A Remote Surveillance Program for High-Risk Surgical Patients

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Disclosures

Equity ownership in Position Health, Inc.

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A Case Example

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45 yo M hx of HIV on HAART s/p emergent R open globe repair secondary to rock in eye when hammering.

Hospital Course
- Uncomplicated repair of globe in late evening Saturday
- Transferred to inpatient floor
- Began experiencing dyspnea (SpO2 high 80s intermittently), sinus tachycardia (130s).
- **Alert paged** out to SICU fellow at 01:00 AM Sunday for tachycardia and hypoxia

Post-Alert Page Course
- SICU Fellow reviewed chart and evaluated patient at bedside
- Patient had increased work of breathing, rhonchi, productive cough, 7L O2 requirement, MAP trending lower, and tachycardia. Also found to have several small ulcers in the oral mucosa. Also noted to have tingling of palmar surfaces of his hands bilaterally.
- Spoke with nursing team (previous plan was to wait until morning to discuss with medical hospitalist service). Ophthalmologist unaware of patient's decline.

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A Case Example

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Post-Alert Page Course
- Discussed with ophthalmologist
- SICU Fellow recommended that team to initiate immediate work-up including:
  - CBC
  - Lactate
  - Sputum culture, AFB
  - CD4
  - Viral load
  - Quant Gold
  - RPR
  - CXR
- CXR revealed bilateral infiltrates consistent with PNA; CD4 200; RPR positive
- SICU Fellow discussed with ophthalmology team and initiated:
  - Empiric antibiotics for CAP
  - IV fluid resuscitation
  - Nebulizers
  - ID consult
- Improved over the next 2 days
  - Vital signs normalized
  - Off of oxygen
  - Started on PCN for treatment of secondary syphilis, DPH alerted
  - Set home with PCN x 3 wks

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Introduction

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Remote Surveillance

- **Definition**
  - A strategy of collecting and digitally transmitting clinical data from a patient in a location different from where the clinician is located
  - Employs data from any combination of invasive and non-invasive monitors, wearable devices, biosensors, electronic health records (EHR), video cameras, and more[1,2]
- **Aim**
  - Enable clinicians to monitor, diagnose, and intervene in a variety of settings in order to increase the timeliness and safety of care
- **Opportunity**
  - Increase the value of anesthesiologists by expanding their roles as the hospital's experts in physiologic monitoring throughout the perioperative continuum
- **Important Considerations**
  - Few studies exist on how these technologies should be implemented, scaled, and made sustainable

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Introduction

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Why Now?

Old and New
- Although components of remote surveillance have been in development for nearly a decade, the coming together of multiple advances in health information and digital technology present the opportunity for broader applications.

Three Major Developments in Recent Years
- **Un-Siloing Data**
  - patient data previously siloed into different data systems in now collected, stored, and retrieved in a common system, increasing the volume, diversity, and accessibility of data related to the patient clinical state
- **Convenient Monitors**
  - newer continuous non-invasive physiologic monitors are convenient for patients, such that monitoring can be performed and data gleaned in a growing number of clinical settings—from their home prior to surgery, through their operation to the post-operative general care ward and back home again
- **Better Predictions**
  - more sophisticated prediction algorithms can automatically sort through massive amounts of clinical data and identify constellations associated with adverse clinical events so as to increase the specificity of alerts and reduce alarm fatigue.

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Building a Remote Surveillance Program

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Components Effective Remote Surveillance

Data
- Continuous physiologic data
- EMR data (e.g., labs, medications, flowsheet data, orders data)
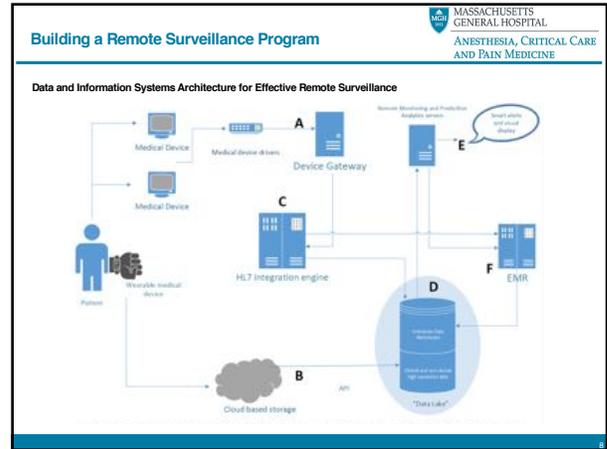- Common data repository
- Quarriable on a real-time basis

