



# Remote Ventilated Patient Management Using Mobile Devices



Armando Kurili

Clinical Specialist

Brian Smith

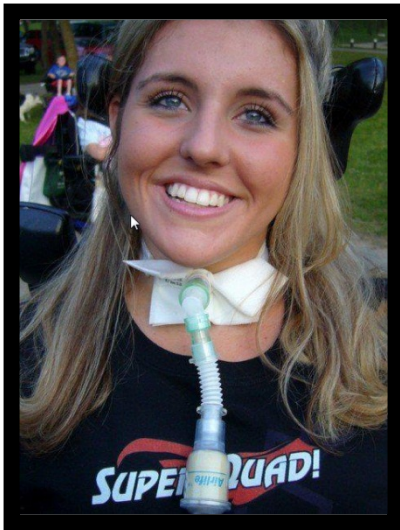
Virtual Health Support Analyst

# WHAT HAPPENED ONLY 20 YEARS AGO



# WHAT HAPPENED ONLY 10 YEARS AGO

- **iPhone**
- **Facebook**
- **Twitter**
- **Airbnb**
- **Hadoop iCloud**



# Let Me Breathe!

## Remote Ventilator Management

Julie Hanley & Armando Kurili

(Adult Assisted Ventilation Clinic -University of  
Michigan Internal Medicine)

Brian Smith & Steve Jordan

(Virtual Health Support Analyst)

# A Team Effort – The Initial Telemedicine Ventilation Team



## **Adult Assisted Ventilation Clinic Team Members**

- Robert Sitrin, MD & Director
- Kristy Bauman, MD
- Julie Hanley, NP
- Armando Kurili, RT



## **Virtual Health Team Members**

- Andrew Haig, MD & Director
- Noura Bashshur, Manager
- Steve Jordan, Operations
- Brian Smith, Engineer
- Michael Gates, Admin

Adult Assisted Ventilation Clinic Mission  
Intervene and triage ventilation patients at  
home or in the clinic to resolve their  
problems and avoid:

- **Unnecessary trips** to the ED
- **Costly hospital admissions** – complex patient so tend to admit to be safe
- **Excessive treatments**
- Time consuming and logistically **complex travel** to the clinic or patient's home

# The Clinical Ventilator Support Team

- **Physician (MD)**
- **Nurse Practitioner (NP)**
- **Registered Nurse (RN)**
- **Respiratory Therapist (RT)**
- **Caregiver/Nurse at Patients Home**
- **Patient's Family**

# Background on NMD and SCI Patients

- 276,000 SCI patients in the U.S. in 2014, 38,000 SCI's at or above C4 – many 100% mechanical ventilator dependent (Jones et al., 2015).
- Number with NMDs hard to estimate (>30 types - Deenen et al., 2015).
- Cost for three (ALS, DMD, and DM) = \$2.26B annually (Larkindale et al., 2014).

## *Estimated Lifetime Costs for Patients with Spinal Cord Injuries*

Severity of Spinal Cord Injury	Average Yearly Expenses (in 2014 dollars)		Estimated Lifetime Costs by Age At Injury (discounted at 2%)	
	First Year	Each Subsequent Year	25 Years Old	50 Years Old
High Tetraplegia (C1-C4)	\$1,064,716	\$184,891	\$4,724,181	\$2,596,329
Low Tetraplegia (C5-C8)	\$769,351	\$113,423	\$3,451,781	\$2,123,154
Paraplegia	\$518,904	\$68,739	\$2,310,104	\$1,516,952
Incomplete Motor Functional at Any Level	\$347,484	\$42,206	\$1,578,274	\$1,113,990

ALS = amyotrophic lateral sclerosis, DMD = Duchenne muscular dystrophy, and DM = myotonic dystrophy

DeVivo et al. (2011) and converted to 2014 dollars by Spinal Stats (2014).



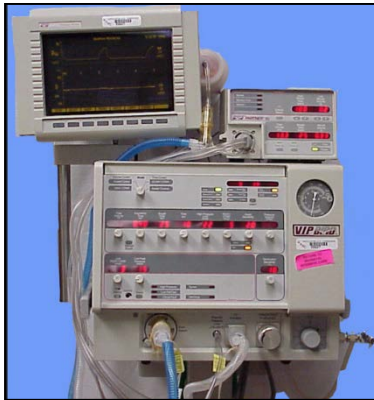
# Some Causes of Neuromuscular Respiratory Failure

- Spinal Muscular Atrophy (SMA)
- Multiple Sclerosis (MS)
- Poliomyelitis
- Duchenne Muscular Dystrophy
- And ~30 Other Causes of  
Neuromuscular Respiratory Failure

# The Need for Mechanical Ventilation

- Breathe for People That Have Lost All Ability to Breathe On Their Own
- Get Oxygen Into The Lungs and to cells, tissues, and organs
- Remove Carbon Dioxide from the Body
- Help People Breathe Easier

