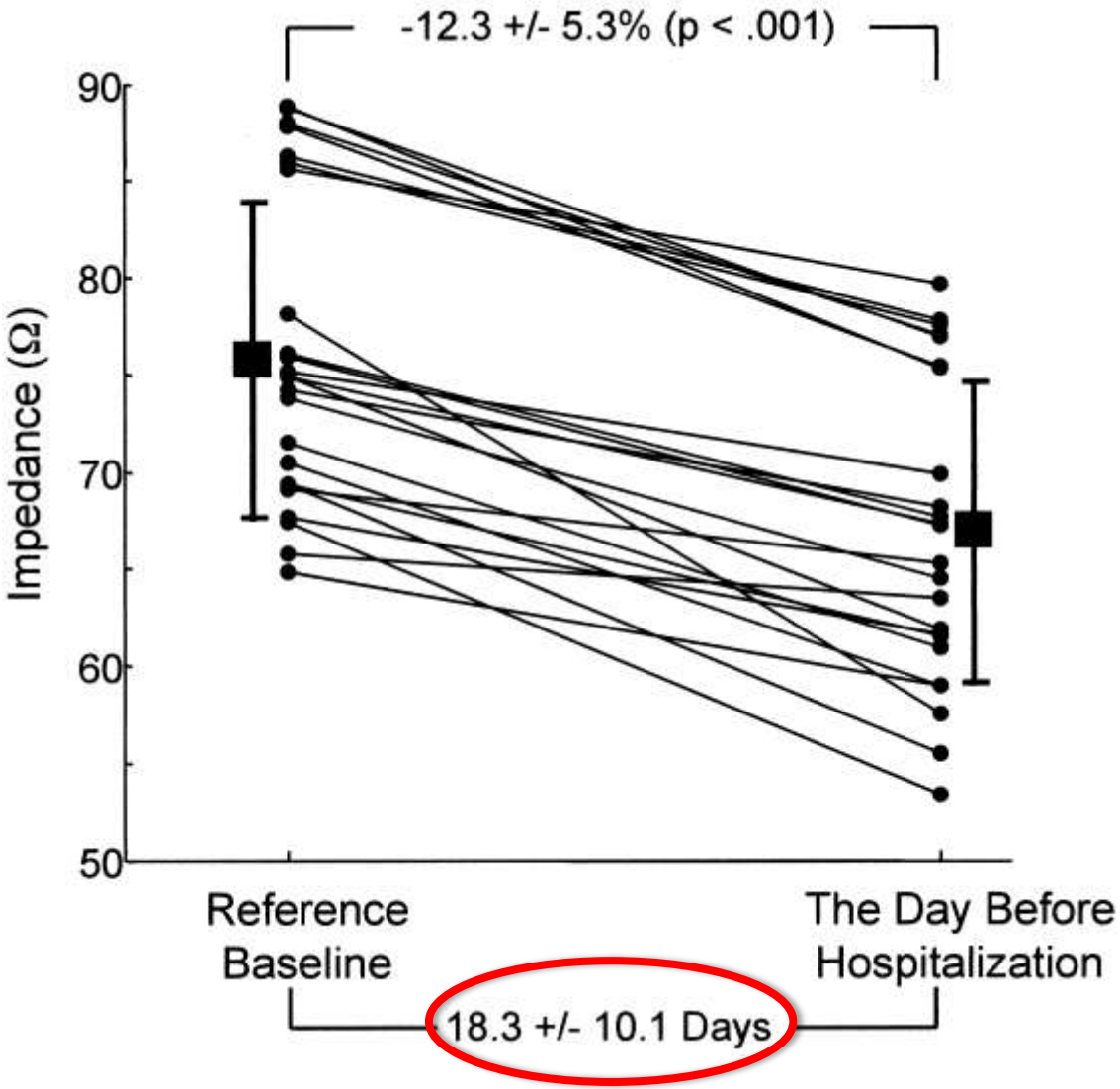
Better



Wetter lungs means the transthoracic impedance is lower

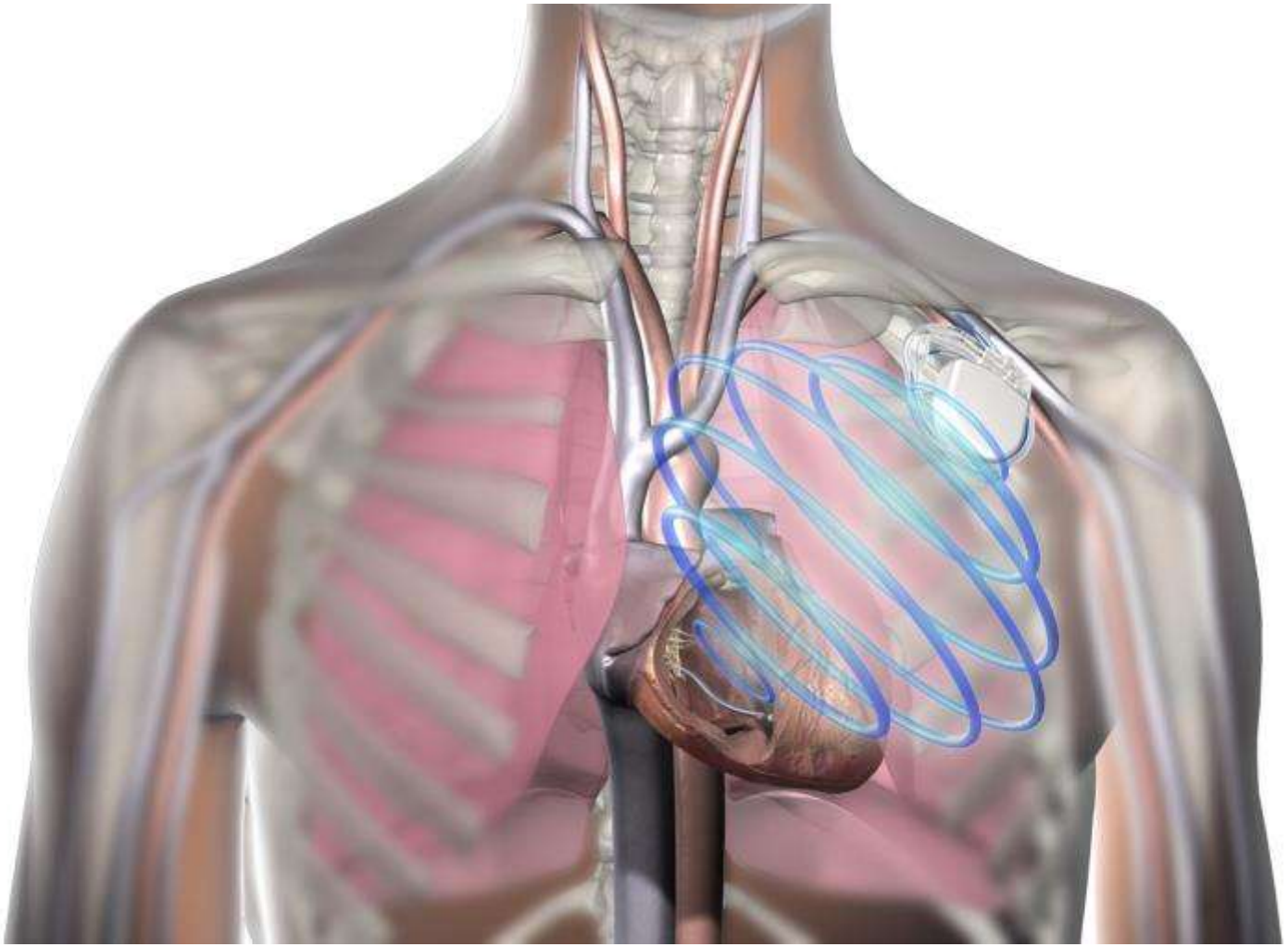
Worse

INTRATHORACIC IMPEDANCE: MIDHEFT

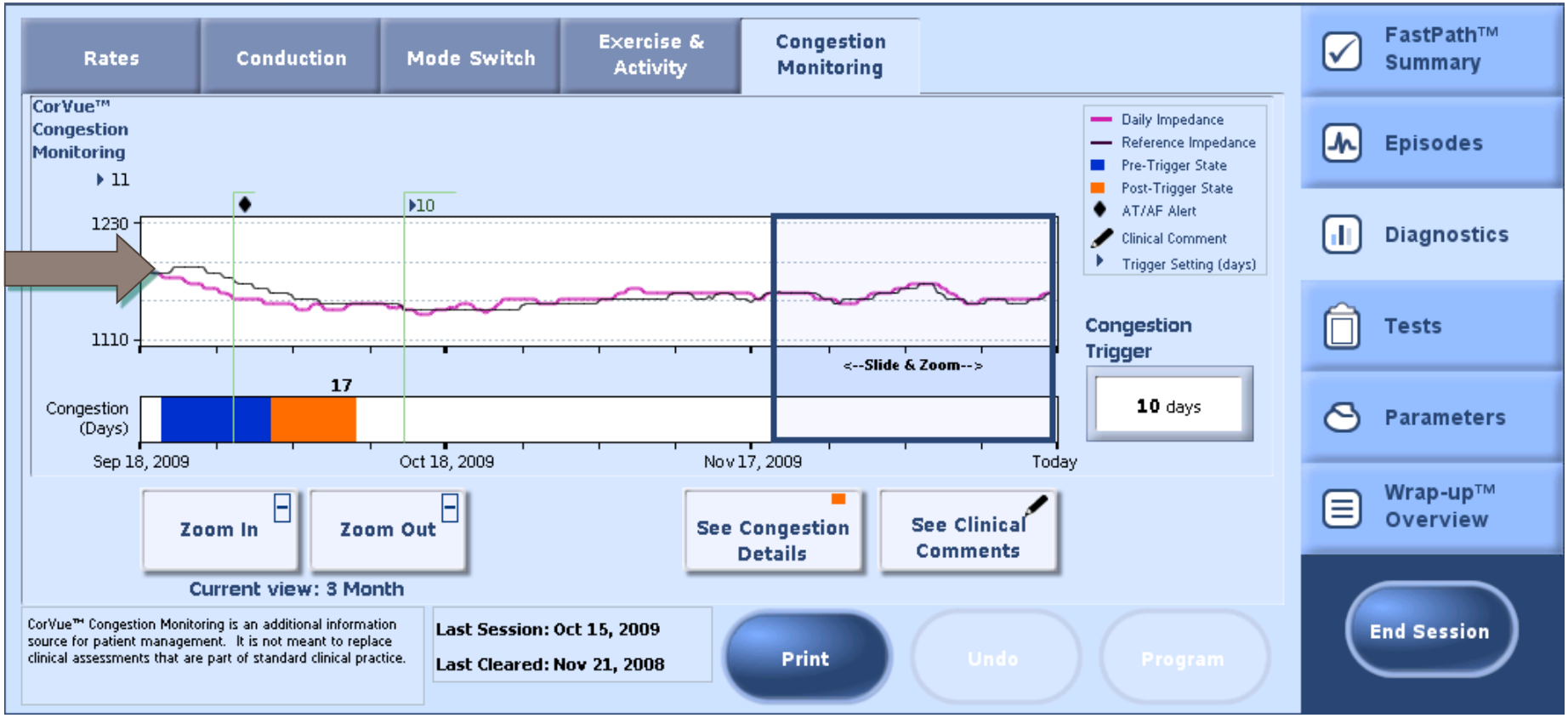


Yu CM et al. Circulation 2005;112:841-48

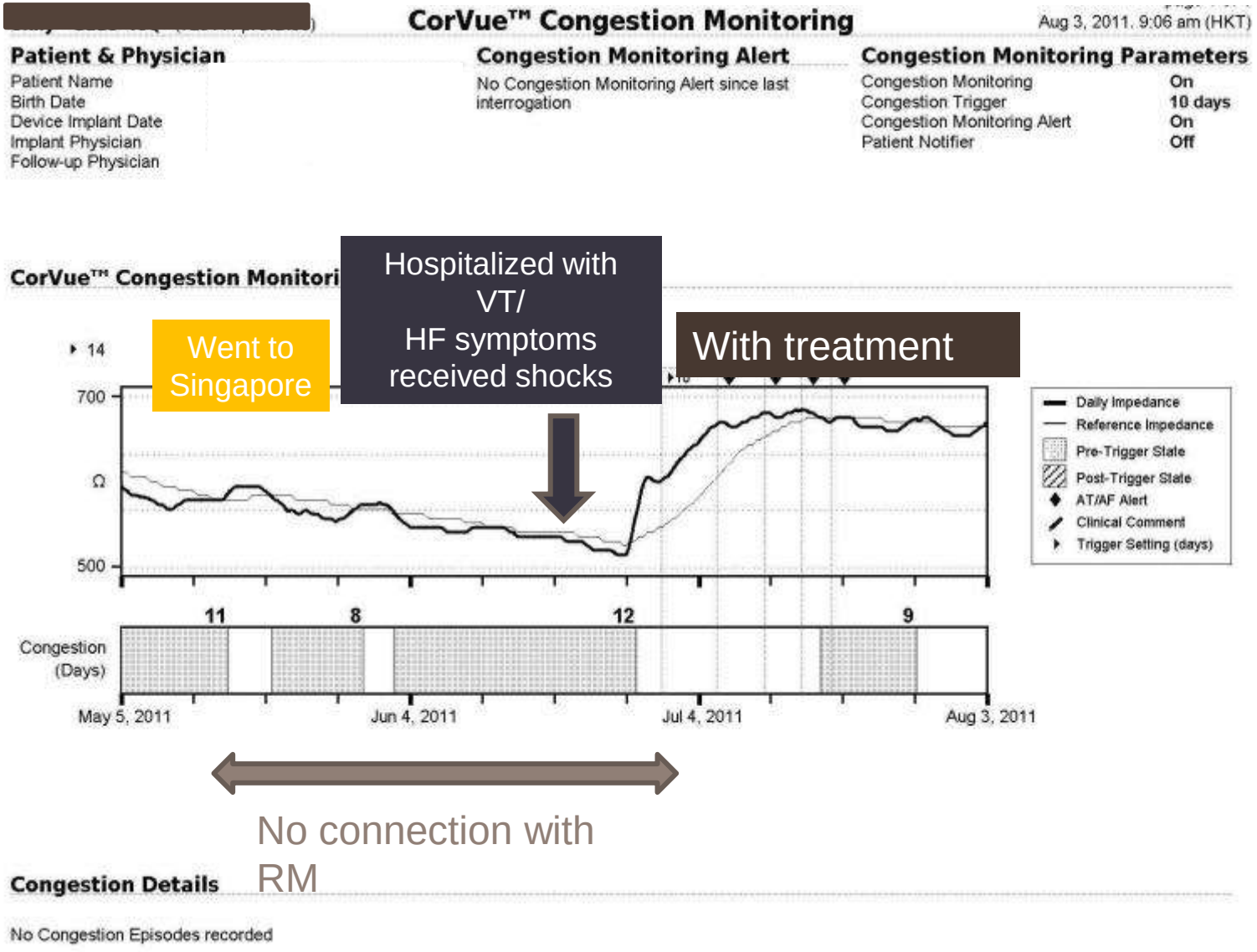
INTRA-THORACIC IMPEDANCE & FLUID STATUS MONITORING

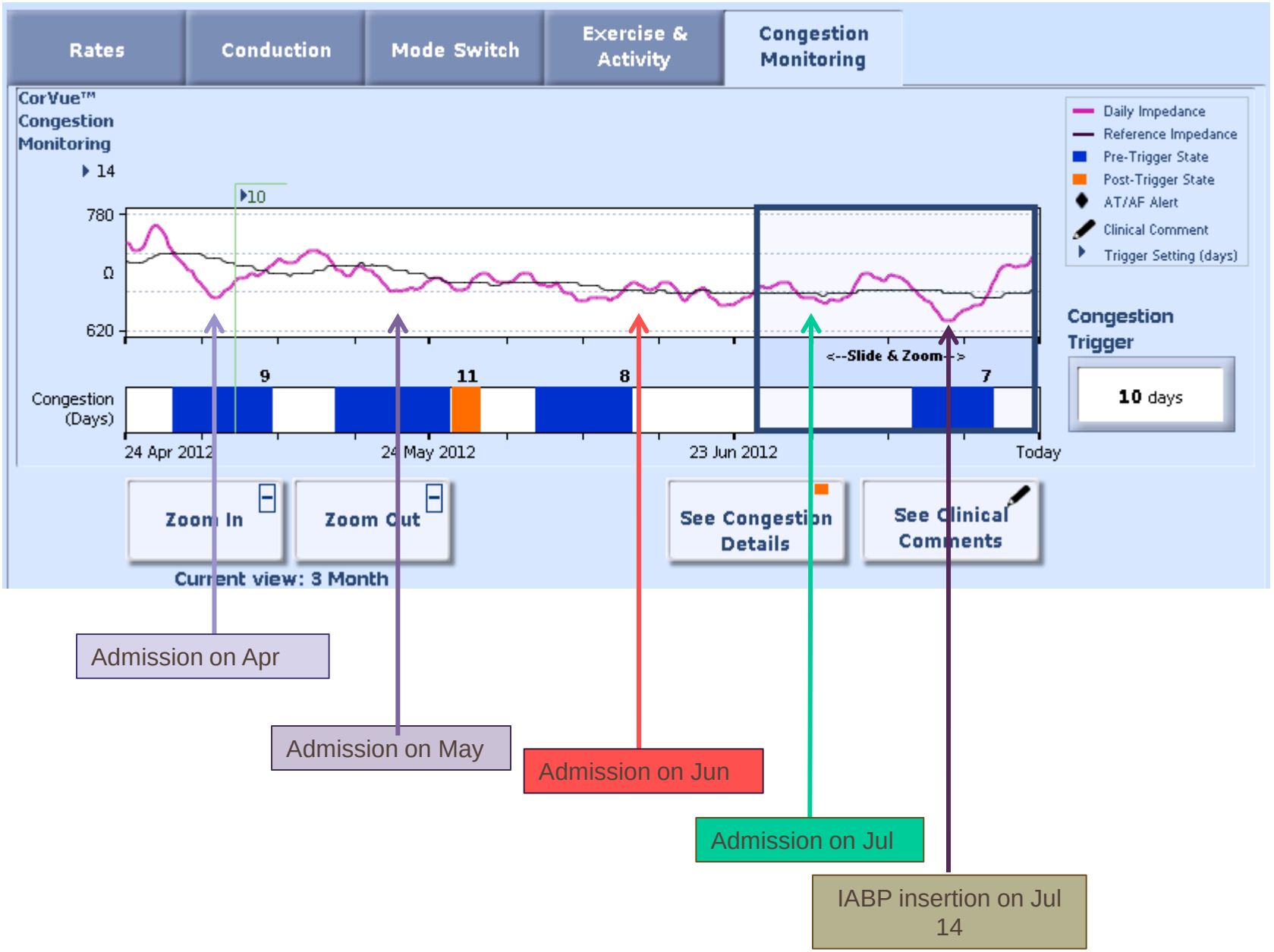


DEVICE CONGESTION MONITORING



42 yrs old lady with CCTGA
VSD and subvalvular PS with previous surgeries