Prediction
- Clinically relevant events
- Early enough that intervention could change patient outcome
- High sensitivity
- High specificity
- Performed in real-time

Alert and Response
- Manageable number of alarms
- Targets appropriate responders
- Convenient alert delivery mechanism (e.g., pager, EMR alert, visible dashboard)
- Appropriately trained responders

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Building a Remote Surveillance Program

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Data and Information Systems Architecture for Effective Remote Surveillance

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Use Cases

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Remote Surveillance Across the Perioperative Continuum

Pre-Operative Assessment
- Objective, quantifiable functional assessment performed at home

Operating Room
- Air traffic control across multiple ORs
- Driving high-value care initiatives
  - ERAS
  - Appropriate Tidal Volume Ventilation

PACU
- Remote monitoring for the anesthesiologist in the OR
- Opioid-Induced Ventilatory Insufficiency

ICU
- Hardware-less TeleICU

General Care Ward
- Remote alerting for high-risk surgical patients
  - Complex patients
  - Low resource care settings

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Remote Surveillance Program: A High Risk Post-Op Setting

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Rationale
- Our institution's surgical ICU is responsible for emergent airway and any critical care needs, should they arise, of a neighboring hospital that specializes in ENT and ophthalmologic care
- Many of these patients are surgically complex and medically comorbid
- Surgical staffing of the 24-bed inpatient unit is low on night and weekends
- Housestaff (PGY-2 or greater) are typically not located on the unit and lack experience in critical care

Aim
- Build a model of proactive consultative critical care in which intensivists provide guidance to surgical teams when there is evidence of acute clinical deterioration before an adverse event occurs.

Design
- Feasibility study
- Prospective case series

Measures
- Overall rate of alerts
- Rate of false positive; false negative alerts
- Clinical etiology of alerts
- Clinical response time
- Subsequent action by clinician
- Actionability of alert to improve care

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Remote Surveillance Program: A High Risk Post-Op Setting

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Background

- Monitoring was conducted over a **108-day period** from August to November, 2017.
- **Laboratory** and **vital sign data** were analyzed by the software **every 15 minutes** 24/7.
- Alerts were generated using a **software algorithm** pre-specified by the study team to detect evidence of acute clinical deterioration. If an alert was triggered, it was automatically delivered **via pager** to an intensivist
- **Retrospective chart review** was performed on patients for whom an alert was generated to assess the etiology of the alert and opportunities for the intensivist to improve care.

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Remote Surveillance Program: A High Risk Post-Op Setting

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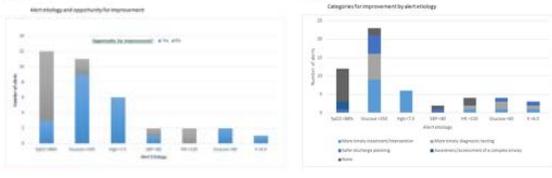
Results

- **817 patients** were monitored during the study period. **91,981 data items** were processed by the technology (**851.6 data items per day**)
- **43 alerts** were generated: on average **2.8 alerts per week**, 0.4 alerts per day
- There were **0 false negative alerts**
- There were **4 (8.9%) false positive alerts**
- 100% of alerts generated were subsequently received via page

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Remote Surveillance Program: A High Risk Post-Op Setting

Results: alert etiology and opportunities for improvement

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Remote Surveillance Program: A High Risk Post-Op Setting

Results: categories for improvement
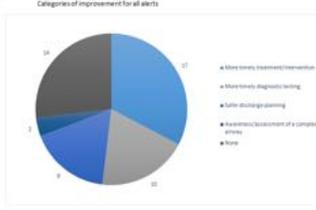
Themes of Quality Improvement

- Delays in blood transfusion (up to 12 hrs after Hgb <7 until RBC administered)
- Hyperglycemia management (route of admin, follow-up labs, recognition of DKA)
- Undiagnosed sleep apnea (referrals for sleep study)

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Future Aims

Remote Surveillance Across the Perioperative Continuum

Populations in whom we have assessed the opportunity and/or begun monitoring
- 48-hour post-SICU discharge
- Orthopedic geriatric trauma pre/post-op
- Chimeric Antigen Receptor T-Cell (CAR T) patients
- Obstructive Sleep Apnea patients post-op
- High-risk opioid patients
- ERAS pathway patients intra/post-op
- ED boarder population