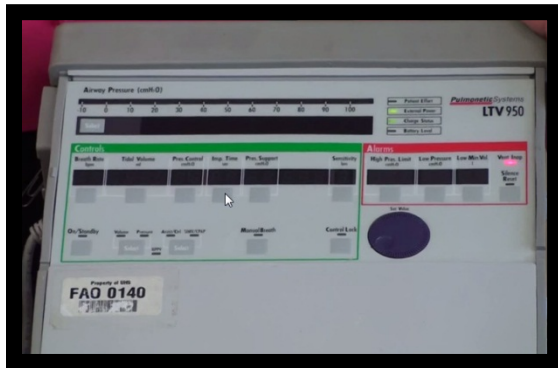
# Many Types of Ventilators



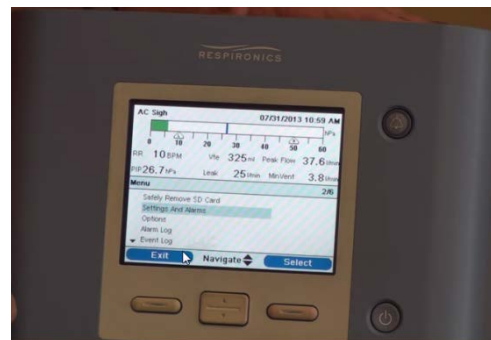
Newport™ HT70 Plus™



LTV 950



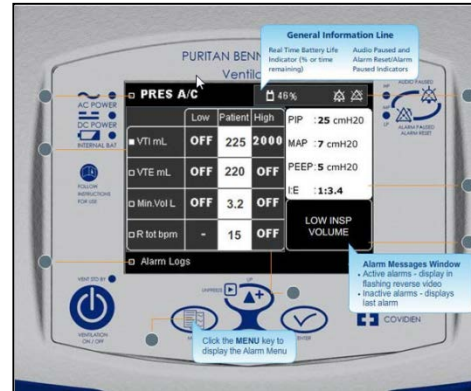
Trilogy 100



Trilogy 200



iVent 201



Puritan  
Bennett 840

LTV 1000



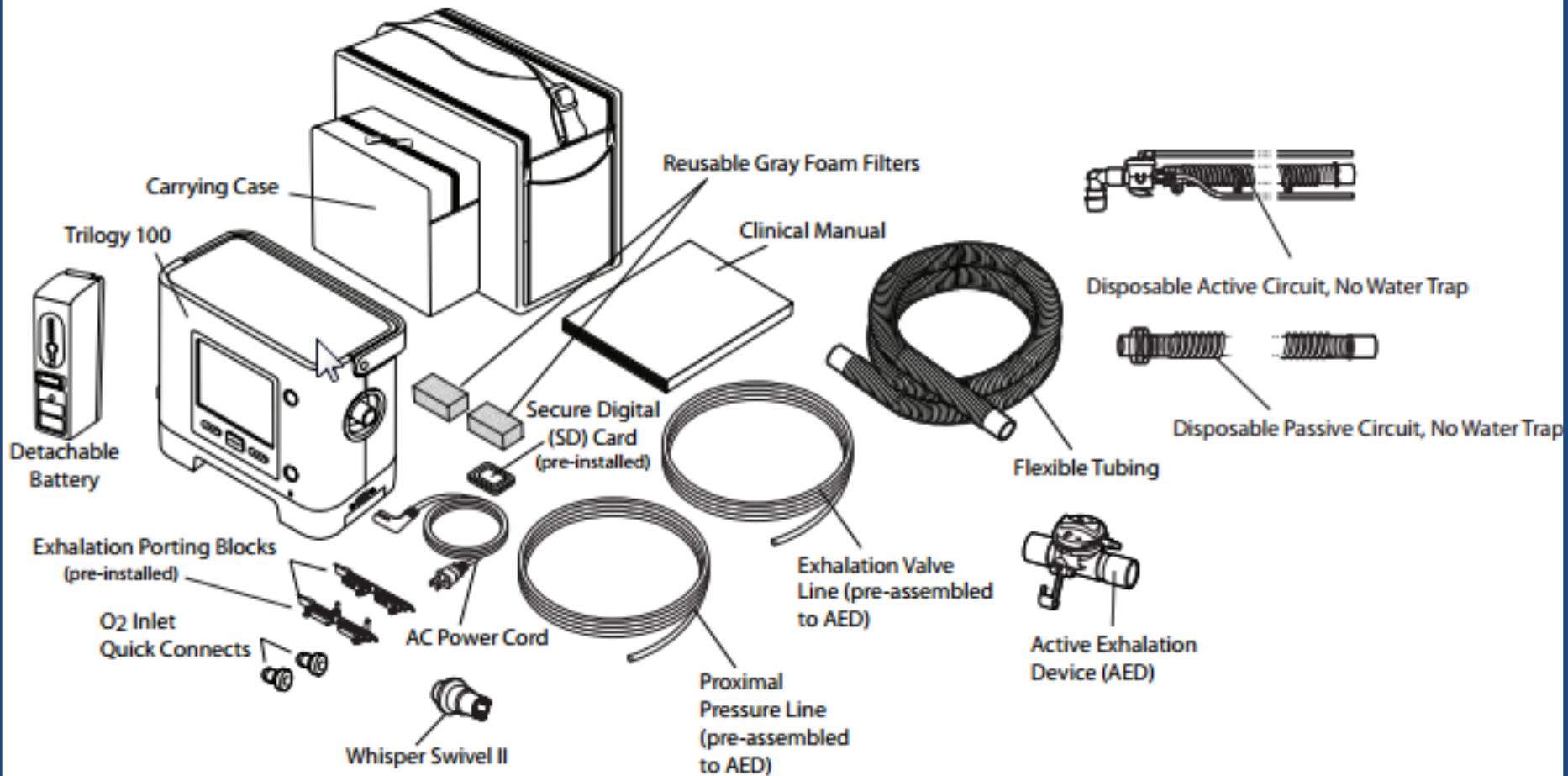
Esprit



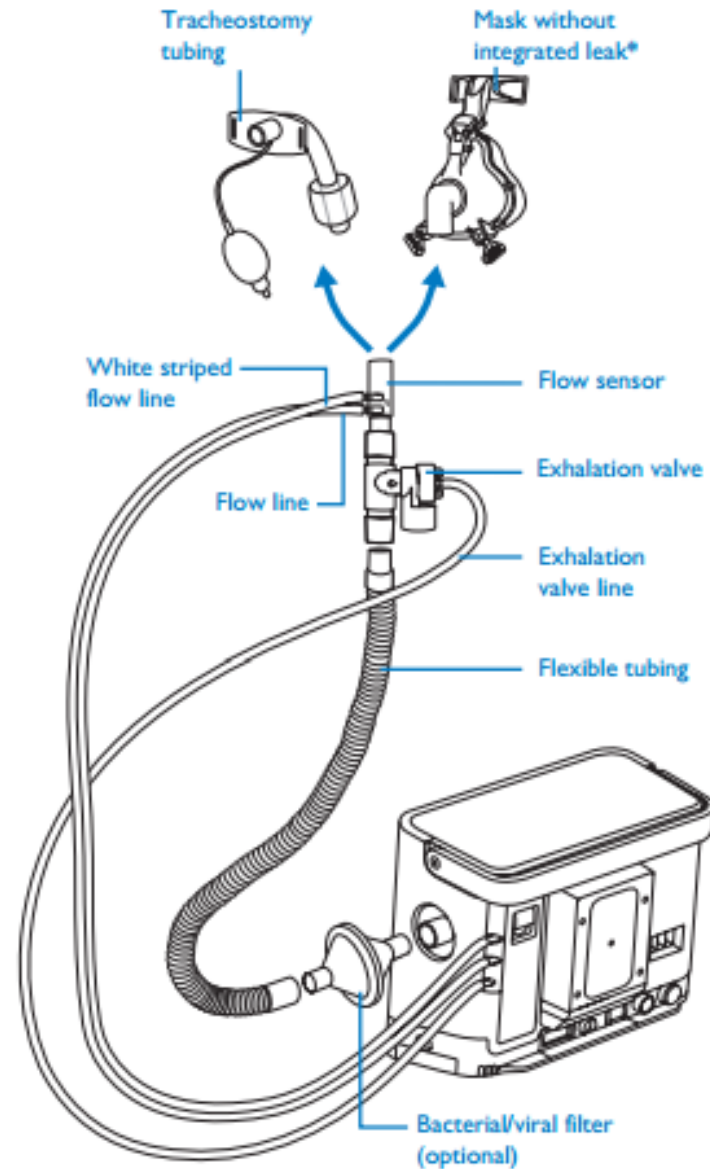
Puritan  
Bennett 360



# Set-up and Adjusting a Trilogy 100 Ventilator .. Read the Instructions!



# Adjusting a Trilogy 100 Ventilator (cont'd)



# “Dialing In” a Trilogy 100 Can Be A Complex Task



Over 200 Setting  
Options

<http://www.ahcah.com/Manuals/Trilogy%20100%20Patient%20Manual.pdf>

36 Variable Parameters

## 9 Different Modes

	Therapy Modes								
	CPAP	S	S/T	T	PC	PC-SIMV	CV	AC	SIMV
Dual Prescription	✓	✓	✓	✓	✓	✓	✓	✓	✓
Circuit Type	✓	✓	✓	✓	✓	✓	✓	✓	✓
CPAP	✓								
IPAP		✓	✓	✓	✓				
AVAPS (On, Off)*		✓	✓	✓	✓				
IPAP Max Pressure		✓	✓	✓	✓				
IPAP Min Pressure		✓	✓	✓	✓				
EPAP		✓	✓	✓	✓				
Inspiratory Pressure						✓			
Pressure Support (PS)						✓			✓
PEEP						✓		✓	✓
Tidal Volume		✓	✓	✓	✓		✓	✓	✓
Breath Rate			✓	✓	✓	✓	✓	✓	✓
Inspiratory Time			✓	✓	✓	✓	✓	✓	✓
Trigger Type*		✓	✓		✓	✓		✓	✓
Flow Trigger Sensitivity	✓	✓	✓		✓	✓		✓	✓
Flow Cycle Sensitivity	✓	✓	✓			✓			✓
Ramp Length	✓	✓	✓	✓	✓				
Ramp Start Pressure	✓	✓	✓	✓	✓				
Flex *	✓	✓							
Rise Time		✓	✓	✓	✓	✓			✓
Flow Pattern							✓	✓	✓
Sigh							✓	✓	✓
Circuit Disconnect	✓	✓	✓	✓	✓	✓	✓	✓	✓
Apnea	✓	✓	✓		✓	✓		✓	✓
Apnea Rate		✓	✓		✓	✓		✓	✓
High Vte*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Low Vte*	✓	✓	✓	✓	✓	✓	✓	✓	✓
High Vti*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Low Vti*	✓	✓	✓	✓	✓	✓	✓	✓	✓
High Minute Ventilation	✓	✓	✓	✓	✓	✓	✓	✓	✓
Low Minute Ventilation	✓	✓	✓	✓	✓	✓	✓	✓	✓
High Respiratory Rate	✓	✓	✓	✓	✓	✓	✓	✓	✓
Low Respiratory Rate	✓	✓	✓	✓	✓	✓	✓	✓	✓
High Inspiratory Pressure							✓	✓	✓
Low Inspiratory Pressure							✓	✓	✓

\* AVAPS, Trigger Type, Flex, High Vte and Low Vte settings are only available with the Passive circuit type. Trigger Type is not available with the Passive circuit in CPAP mode. High Vti and Low Vti settings are only available with the Active circuit with PAP.

# Managing Screens and Parameters Can Be Challenging

**Primary : CPAP**  
03/20/2007  
05:20 PM

**Primary : S/T** 04/14/2008 05:32  
Pressure 21.7 cm H<sub>2</sub>O RR 20 BPM Vte 837 ml Leak 31  
PIP 23.3 cm H<sub>2</sub>O I:E Ratio 1:3.2 Peak Flow 120.0  
MAP 11.0 cm H<sub>2</sub>O Min/Vent 11.7

**Primary : S/T** 06/11/2008 09:04 PM  
RR 20 BPM Vte 837 ml Peak Flow 71.6 l/min  
PIP 21.0 cm H<sub>2</sub>O Leak 35 l/min Min/Vent 11.7 l/min

**Menu** 1/8  
Switch to Secondary Settings  
Safely Remove SD Card  
Primary Settings and Alarms  
Secondary Settings and Alarms  
Options  
Exit Navigate Select

**Primary : S/T** 06/11/2008 09:09  
RR 20 BPM Vte 837 ml  
PIP 21.0 cm H<sub>2</sub>O Leak 35 l/min

**Menu**  
Switch to Secondary Settings  
Safely Remove SD Card  
Primary Settings and Alarms  
Secondary Settings and Alarms  
Options  
Exit

**Primary : S/T** 06/24/2008 12:30 PM  
RR 20 BPM Vte 837 ml Peak Flow 71.6 l/min  
Min/Vent 11.7 l/min  
Leak 31 l/min

**Passive CV** 01/28/2013 01:42 PM  
RR 20 BPM Vte 4010 ml Leak 1310 l/min  
P cm H<sub>2</sub>O  
V l/min  
60 seconds  
Exit Graph

**Settings and Alarms**  
Options  
Alarm Log  
Event Log  
Information  
Exit

Setting	Value
Dual Prescription	Off
Circuit Type	Active PAP or Passive
Therapy Mode	S/T
AVAPS (passive circuit only)	Off
IPAP	20 cm H <sub>2</sub> O
EPAP	4 cm H <sub>2</sub> O
Breath Rate	12 BPM
Inspiratory Time	1.6 seconds
Trigger Type (passive circuit)	Auto-Trak
Flow Trigger Sensitivity (active PAP circuit)	6.0 l/min
Flow Cycle Sensitivity (active PAP circuit)	20%

**Alarms and Messages** 1/2  
Low Inspiratory Pressure 09:52 PM  
Low Vte 09:52 PM  
Low Respiratory Rate 09:52 PM  
Low Minute Ventilation 09:52 PM  
Circuit Disconnect 09:52 PM  
Reset Page Modify

**VENTILATOR INOPERATIVE**

## Mode Setting

- CPAP
- S
- S/T
- T
- PC
- PC-SIMV
- CV
- AC
- SIMV

## Mechanical Ventilator Summary:

Assembling, Setting Ventilator Modes and Parameters, and Trouble Shooting a Problem are Complex Tasks – Now Add the Fact That Your Patient Can't Breathe!