SSS with sinus arrest/ VT and CHF- CRT-D implanted 12/ 2010




Rates
Conduction
Mode Switch
Exercise & Activity
Congestion Monitoring
CorVue™ Congestion Monitoring
14
10
780
Ω
620
Daily Impedance
Reference Impedance
Pre-Trigger State
Post-Trigger State
AT/AF Alert
Clinical Comment
Trigger Setting (days)
Congestion Trigger
10 days
<--Slide & Zoom-->
9
11
8
7
Congestion (Days)
24 Apr 2012
24 May 2012
23 Jun 2012
Today
Zoom In
Zoom Out
See Congestion Details
See Clinical Comments
Current view: 3 Month
Admission on Apr
Admission on May
Admission on Jun
Admission on Jul
IABP insertion on Jul 14

Limitations of Device-Based Intrathoracic Impedance

False positives

Impedance can change as a result of:

- Prolonged scar tissue at implant site
- Prolonged healing of the device pocket
- Disruption of the electrode-tissue interface secondary to lead dislodgement
- Infection affecting device pocket or electrodes
- Pericardial effusion
- Pneumonia
- Lead/electrode malfunctions
- Other unexplained changes

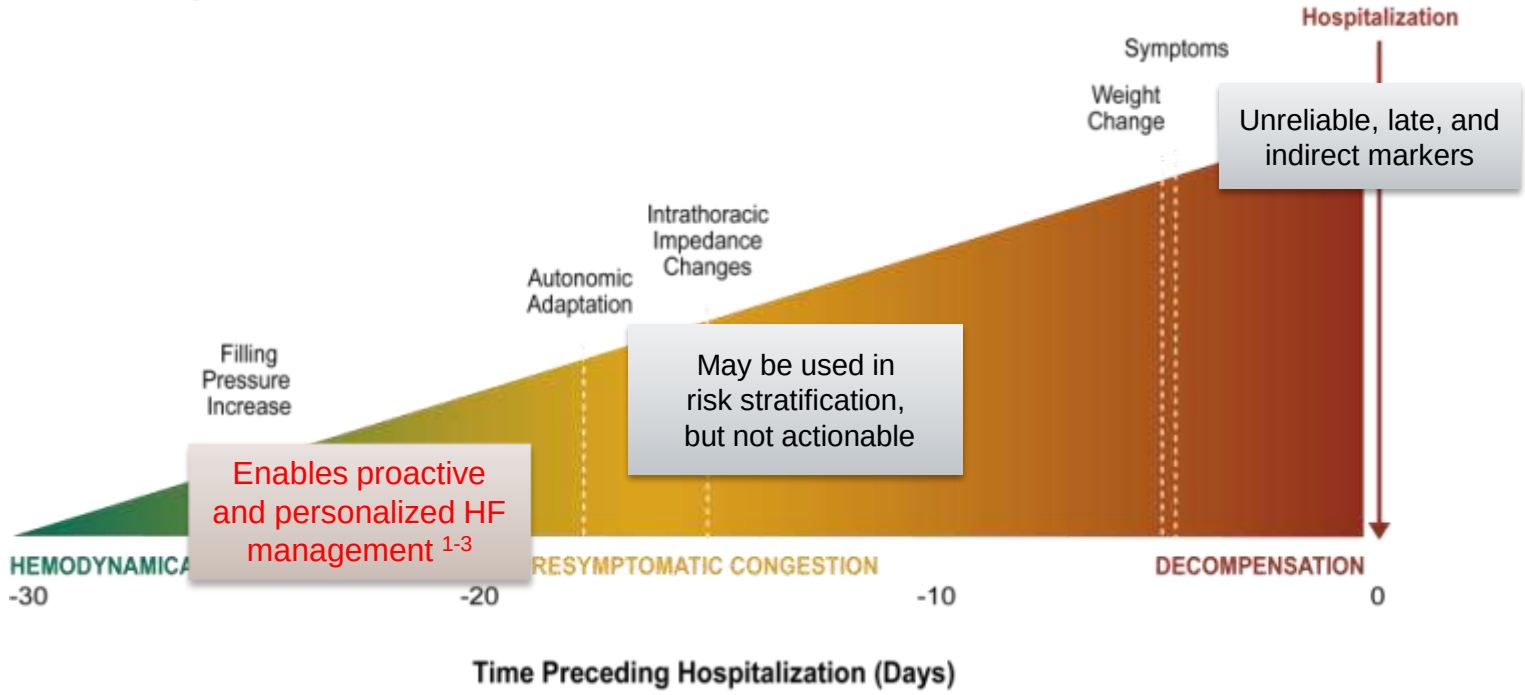
A GLIMPSE INTO THE FUTURE...