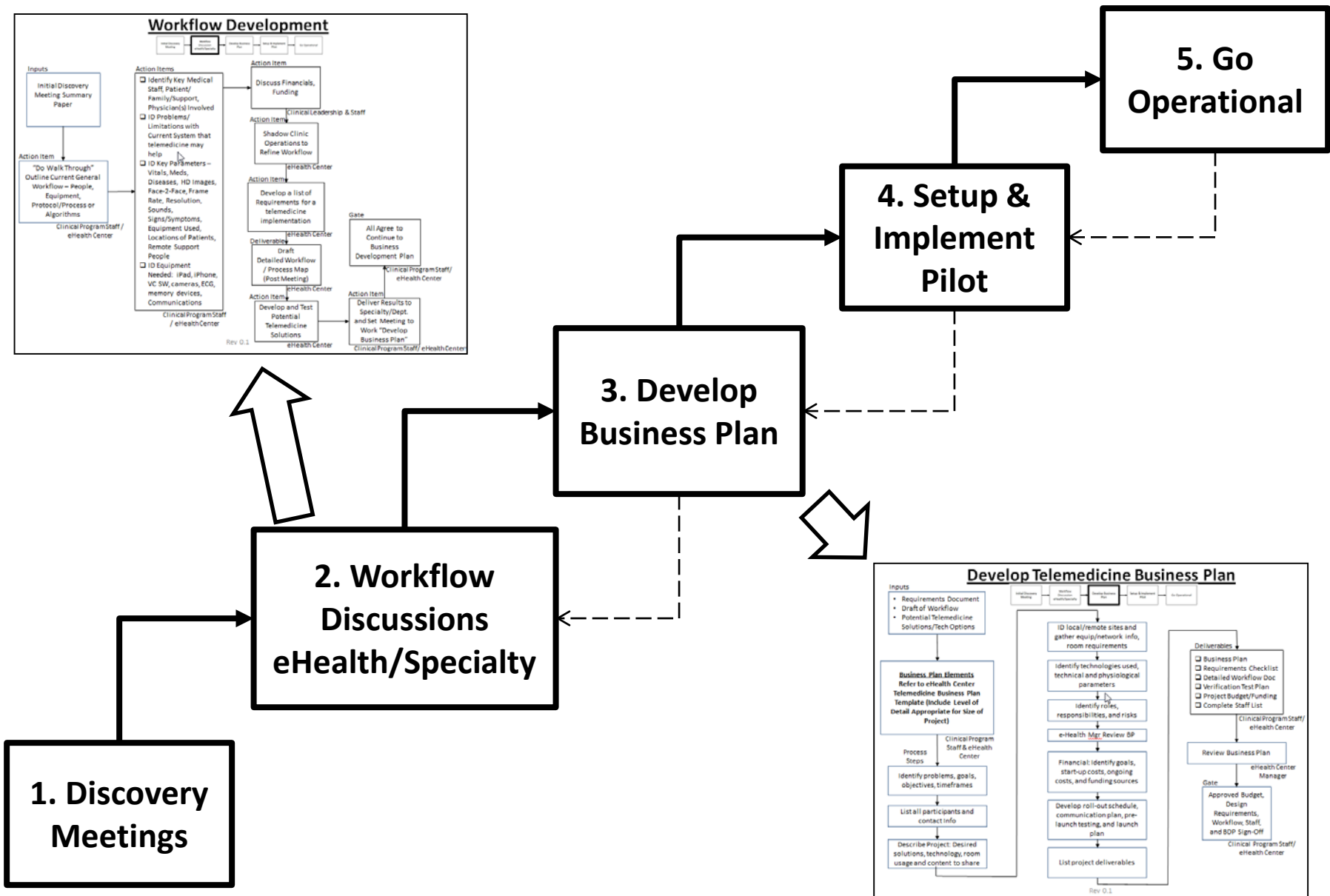
# **Thinking About Telemedicine? Where Do You Begin?**

**Virtual Health Can Help ...**

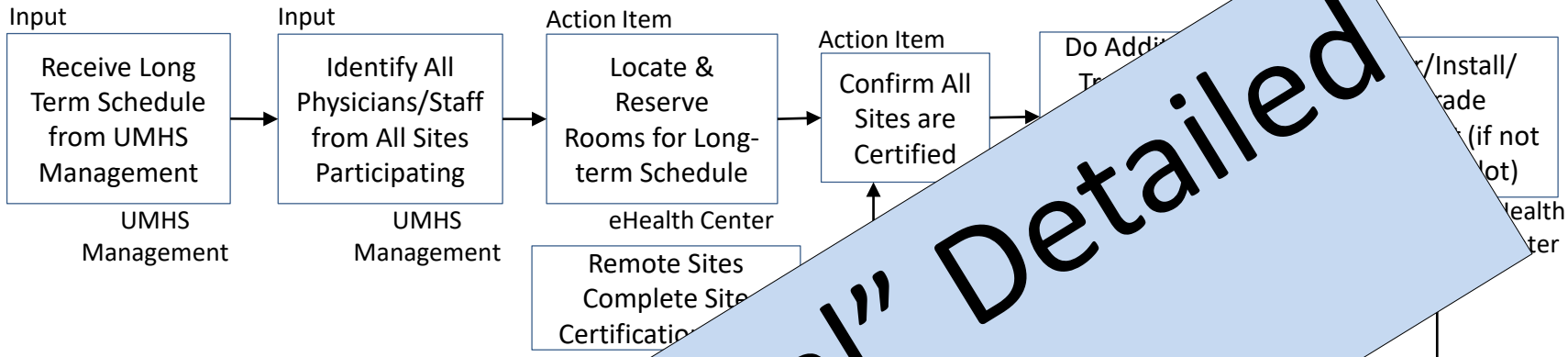
# Virtual Health Mission

**Support UMHS Clinical  
Specialties to Integrate  
Telemedicine Capabilities Into  
Their Clinical Workflows to  
Improve and Enable Remote  
Patient Care**

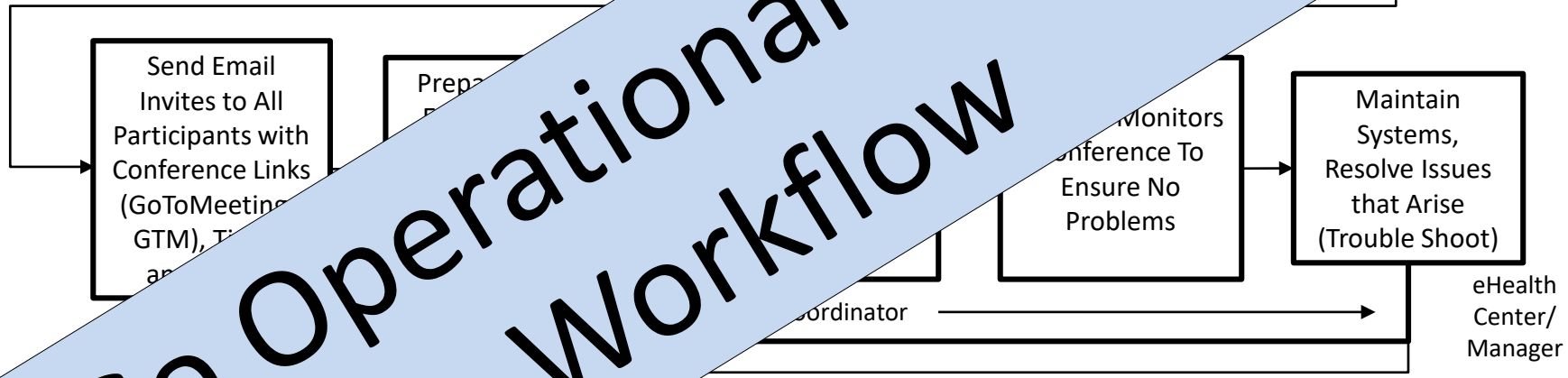
# Clinical Telemedicine Consultation Process



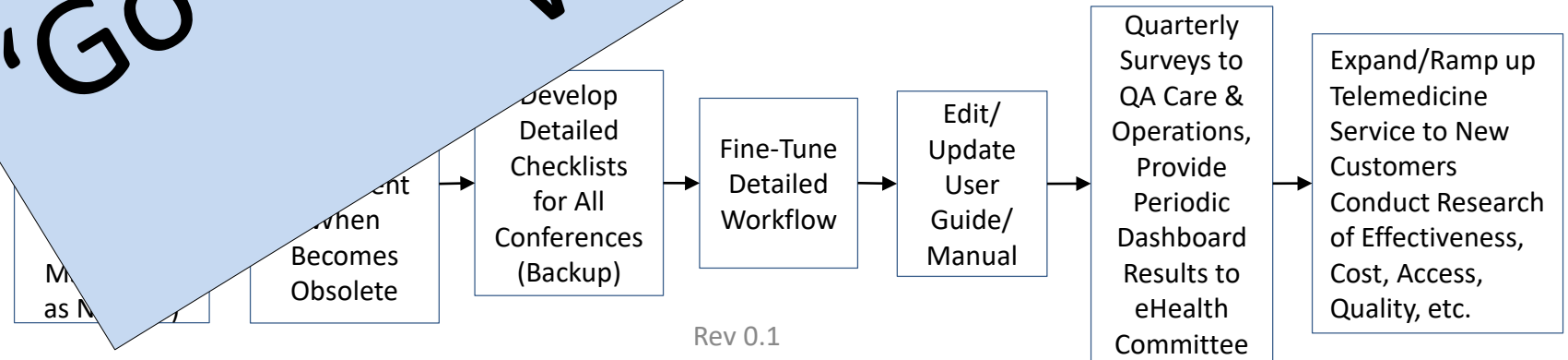
**Telemedicine Preparation**



**Ongoing Operation**



**Exception and Background Activities**



Rev 0.1

**“Go Operational” Detailed**

# Telemedicine Business Development Plan

## Template – *What do we care about?*

- Stakeholders
- Problems
- Patient Needs
- Project Mgmt
- Workflows
- Quality
- Goals
- Consent
- Schedule
- Legal/Billing
- Cameras, Micro-phones, Speakers, Software
- Networking, Firewalls, NAT
- Bandwidth
- Packet Loss
- Frame Rates
- Resolution
- Echos/CTs/MRIs/Xrays
- Peripherals (Stethoscopes, EKG, Ultrasound,...)
- Vitals (BP, Pulse, Weight, Temp, SpO2, CO2, Sounds, Glucose..)
- Risks, Costs,..
- Site Certification
- Training
- Support

# THREE PROBLEMS AREAS

1. Patient/Caregiver Problems
2. Ventilator Problems
3. Remote Telephone Support Problems

# Patient/Caregiver Problems

- Patient respiratory changes
- Blood clots
- Airway Mucus / Can't cough)
- Infections
- Pressure Wounds
- Bruises other wounds
- Acute Resp. Distress Syn. (ARDS)
- Pneumothorax
- VAP (Vent-Associated Pneumonia)
- Oxygen Toxicity (O2 High)
- Lung Damage
- New or Inexperienced Caregiver
- Deciding when to go to the ED
- Unsure how to adjust ventilator settings
- Difficult to travel to clinic 1 or 2 hours away and 100s of miles
- Telephone support & guidance is all based on verbal exchange
- New problems with patient or ventilator
- How do you describe sputum color and viscosity?