Clinical tools to manage Heart Failure

There are many signs and symptoms of HF decompensation

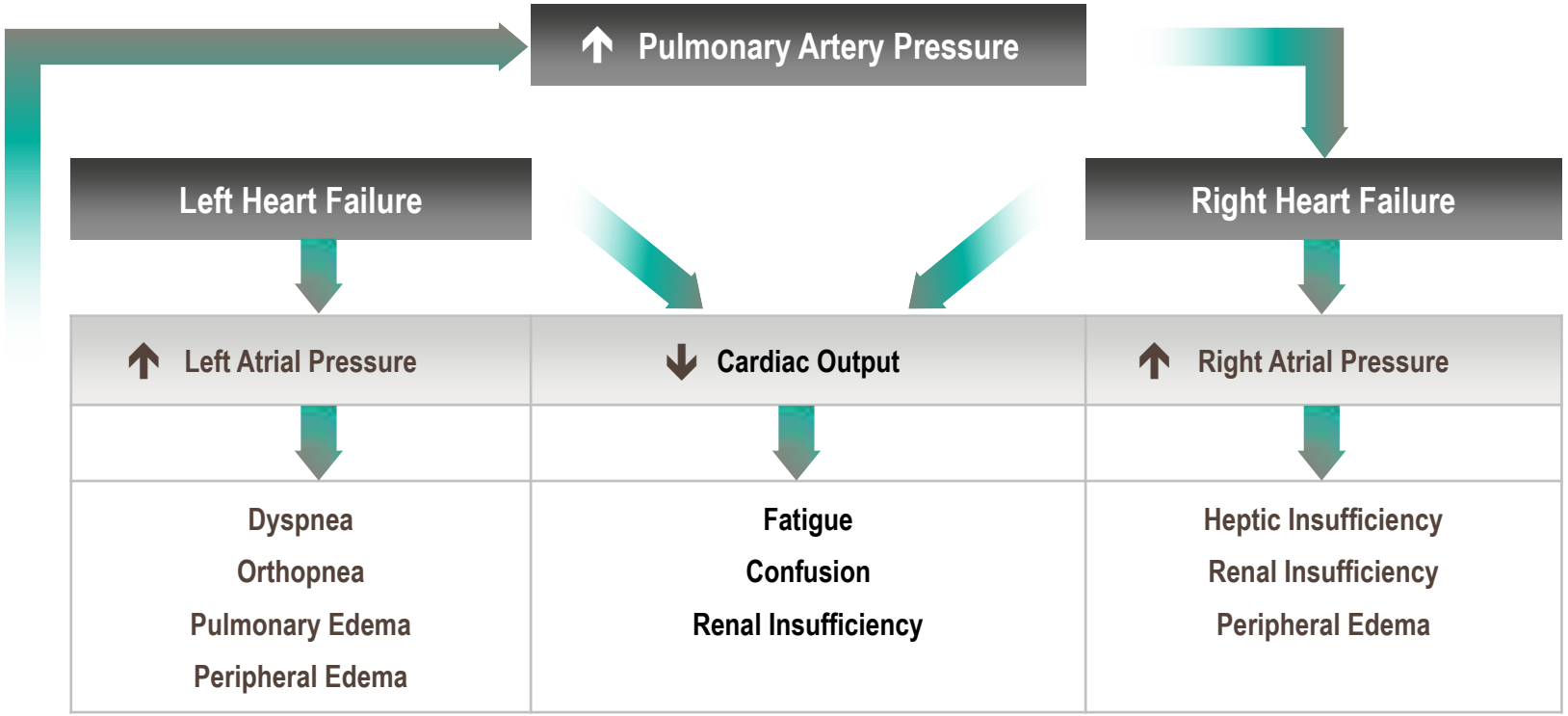
- *Atrial Fibrillation*
- *Dyspnea*
- *Orthopnea*
- *Exercise Intolerance*
- *Increased Heart Rate*
- *Pulmonary Edema*

Early warning with clinical data can lead to earlier intervention



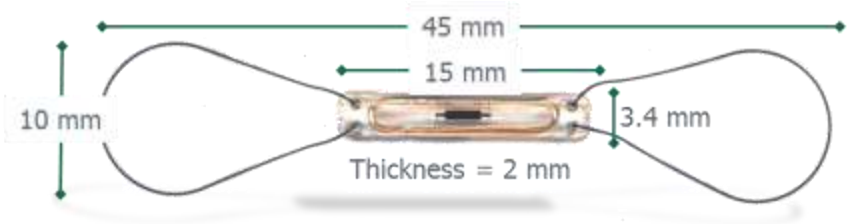
* Graph adapted from Adamson PB, et al. Curr Heart Fail Reports, 2009.