# Ventilator Problems

- Battery Changes
- Leaks in the tubing or connections
- Incorrect settings
- What is causing alarms to trigger???
- High pressure blocks
- Difficult to debug tube leaks over the phone
- Replacing filters, batteries, SIM card
- Complexity of Modes and Parameters



# Telephone Only Remote Support Problems

- Does patient/caregiver description match what clinician perceives?
- Is the caregiver adjusting settings correctly on vent or cough assist devices?
- How do you check patient's throat?
- How do you examine bruises/sores?
- Guiding caregiver through a new procedure.



# Telephone Limitations



- **Uncertainty** without seeing
- Caregiver **description** vs. clinician **perception**
- Clinician **guidance** vs. caregiver **execution**
- Difficult to guide caregiver through **steps** (e.g. ventilator adjustments – which screen?)
- **Difficult to adjust** multiple interacting variables
- Picture is worth a 1000 words – but more time required in verbal interaction to accomplish tasks

# The Proposed Solution

- ❑ Leverage patient owned technology – smartphones, tablets, laptops, or desktops
- ❑ Use video conferencing to create a “window” into the patients/caregivers remote home environment



# So You Want to “Skype”? Finding Video Conferencing Solutions

Vidyo  
Cisco Jabber  
Lync  
Skype  
Polycom Real Presence Mobile  
GoToMeeting  
AdobeConnect  
GoToMeeting  
Blue Jeans  
HIPAAChat  
WebEx  
VSee  
Facetime  
Lifesize

Many Options ...

## Video Conferencing Requirements or “Musts”!

- Must be HIPAA/HITECH Compliant
- Must work outside the UMHS VPN
- Must not be blocked by the UMHS firewall
- Must work with Apple, Android, and Windows products ... what the patient owns
- Must be easy to use and support
- Must have adequate resolution to see ventilator (settings screen) and patient (e.g. throat, tracheostomy, pressure wounds ...)
- Must leverage UMHS/Patient infrastructure

# UMHS vs. Patient Owned Infrastructure

Our ACO has 120,000 Medicare  
Beneficiaries ...

120,000 Patients X \$300/Smartphone  
= \$36,000,000!

Obsolete in a year or so!

# HIPAA/HITECH Cloud/Server, Physical, Technical, & Administrative Requirements

## Cloud & Server Standards

- HIPAA
- SOC 1 Type II
- SSAE 16
- ISAE 3402 (formerly SAS 70 Type II)
- SOC 2, Type II
- SOC 3
- FISMA
- DIACAP
- FedRAMP
- PCI DSS
- ISO 27001
- ITAR
- Sarbanes-Oxley (SOX)
- FIPS 140-2

HIPAA/HITECH Regulations!

### Physical Safeguards: 45 CFR §164.310 Requirements

Safeguard Title	Subsections of §164.310
Facility Access Controls (STANDARD)	§164.310(a)(1)
Contingency Operations (ADDRESSABLE)	§164.310(a)(2)(i)
Facility Security Plan (ADDRESSABLE)	§164.310(a)(2)(ii)
Access Control and Validation Procedures (ADDRESSABLE)	§164.310(a)(2)(iii)
Maintenance Records (ADDRESSABLE)	§164.310(a)(2)(iv)
Workstation Use (STANDARD)	§164.310(a)(3)(i)
Workstation Security (STANDARD)	§164.310(a)(3)(ii)
Device and Media Controls (STANDARD)	§164.310(a)(4)(i)
Disposal (REQUIRED)	§164.310(a)(4)(ii)
Media Re-use (REQUIRED)	§164.310(a)(4)(iii)
Accountability (ADDRESSABLE)	§164.310(a)(4)(iv)
Data Backup and Storage (ADDRESSABLE)	§164.310(a)(5)

### Technical Safeguards: 45 CFR §164.312 Requirements

Safeguard Title	Subsections of §164.312
Access Control (STANDARD)	§164.312(a)(1)
Unique User ID (REQUIRED)	§164.312(a)(2)(i)
Emergency Access Procedure (REQUIRED)	§164.312(a)(2)(ii)
Automatic Log-off (ADDRESSABLE)	§164.312(a)(2)(iii)
Encryption and decryption (ADDRESSABLE)	§164.312(a)(2)(iv)
Audit Controls (STANDARD)	§164.312(b)
Integrity (STANDARD)	§164.312(c)(1)
Mechanism to authenticate electronic protected health information (ADDRESSABLE)	§164.312(c)(2)
Person or Entity Authentication (STANDARD)	§164.312(d)
Transmission Security (STANDARD)	§164.312(e)(1)
Integrity Controls (ADDRESSABLE)	§164.312(e)(2)(i)
Encryption (ADDRESSABLE)	§164.312(e)(2)(ii)

### Administrative Safeguards: 45 CFR §164.308 Requirements

Safeguard Title	Subsections of §164.308
Administrative Safeguards (REQUIRED)	§164.308(a)(1)
Security Management Process (REQUIRED)	§164.308(a)(1)(i)(A)
Risk Analysis (REQUIRED)	§164.308(a)(1)(i)(B)
Security Measures (REQUIRED)	§164.308(a)(1)(i)(C)
Security Incident Response Plan (REQUIRED)	§164.308(a)(1)(i)(D)
Security Officer or Security Manager (REQUIRED)	§164.308(a)(2)
Security Awareness and Training (STANDARD)	§164.308(a)(3)(i)
Workforce Security (ADDRESSABLE)	§164.308(a)(3)(ii)(A)
Workforce Clearance (ADDRESSABLE)	§164.308(a)(3)(ii)(B)
Termination Procedures (ADDRESSABLE)	§164.308(a)(3)(ii)(C)
Information Access Management (STANDARD)	§164.308(a)(4)(i)
Isolation of Clearinghouse Functions (REQUIRED)	§164.308(a)(4)(ii)(A)
Access Authorization (ADDRESSABLE)	§164.308(a)(4)(ii)(B)
Access Establishment and Modification (ADDRESSABLE)	§164.308(a)(4)(ii)(C)
Security Awareness and Training (STANDARD)	§164.308(a)(5)(i)
Security Reminders (ADDRESSABLE)	§164.308(a)(5)(ii)(A)
Protection from Malware (ADDRESSABLE)	§164.308(a)(5)(ii)(B)
Log-in Monitoring (ADDRESSABLE)	§164.308(a)(5)(ii)(C)
Password Management (ADDRESSABLE)	§164.308(a)(5)(iii)(D)
Security Incident Procedures (STANDARD)	§164.308(a)(6)(i)
Response and Reporting (REQUIRED)	§164.308(a)(6)(ii)
Contingency Plan (STANDARD)	§164.308(a)(7)(i)
Backup Plan (REQUIRED)	§164.308(a)(7)(ii)(A)
Disaster Recovery Plan (REQUIRED)	§164.308(a)(7)(ii)(B)
Emergency Mode Operations Plan (REQUIRED)	§164.308(a)(7)(ii)(C)
Testing and Revision Procedures (ADDRESSABLE)	§164.308(a)(7)(iii)(D)
Application and Data Criticality Analysis (ADDRESSABLE)	§164.308(a)(7)(iii)(E)
Evaluation (periodic reviews) (STANDARD)	§164.308(a)(8)
Business Associate Contracts (and other Arrangements) (STANDARD)	§164.308(b)(1)
Written Contract or Other Arrangements (REQUIRED)	§164.308(b)(4)

# Penalties for Violating HIPAA/HITECH

**Table 2. TIERS OF CIVIL MONEY PENALTIES (CMP) RELATING TO DEFINED LEVEL OF GUILT**

Violation Category	Potential Cost of Violation	Total CMP for Violations of an Identical Provision in a Calendar Year
Unknowing	\$100 – \$50,000	\$1,500,000
Reasonable Cause	\$1,000 – \$50,000	\$1,500,000
Willful Neglect – Corrected	\$10,000 – \$50,000	\$1,500,000
Willful Neglect – Not Corrected	At least \$50,000	\$1,500,000

<http://www.the-dermatologist.com/sites/default/files/issues/May2013/Legal%20Ease%20Table%202.png>

**HITECH  
Gave HIPAA  
TEETH!**

## HIPAA Enforcement

### CRIMINAL PENALTIES

- Knowingly or wrongfully disclosing or receiving PHI:  
\$50,000 fine and/or one year prison time
- Commit offense under false pretenses:  
\$100,000 fine and/or five years prison time
- Intent to sell PHI or client lists for personal gain or malicious harm:  
\$250,000 fine and/or ten years prison time.
- **Again, you can be personally liable!**

(Penalties, 2014)



# Infrastructure:

## Point-to-Point vs. Multi-Point Connectivity

Point-to-Point Connections (2 only) | Multi-Point Connections (> or = 2)