INCREASES IN PRESSURE START THE CYCLE OF WORSENING HEART FAILURE

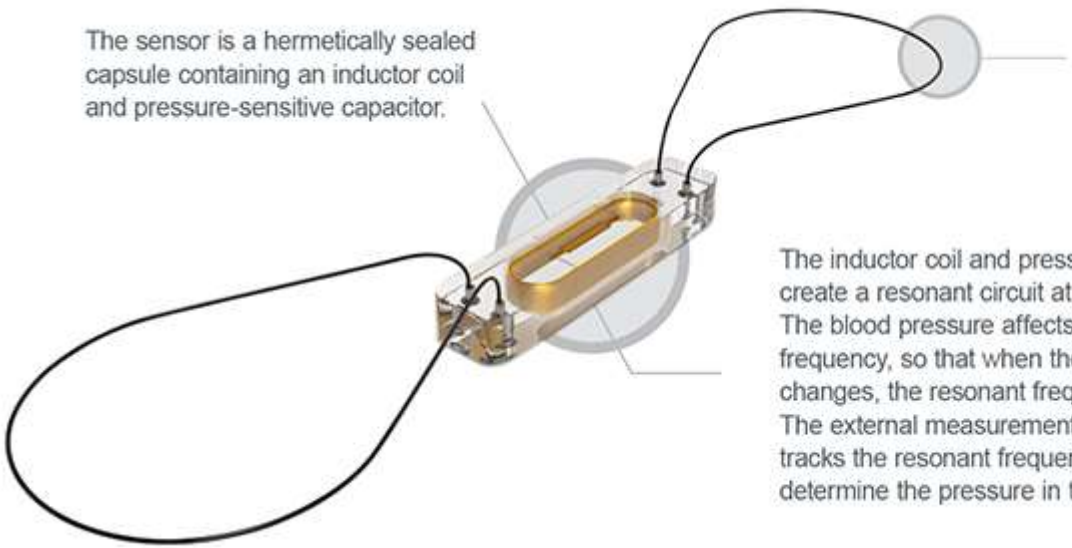


Adapted from *Jaski BE, "Basics of Heart Failure A Problem Solving Approach"*

CARDIOMEMS™ PA SENSOR TECHNOLOGY



The sensor is no larger than the size of a US dime

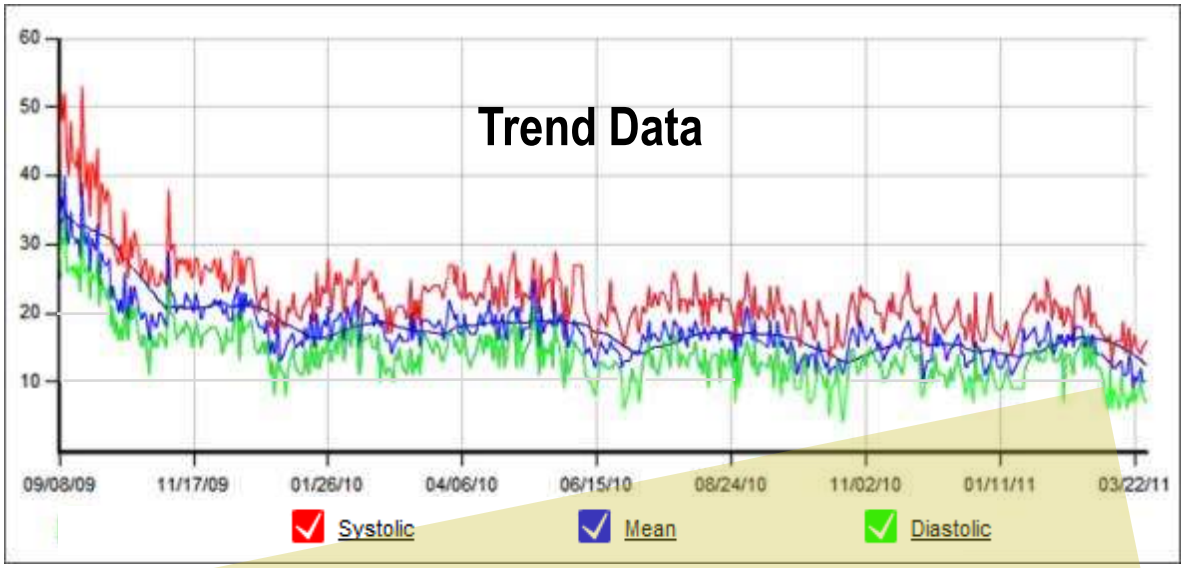


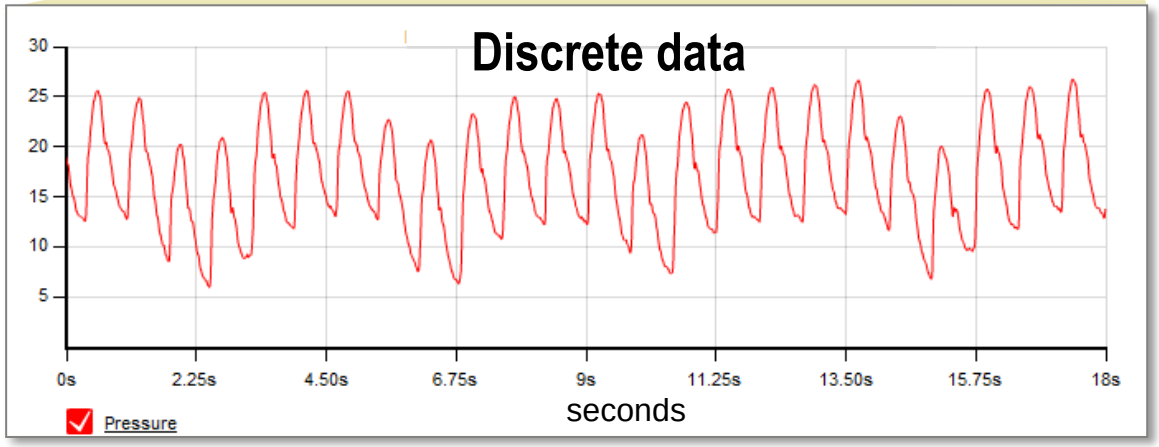
PATIENT TRANSMISSION

SECURE WEBSITE

CLINICIAN REVIEW

PULMONARY ARTERY PRESSURE DATABASE

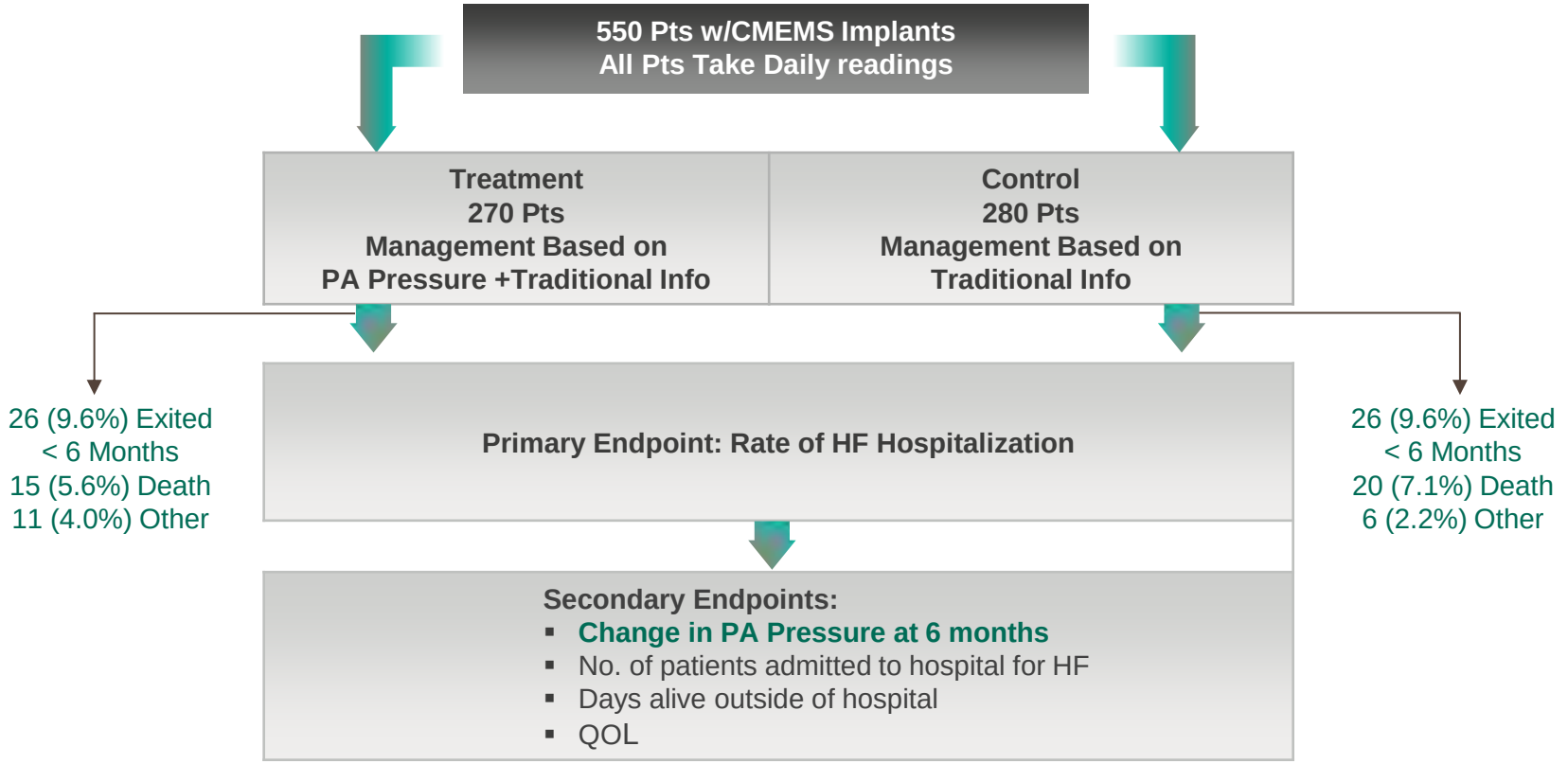




Reading	
Systolic:	24
Mean:	19
Diastolic:	16
Heart Rate:	81

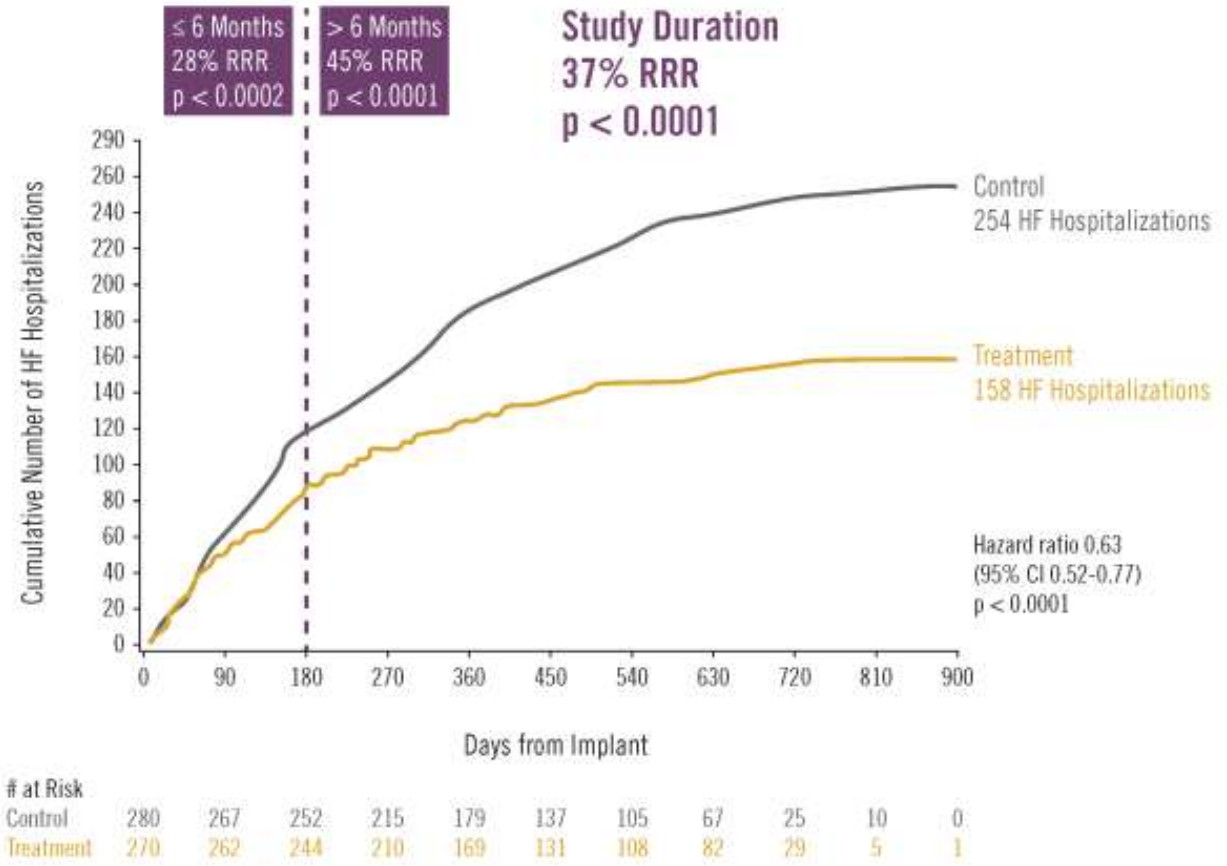
CHAMPION CLINICAL TRIAL

Patients with moderate NYHA class III HF for at least 3 months, irrespective of LVEF and a HF hospitalization within the past 12 months were included in the study.



Abraham WT, et al. Lancet, 2011.

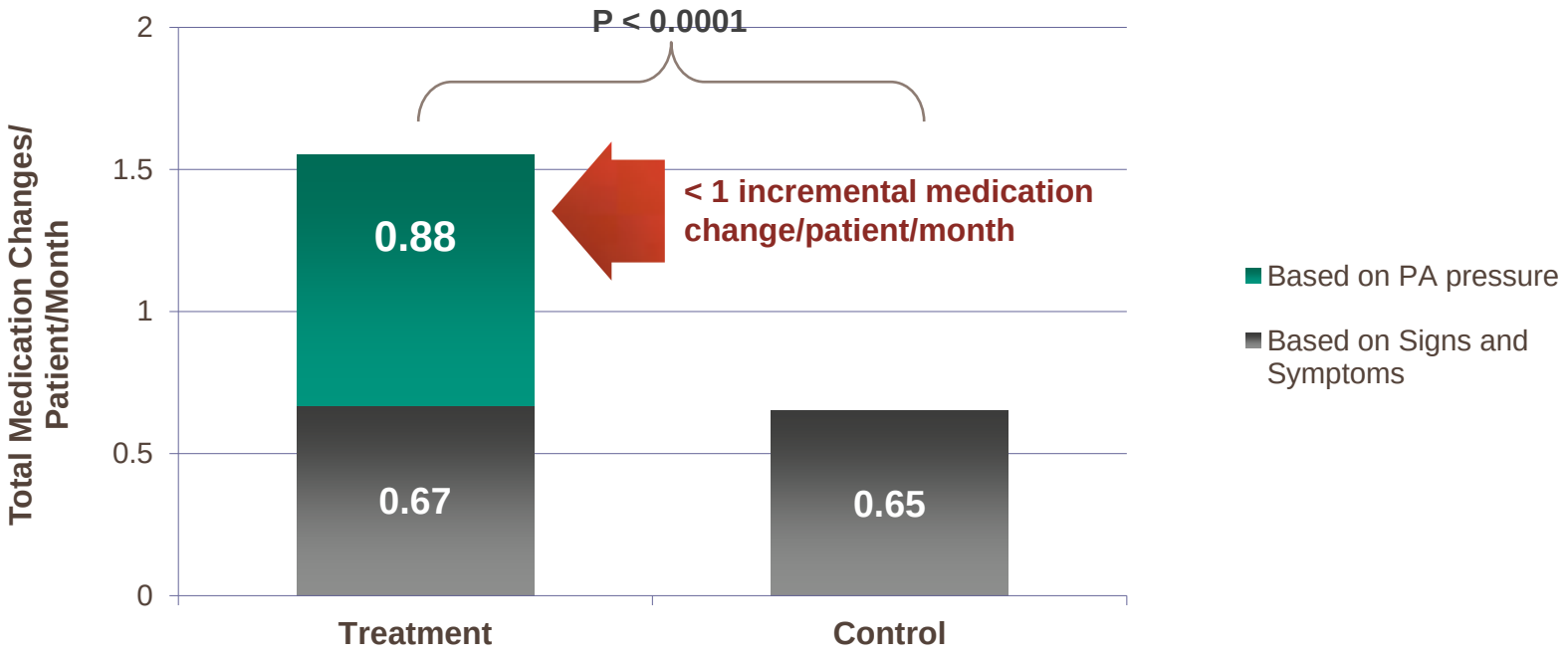
PA PRESSURE-GUIDED THERAPY REDUCES HF HOSPITALIZATIONS



Patients managed with PA pressure data had **significantly fewer HF hospitalizations** as compared to the control group.