*One of These*

Apple  
Smart-  
phone or  
Tablet

Android  
Smart-  
phone or  
Tablet

Laptop

Desktop  
PC

**VC Applications:**

- Blue Jeans
- HipaaChat
- Vidyo
- EPIC
- GoToMeeting
- Real Presence

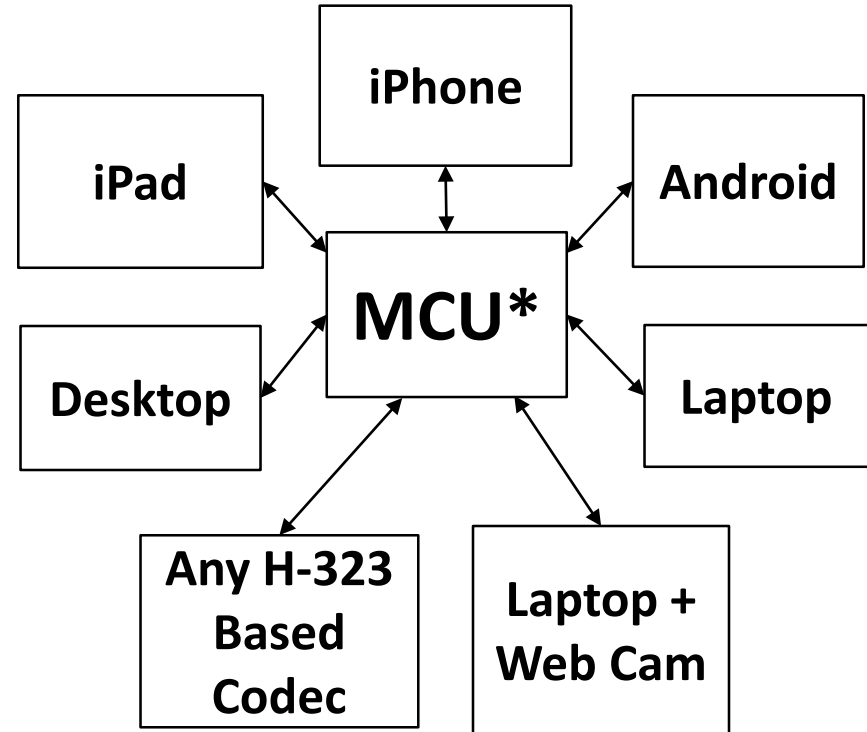
*One of These*

Apple  
Smart-  
phone or  
Tablet

Android  
Smart-  
phone or  
Tablet

Laptop

Desktop  
PC

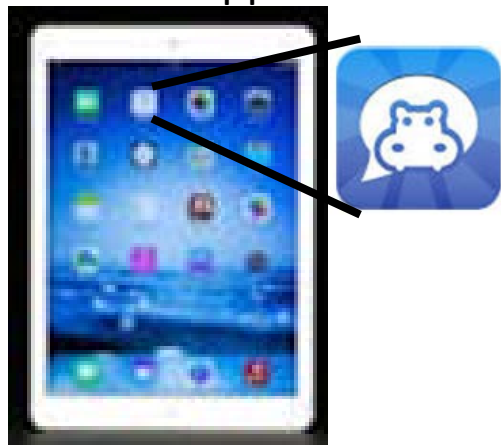


**H-323: Polycom Real Presence,  
Blue Jeans, Cisco ...**

\*MCU = Multipoint Control Unit for  
any H-323 Based Connections

# Connecting with the Patient Using HipaaChat

1. Download HipaaChat from App Store



2. Select Patient from Contact List

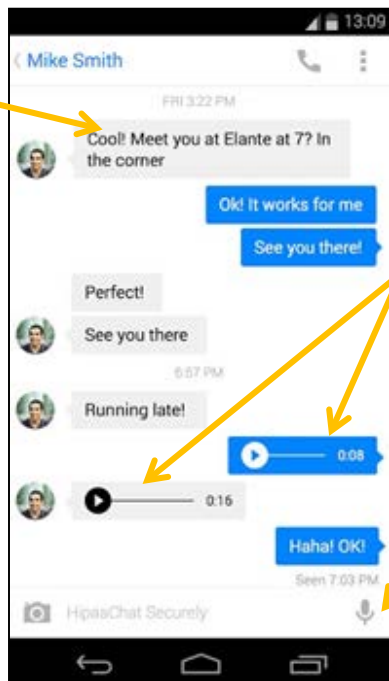


Video Conference

Front/Back Camera Select

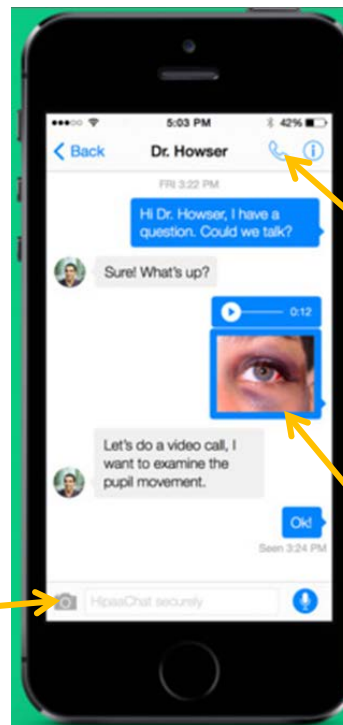


Text



Send/Receive Walkie-Talkie Voice Messages

Take a Picture



Open real-time voice communication

Send Images

Can People Be Guided Remotely Using Mobile Devices?

# The “Zero Knowledge Ventilator Test”

# The “Zero Ventilator Knowledge Test”

Turning Off Alarm on LTV 950



Adjusting LTV 950 Settings



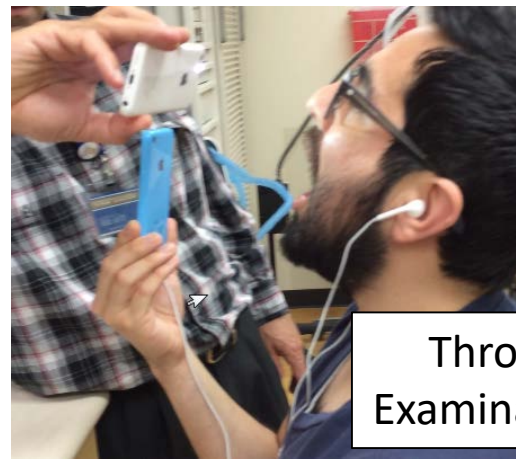
Adjusting Settings on A Trilogy 950



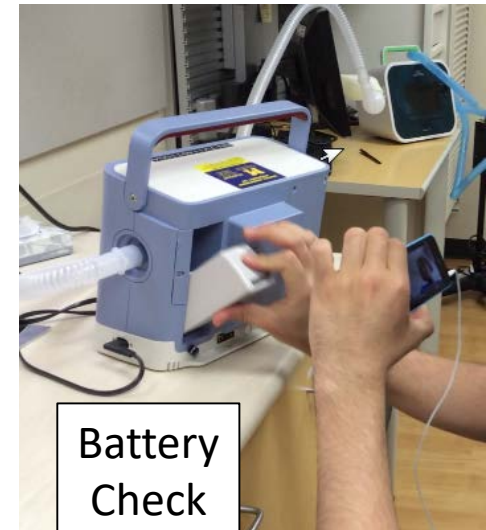
Now – Checking Pressure



Throat Examination



Battery Check

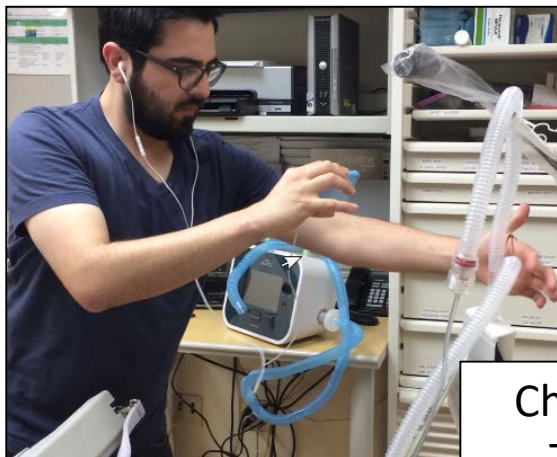


Note: White iPhone is for LED light

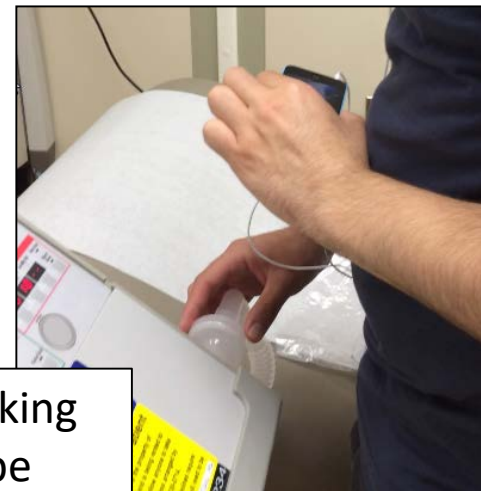
# The “Zero Ventilator Knowledge Test”



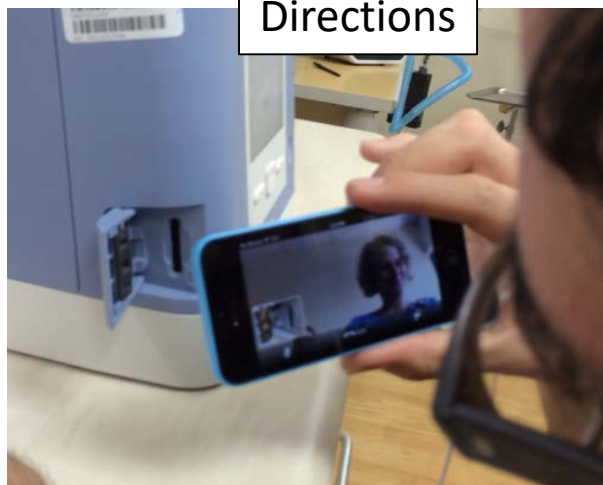
“Dialing In” On  
A Trilogy 100



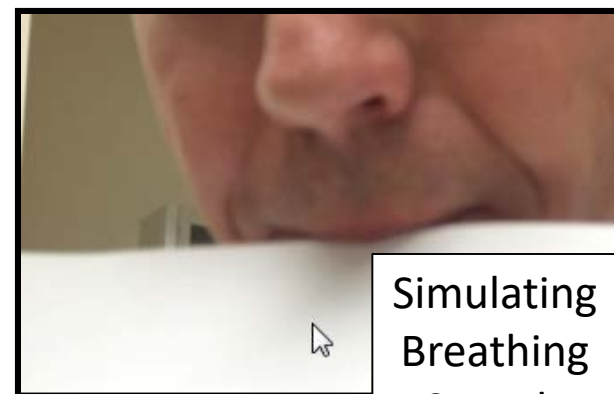
Checking  
Tube  
Connections



SIM Card  
Directions



Checking  
A Bruise



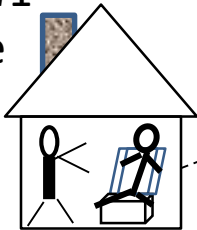
Simulating  
Breathing  
Sounds

## **Our First Test Patient ...**

- Patient #1 **Downloaded** HipaaChat, Enabled Cameras, Entered Clinic's Phone # & Email Address ... Then Called Us to **Check His Setup**
- **100%** Mechanical Ventilator Dependent
- **Uses a Mouth Stick to Control His iPhone** 4S and His iPad Mini Held in a Special Rack Near His Face
- His **Caregiver** Was There to **Assist**
- NP and RT **Used an iPad Air**