Abraham WT, et al. Lancet, 2011.

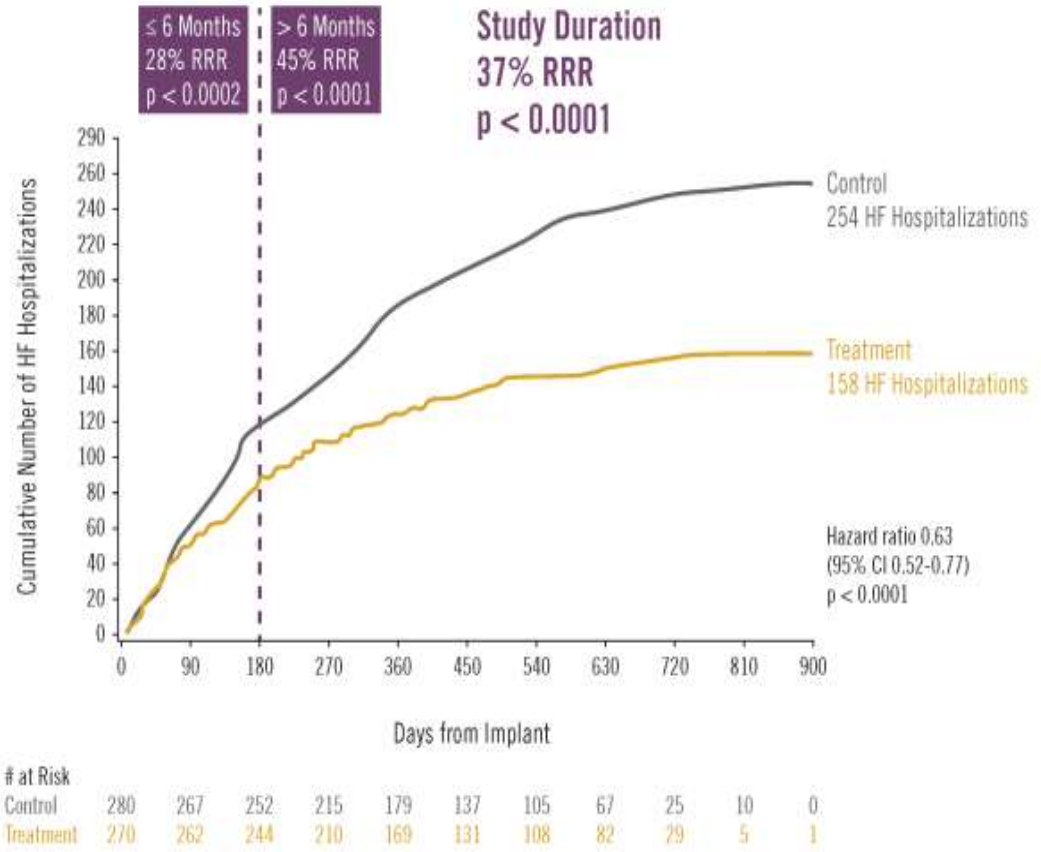
CHAMPION CLINICAL TRIAL: HF MEDS CAN BE MORE EFFECTIVELY TITRATED WITH PULMONARY ARTERY (PA) PRESSURE INFORMATION



Compared to the control group, patients managed with PA pressures had significantly more total medication changes, resulting in < 1 incremental medication change/month.

Costanzo MR, et al. Journal of Cardiac Failure, 2011

PA PRESSURE-GUIDED THERAPY REDUCES HF HOSPITALIZATIONS



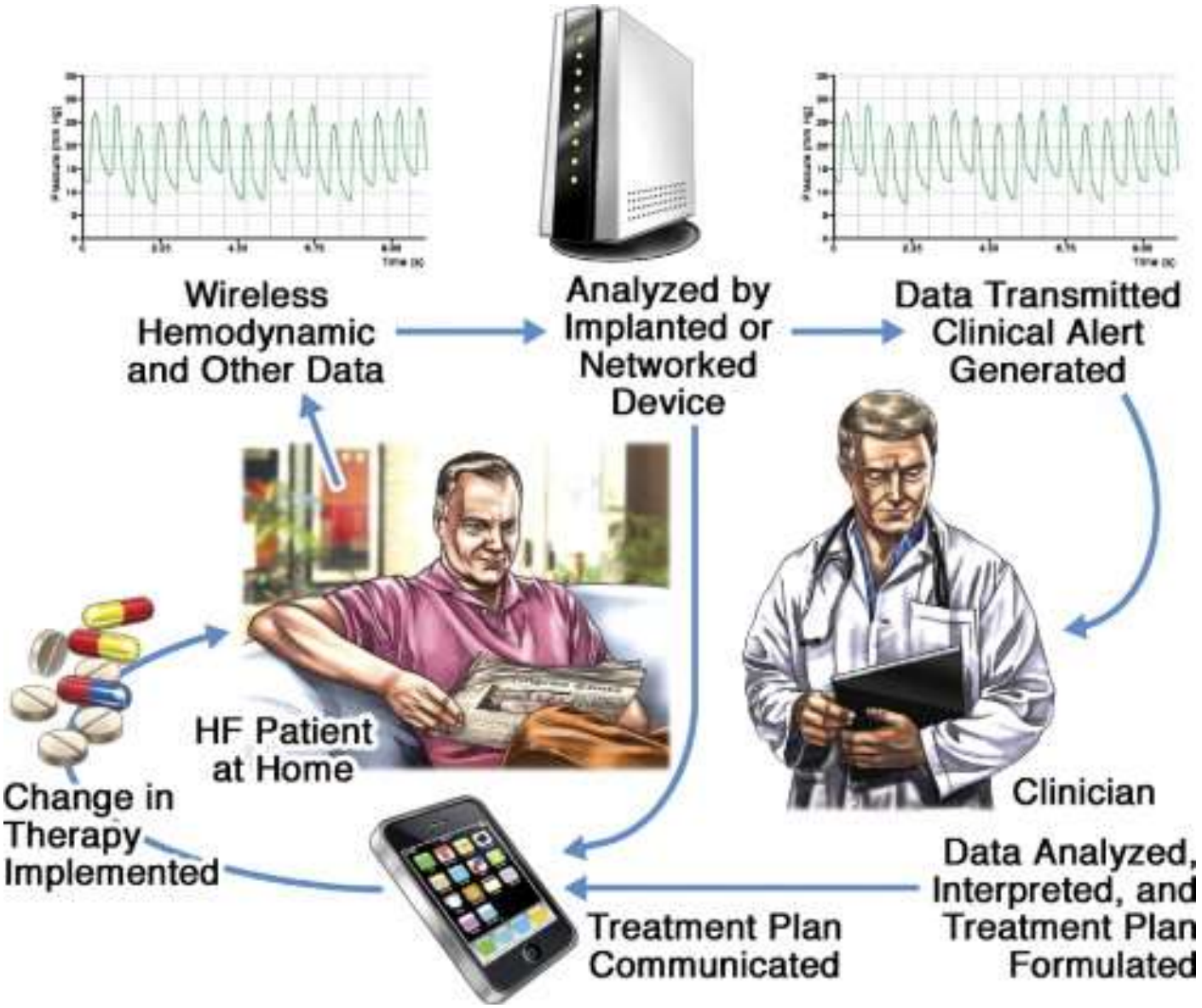
- FDA approved for class III HF in May 2014
  - Success of trial relied on:
  - Effective processing of large data
  - Heart failure RN's to monitor trends
  - Oversight by HF physicians adept at interpreting hemodynamics
- Is clinical practice equipped?