# Connecting Clinician to Patient/Caregiver at Home

Patient #1  
At Home



WiFi/Cellular

iPhone 4S

iPad Mini

HipaaChat App



Internet/Cellular



iPad  
Air

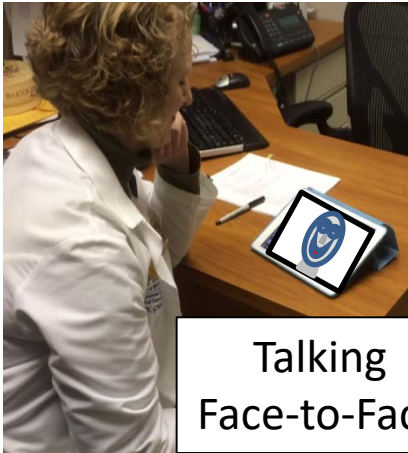
WiFi

Adult Assisted  
Ventilation Clinic

HipaaChat App

**University of Michigan  
Hospital System**

# First Patient Results Using an iPad Mini



Talking  
Face-to-Face



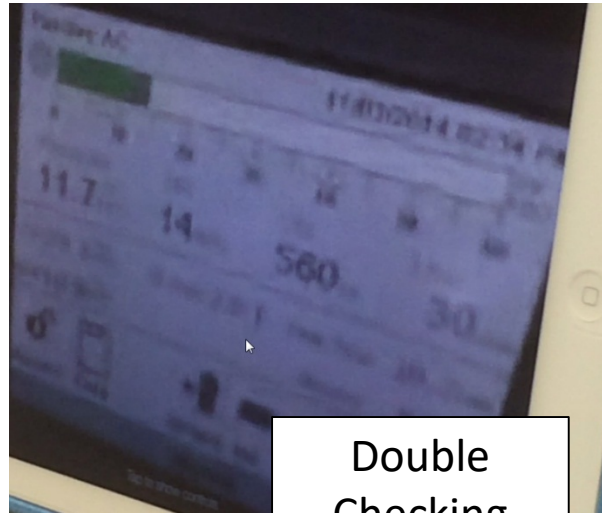
Catching  
Up!



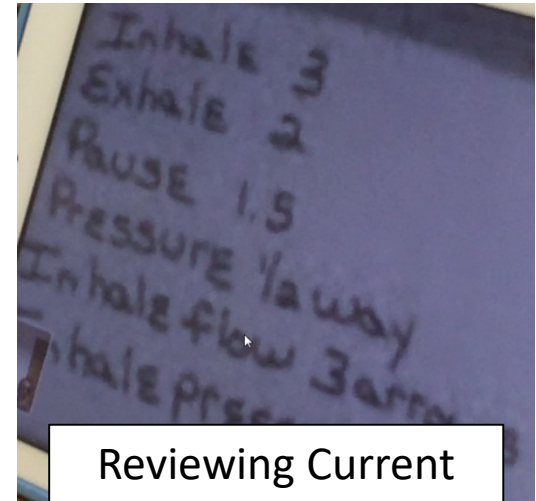
Checking  
Tracheostomy



Checking Vent  
Tubing



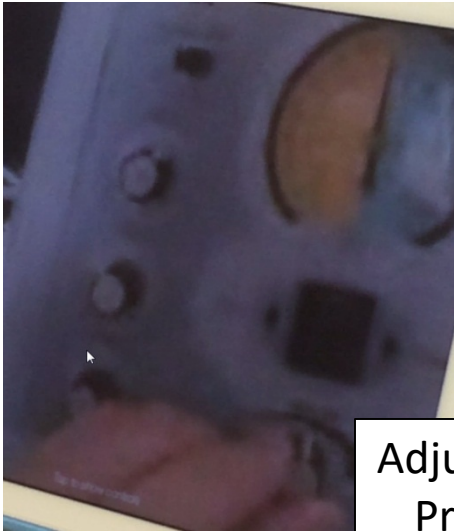
Double  
Checking  
Vent Settings



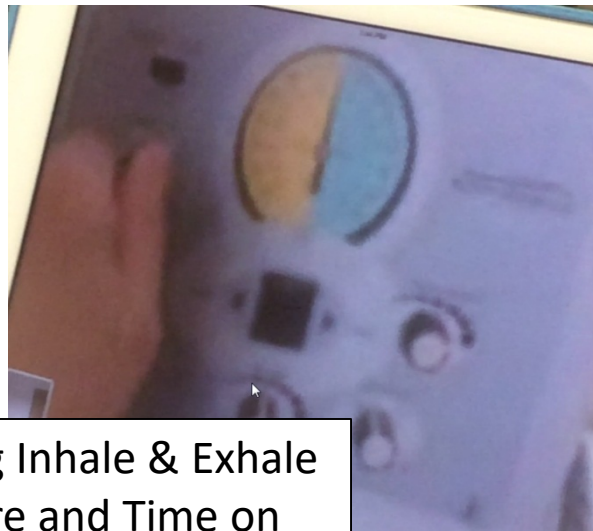
Reviewing Current  
Cough Assist Settings



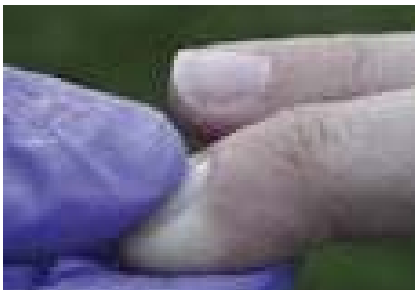
# First Patient Results with iPhone 4S



Adjusting Inhale & Exhale Pressure and Time on Cough Assist Machine



Examined Tongue And Throat\*\*

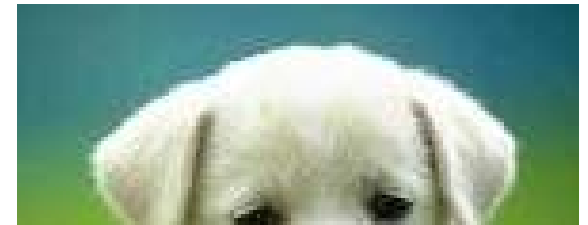


Checked Nail Bed & Capillary Refill\*\*



We Were Able to See His Home Environment \*\*

Able to Observe Leg Spasms Visually



We Were Even Introduced To His Dog \*\*

# Current Status

- Workflows being finalized
- Need to Survey Vent Patients and Caregivers to:
  - Determine What Technologies They Own
  - Their Openness to Telemedicine
- Resolve Billing Issues
- Refine Videoconferencing (Lighting, Acceptable Devices, Software/Device Versions, Camera Resolutions, etc.)
- Request Vendors Activate LED on Smartphone/ Tablet for Illumination
- More Research

# Research...IRB...Experiments...Publish

## Ventilator Telemedicine Simulation Project Case Script

Case # \_\_\_\_\_

Case # \_\_\_\_\_

Date \_\_\_\_\_

Start Time \_\_\_\_\_

Patient side staff \_\_\_\_\_

Remote clinician \_\_\_\_\_

Video observer \_\_\_\_\_

### General setup:

- Date and time for case set
- Room for case set
- 'family' (a UMHS employee) trained and available
- Videographer/ helper trained and available
- Equipment in place
- Clinician named/clinician is free
- Post-hoc video observer assigned
- Patient side forms prepared (randomization)
- Clinician form ready and available
- Masked silent asynchronous video

### Patient side Set up

- 
- 
- 
- 
- Water \_\_\_\_\_ for forearm 'wound'
- Ruler \_\_\_\_\_

### Clinician side set up

- Computer camera
- Script and recording forms
- Clinician is available for case

- 'patient' calls vent clinic number (XXX), explains the situation and asks to have
- Dr. \_\_\_\_\_ paged to phone # \_\_\_\_\_
- Doctor calls to confirm receipt
- Doctor and patient agree this is case # \_\_\_\_\_
- Doctor sends Go to Meeting link \_\_\_\_\_
- Patient receives Go to Meeting link \_\_\_\_\_
- Family performs \_\_\_\_\_ (videographer...).
- Family \_\_\_\_\_
- 5 minutes \_\_\_\_\_

“Ventilator Telemedicine Simulation Project”  
Case Script

### Randomization set up of cases

Randomization scenarios are chosen by random allocation prior to the case. Synchronous and asynchronous clinicians cannot see these scenarios. The patient places an X on the scenario to indicate the actions to be taken. The clinician sees actions and places an X to indicate their observations. Randomizations include:

### Facial expressions:

- 1 Doing fine
- 2 Acutely sob
- 3 Wheezing
- 4 Anxious
- 5 Coughing

### Trach status:

Patient assigned (Randomly generate numbers 1-3 and place an X in each trial on the patient side. Clinician reads from a distance. )

- 1 Trach out
- 2 Trach partially in
- 3 Trach not in

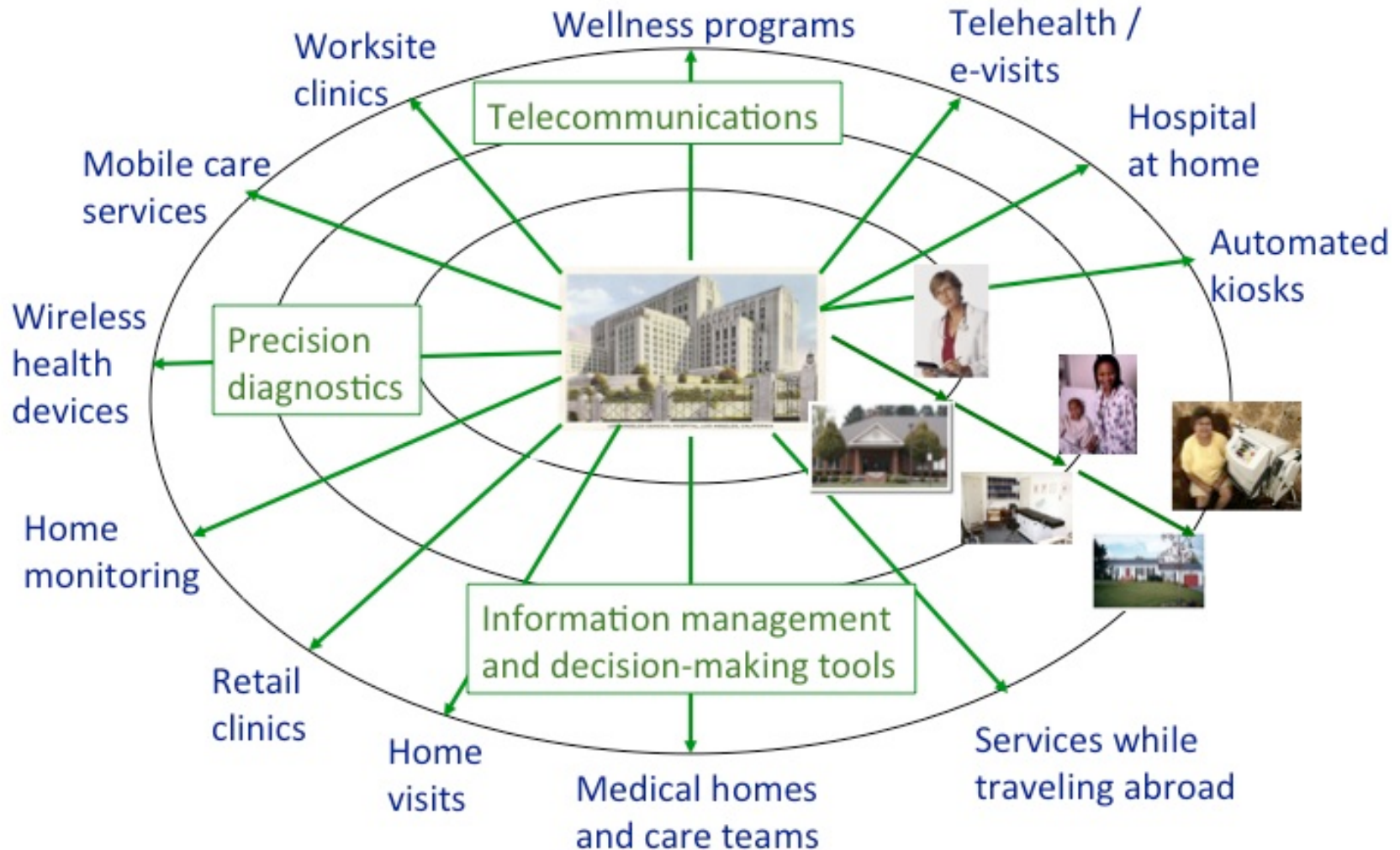
# Some Other Telemedicine Projects at UMHS

- Remote Second Opinions (RSO) – many specialties
  - Telemedicine Home Pharmacy Management
  - HomeMed Infusion Pump Roll-Out and Training
  - Teleophthalmology Remote/home Consultations
  - Variety of Survival Flight Telemedicine Projects
  - Infant Oximetry – Pediatric Cardiology
  - Pediatric Critical Care Consultations
  - Pediatric Congenital Heart Patient at Home Follow-Up
  - State Initiative for Telehealth - Peds Epilepsy
  - NeuroSport Concussion Teleconsultations
  - Teleneurology
  - Telestroke
  - Inflammatory Bowel Disease
  - Neonatology – Allegiance
  - Bladder Cancer Post-Op Follow-up
  - Teledermatology (Store & Forward)
  - Home Speech/Language Therapy
  - Pediatric Nephrology ICU
  - Partial Nephrectomy Post-Op Follow-Up
  - Psychiatry Teleconsultations
  - Home Speech/Language Therapy
- ... quite a few more

# Disruptive Models and Technologies in Medicine

# Disruptive Business Models in Medicine

A new ecosystem of disruptive business models must arise

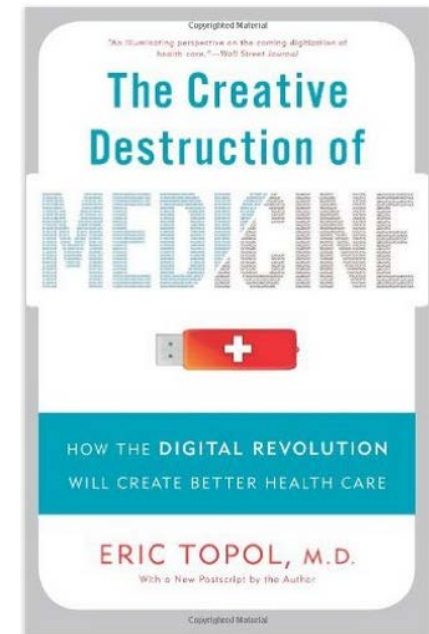
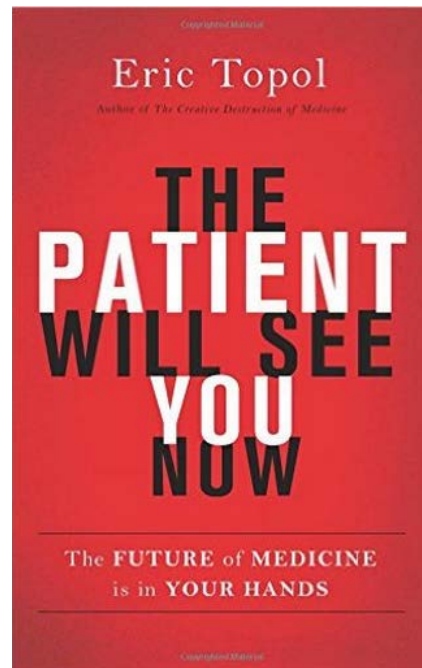


# Telemedicine Technology Building Blocks

- Sensors
- Processors
  - LCDs
  - Optics
  - Storage
- Wired/Wireless Communications
- Software Tools
  - Peripherals  
(Stethoscope, US, ...)
- Algorithms
- Applications
- Networking
  - Cloud
- Materials Science
  - Data Mining
    - AI
  - Analytics
  - **Security ...**  
(always last - pacemaker)