Remote monitoring technologies need to be coupled with an effective delivery system

Abraham WT, et al. Lancet, 2011.

REMOTE MONITORING FOR HF PATIENTS

A DYNAMIC CONDITION WHERE RETRIEVED DATA DRIVE TREATMENT



HEART FAILURE REMOTE MONITORING IN ASIA
OUR EXPECTATIONS

Improve health outcomes

- Improve QoL by offering more autonomy to patients
- Closer monitoring and more rapid dissemination of clinical data allow more informed and timelier treatment decisions

Reduce costs

- Reduction of unnecessary hospitalizations and physicians visits
- Patients become more self responsible and thus reduces home care expenditures
- Telemedicine reduces costs in traditional data collection, recording and communications

Fully accepted by patients

- Supposed to empower patient and generate high motivation for active participation in treatment process

HEART FAILURE REMOTE MONITORING APPLICABILITY IN ASIA PACIFIC?

Devices Implantation rates and FU methods

- PM ranges from 31/million in China to 565/million in Australia 2009
- ICD ranges from 1/million China and 160/million in Australia
- FU methods:
    - Follow international guidelines/recommendations eg Hong Kong , Singapore, Japan
    - Erratic FU pattern eg China/ India- patients carry their own records to see their doctors

Multifactorial

- Difference in disease patterns
- Regional guidelines for device implantation
- Patient acceptance
- Cost

Government Policy such as healthcare, reimbursement, telecommunication

Technology

- Landline communication can be sparse in some countries
- Wireless communication is now widely available in Asia-Pacific region

CLINICAL EFFICIENCIES AND WORK-FLOW – CALL FOR DISRUPTIVE INNOVATION?

WORK-FLOW CHANGES AND CHALLENGES

Demands on adjustment to different workflow patterns and mindsets

Dedicated trained allied professional who maintain early reaction ability and reported to responsible physicians

Resources needed to operate such a "virtual clinic" including reimbursement may not be universally available

Data management

- Best with interface with electronic medical records within one database

CLINICAL EFFICIENCIES

Greater reduction of routine non-actionable in-person evaluations

Actionable alert notification quickly acted upon

Patient engagement is emphasized

- Maybe included in the loop for access to results and recommendation

Improved patient care

- Expanded framework for multidisciplinary communication and collaboration eg EP and Heart Failure physicians

MOVING CARE OUTSIDE OUR DOORS: COMMUNITY-BASED HEART DISEASE MANAGEMENT?

Yes but….

Remember goal of health system is to improve population health and to be responsive to the population's needs and demands

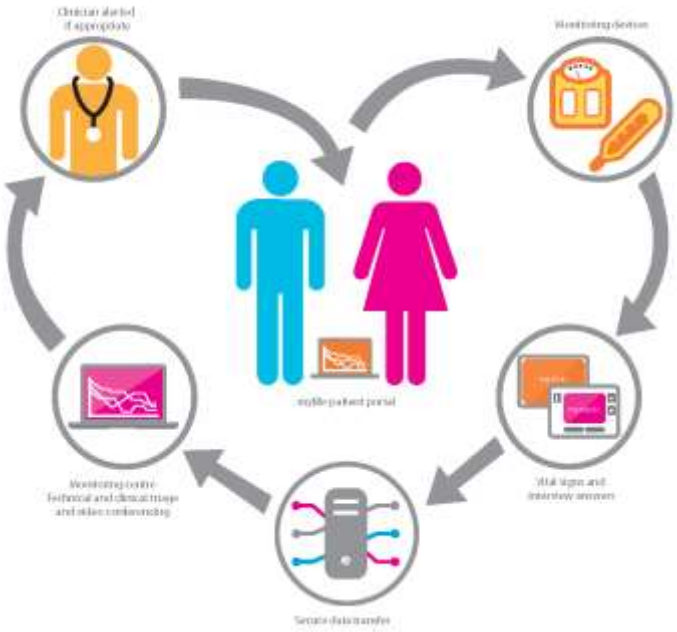
- Acceptance essential through effective communication and education

The standard set has to overcome political, commercial, technical and cultural barriers

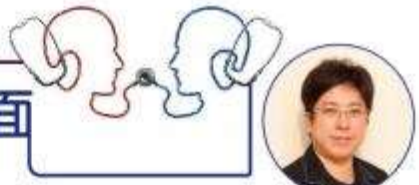
- Countries and companies working together
- a unified open standard not just in name but in spirit

3 important rules:

- Mutual interests
- Open standards
- Fair markets



病人醫護一線牽 監察病情更全面



「你好，現在我將會為你的心臟起搏器進行檢查。」相信植入了心臟儀器，包括起搏器、除顫器、雙室同步起搏器及雙室同步除顫器的病人到診所覆診時，都不會對這句說話感到陌生。隨著時代進步，病人除了可在診所進行植入式心臟儀器檢查外，遙距監察(Remote Monitoring)也成為一種趨勢。遙距監察利用電話或數據網絡，上載病人儀器檢查的資料至雲端系統，再由心臟科主診醫生及護士以密碼登入查看病人的紀錄。上傳的數據包括儀器運作檢查和心律不整紀錄，較先進的儀器更能顯示肺水腫指標以反映心臟衰竭情況，這些資料都用以輔助醫生進行心臟疾病管理。

葛量洪醫院為香港首間發展遙距監察系統的醫院，當初引入系統是由於醫院接收的心臟衰竭病人情況較嚴峻，我們希望更緊密關注他們的心臟健康。我們的監察團隊於二零零九年開始籌備，在二零一零年成立，而參加了遙距監察的病人現已逾百個。團隊的成員至今有十一人，分別為三名心臟科醫生及八名心臟科護士或技術員，他們事前均需接受不同儀器公司及其監察系統的訓練。

我們日常工作主要是訊息檢查，訊息一般分為：儀器自動傳送(圖一)和病人主動傳送(圖二、三)。

(圖一) 心臟科護士及醫生定期檢查病人心臟儀器的報告傳送，包括特別警報。有任何警報，心臟科護士會先與病人確認，再報告醫生，然後對病人作出適當指引或治療。

(圖二) 病人感到不適，主動致電監察小組並傳送心臟儀器資料。

(圖三) 心臟科護士接收儀器資訊，分析情況，並向醫生作出匯報，醫生會根據資料作適當安排和治療。

遙距監察系統不經不覺在醫院已運行了三年多。開始時監察團隊和病人實在需要一段時間協調及適應。然而，當系統發展成熟後，好處亦慢慢顯現。最令我感到窩心的是，整個團隊與病人關係更加密切，每次對話都有着關懷慰問。我們會不厭其煩地提醒病人要注意的事項，病人因此逐漸熟悉心臟健康轉壞的病徵，提高自己對病情的關注。此外，由於儀器警報系統可以立時通知醫護人員有關病人的心臟情況，這大大增加病人接受及時治理的機會，舒緩病情，以免情況惡化。對於病情較穩定的病人，也可減少到門診覆診的次數，避免舟居勞頓。

縱使香港地方小，交通亦四通八達，但相信這個應用將會越來越普及。希望大家能善用科技，為未來的醫療服務帶來進步。

注意：遙距監察系統並不能取代緊急醫療服務，有緊急狀況請即求診!

Thank You!