# *“Future of Medicine” Books by Dr. Eric Topol*

- The Creative Destruction of Medicine
- The Patient Will See You Now





# Dr. Topol's "The Creative Destruction of Medicine"

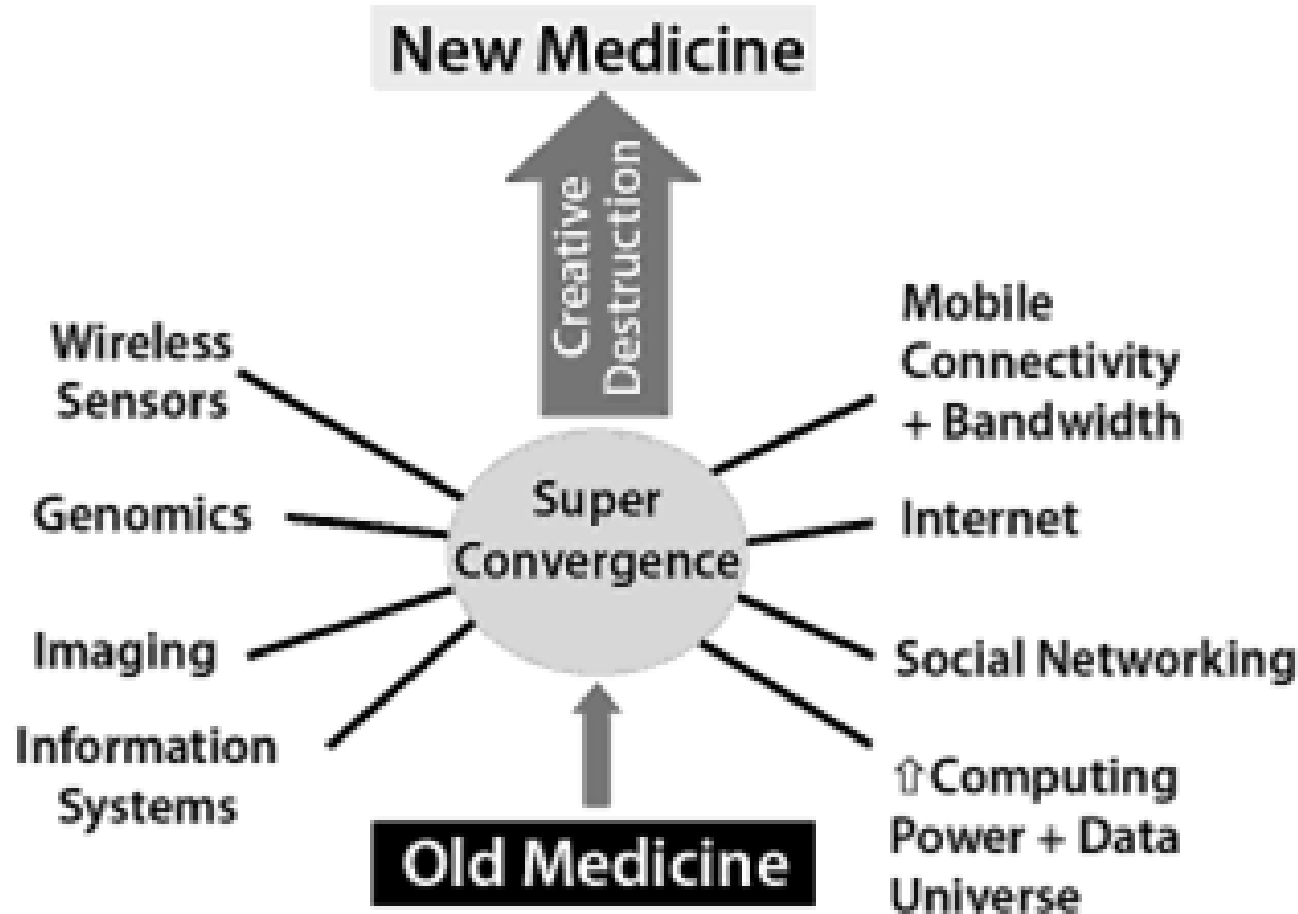
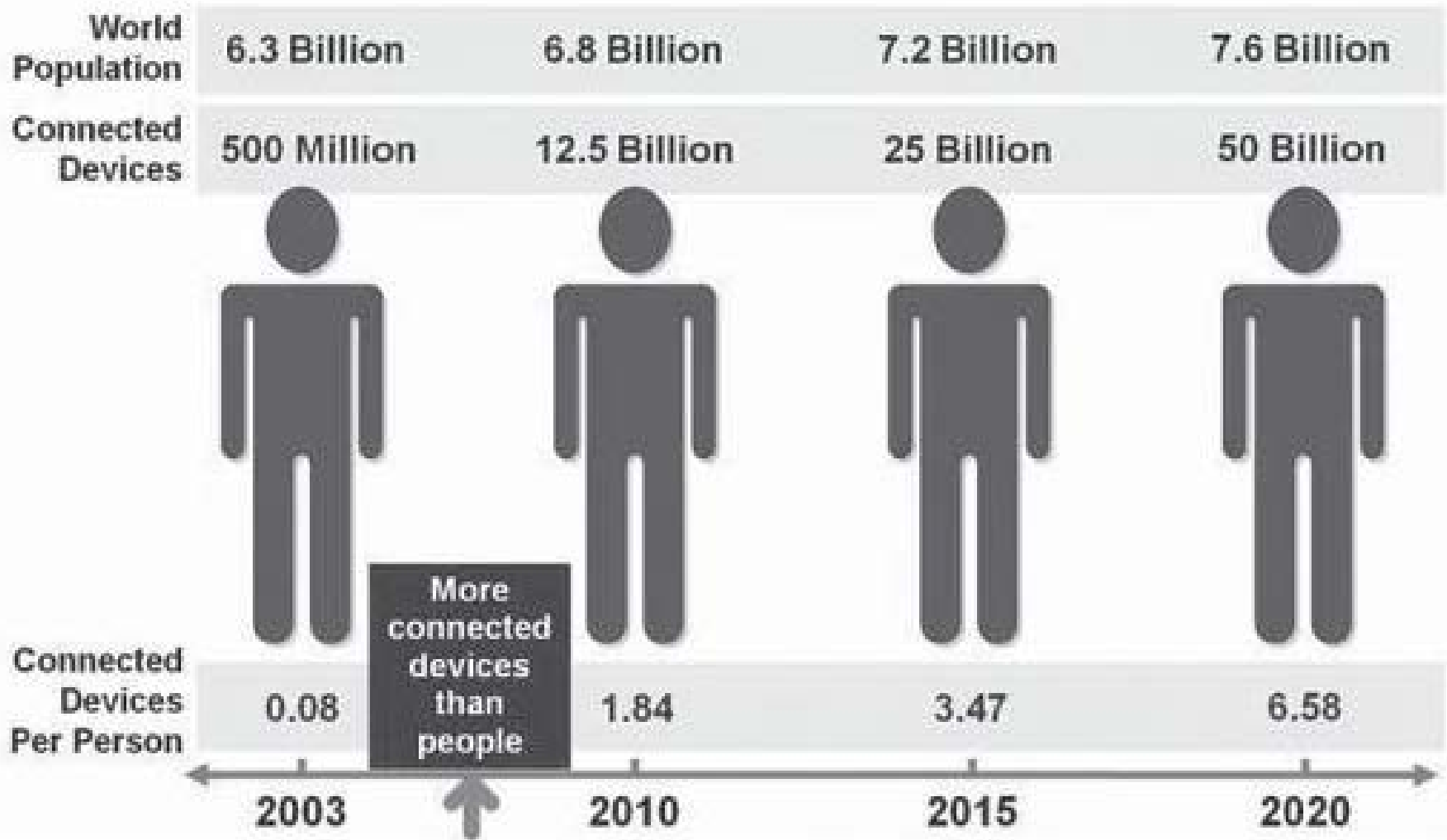


FIGURE INTRO.1: The transformation from medicine today (old, dumbed down) to new, individualized medicine that is enabled by digitizing humans.

# From Dr. Topol's "The Patient Will See You Now"

## *The Number of Connected Devices Per Person*

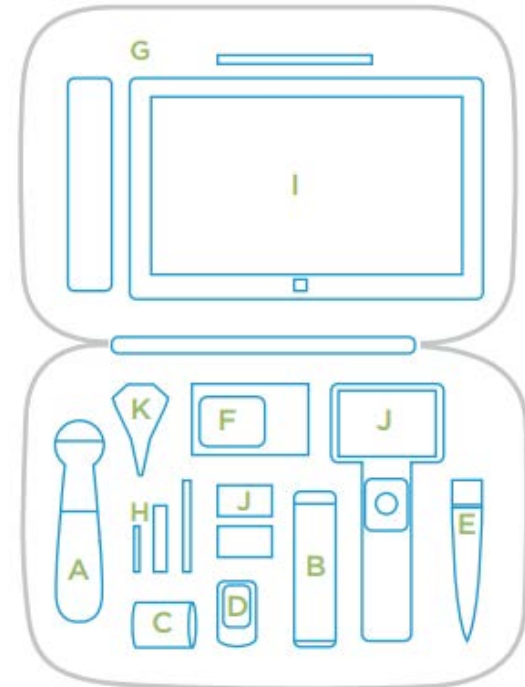


# Medweb Telemedicine Kit \$2500!



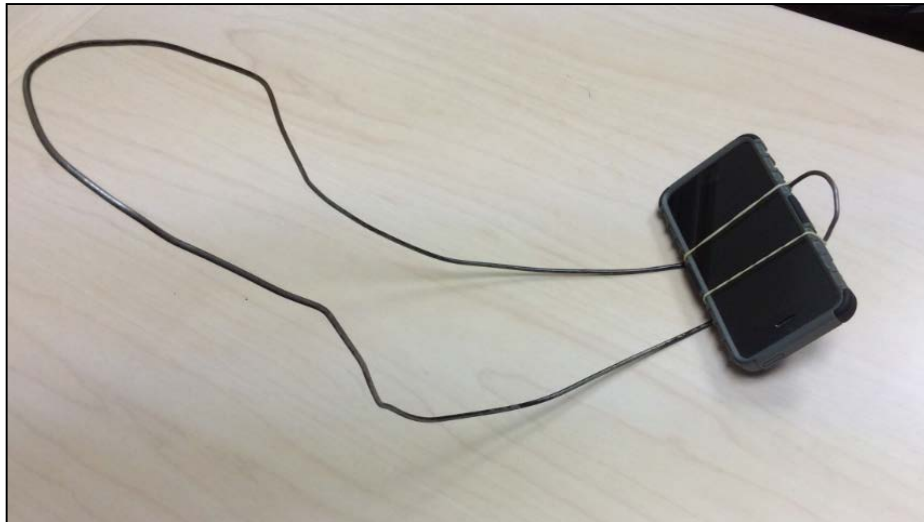
- A Abdominal Ultrasound
- B Eye-Fundus Scope
- C Episcopes
- D Bluetooth Pulse Oximeter
- E Ultrasound Gel
- F Digital EKG
- G Bluetooth Stethoscope
- H Camera Direct wifi SD card
- I Tablet
- J Multi-Scope
- K Otoscope

**FFMI  
Opportunity**



# A Poor Man's Google Glass

(A Prototype: A Wire Hanger and Rubber Band)



**FFMI  
Opportunity**

- Remote Trouble Shooting
- Remote Education
- Hands Free for Performing Tasks Under Observation and Immediate Feedback
- New Infusion Pump Rollout Trouble Shooting and Training
- Remote Vent Patient Care and Adjusting Vent/Cough Assist Devices
- Show Someone "How To", Then Have Them Show You That They Know "How To"

# Leveraging the Patient Owned "Infrastructure"



Retina Imaging

(Retina Imaging, 2014)



Ultrasound

(Ultrasound, 2014)



ECG

The new IMEC/Holst Center ECG app

(ECG, 2014)



Digital Stethoscope

(Digstethoscope, 2014)



Otoscope

(Otoscope, 2014)



Dermoscope

(Dermoscope, 2014)



(MenPhones, 2014)

**More People Have Cell Phones Than Toilets, U.N. Study Shows**  
Out of the world's estimated 7 billion people, 6 billion have access to mobile phones. Only 4.5 billion have access to working toilets

(PhonesThrones, 2014)

*Phones vs. Thrones*

# Smart Toilets: Doctors in Your Bathroom



Toto's new Intelligence Toilet II monitors weight, blood sugar levels, and other vital signs, transferring data to your computer for analysis via WiFi.

# Summary: A New Vision For Healthcare

## *The 3 Cares – Eric Dishman, Intel*

- Care Anywhere (Home, Work, School, Gym, Car, ... while sleeping)
- Care Networking (From Social Networking to Remote Second Opinions)
- Care Customization (Population vs. Individual)

## *The 8-Ps:*

**Prediction, Prevention, Personalization,  
Participation, Price, Population, Performance  
(Quality/Speed), Process (Reliability)**

Thank You.



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# August 2017

