Continuous, High-Quality, Non-Obtrusive 12/15-Lead ECG Monitoring

– The New Standard
- Not Only in The Intensive Care Unit

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Shortcomings of Traditional ECG Monitoring

- Restricted to 1-, 3-, or 5-leads
- Limited to heart rate assessment
- Lacks in-depth rhythm analysis
- Inaccurate for myocardial ischemia diagnosis
  - Hearts attacks only diagnosed w/12-leads
Regular 12/15-lead ECG is Cumbersome

- Shave, Gel, Adhesive, Placement
- Takes ~10 minutes to set up
- Non-uniform electrode placement
- Requires ECG operator or familiarity with device
- Impractical for long-term monitoring
- Restricted to bed-ridden patients
- Obtrusive
12/15-Lead ECG Monitoring: Pros

- **Ischemia with 12/15 Leads**
  - “Gold standard” for diagnosing myocardial infarction
  - 15-lead ECG not routinely done, but
    - stipulated in guidelines to detect right ventricular and posterior wall infarction*
    - ~10% ST-elevation myocardial infarctions go **undetected**......yet detected using posterior leads**
  - Crucial for determining reperfusion

- **Arrhythmia via 12/15 Leads**
  - Vital to determine anatomic orientation of arrhythmias
  - Stipulated in guidelines

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*-Eur Heart J 2012 Oct;33(20):2569-619
12/15-Lead ECG Monitoring: Cons

- Spaghetti of wires
- Skin irritation
- Not for mobile patients
- 12-lead ≠ derived “12-lead” ECG
  - Uses only 5 leads
  - May prohibit detection of subtle ECG changes
  - 2nd ECG required if “event” detected

The HealthWatch Garment Solution

- Continuous ECG Monitoring
- Monitors **actual** 12/15-leads
  - *not* derived 5-leads
- No Electrodes. No Shaving. No Wires
- Standardized electrode placement
- No expertise needed to operate
- Ideal for bedridden and *mobile* patients
- Also for ambulatory in-patients, out-patients, high cardiac risk, and health-conscious individuals
ECG Quality You Can See…Instantly

Standard 12-Lead ECG*

HEALTHWATCH™ Garment

* - Measured via GE MAC 5500
Clinical Implications

In-hospital, Homecare, Recreation

- Monitoring of high-risk non-cardiac unit inpatients
- Earlier discharge of patients; hospital-level surveillance
- Reduced readmissions due to false alarms
- Earlier detection of unrecognized conditions
- Monitoring higher-risk individuals continuously under true, real-life situations
- Virtual clinic visits with serial ECGs rather than a snapshot ECG
Vital Sign Monitoring *Beyond* ECG

- Healthwear device **currently** provides...
  - Body posture and motion status
  - Respiratory rate
  - Skin temperature

- In the near future...
  - Oximetry
  - Non-invasive blood pressure

- Goal
  - Comprehensive cardiopulmonary monitoring
  - Intensive care quality anytime, anywhere!

Augmented Safety to Reduce Hospital-Acquired Conditions (HAC)
Possible Applications

Length of Hospital Stay
3.7.3. Average length of stay for acute myocardial infarction (AMI), 2012 (or nearest year)

<table>
<thead>
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<th>Country</th>
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<tr>
<td>Germany</td>
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From: Health at a Glance: Europe 2014

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National trends in hospital length of stay for acute myocardial infarction in China

Qian Li, Zhen Li, Frederick A Mossey, Jing Li, Li Li, Sonia Hernández-Díaz, Sudhakar V Khurana, Lingli Li, Qiang Wang, John A Spunt, Frank B Hu, Harlan M Krumholz and Klein Jiang

Abstract

Background: China is experiencing increasing burden of acute myocardial infarction (AMI) in the face of limited medical resources. Hospital length of stay (LOS) is an important indicator of resource utilization.

Methods: We used data from the Retrospective AMI Study within the China Patient-centered Initiative Assessments of Cardiac Events, a nationally representative sample of patients hospitalized for AMI during 2001, 2006, and 2011. Hospital-level variation in risk-standardized LOS (RS-LOS) for AMI, accounting for differences in case mix and year, was examined with two-level generalized linear mixed models. A generalized estimating equation model was used to evaluate hospital characteristics associated with LOS. Absolute differences in RS-LOS and 95% confidence intervals were reported.

Results: The weighted median and mean LOS was 12.6 days in 2006 (n=5,533) and 11.1 and 11.9 days variation in RS-LOS across the 140 hospitals; an average 14 days (p=0.02) shorter RS-LOS than relating to capacity for AMI treatment were not found.

Conclusions: Despite a marked decline over the long-term compared with international standards, further improvement of AMI care in China is still required.

Keywords: Acute myocardial infarction, Length of stay

Figure 2 Year-trend Whisker plot of length of stay. Diamond inside the box: mean; line inside the box: median; bottom and top edges of the box: interquartile range (IQR); bottom and top edges of the whiskers: 1.5*IQR; points beyond the whiskers: outliers.
ST-segment elevation myocardial infarction in China from 2001 to 2011 (the China PEACE-Retrospective Acute Myocardial Infarction Study): a retrospective analysis of hospital data
Li J, Xi Li X, Wang Q, et al., for the China PEACE Collaborative Group
The Lancet, Early Online Publication, 24 June 2014

• Hospital admissions for STEMI per 100,000 people increased during the study period from 3.7 in 2001 to 8.1 in 2006, to 15.8 in 2011 (P(trend)<0.0001).

• Median hospital length of stay was 13 days (IQR: 7-18) in 2001, 11 days (IQR: 6-16) in 2006 and 11 days (IQR: 7-14) in 2011 (P(trend)<0.0001).
ECG – Past, Present, Future

From Eindhoven
1 lead ECG
(1902)

To 12-lead ECGs
(1929)

To 12/15 lead ECG
Anytime, Anywhere
(2015)
Step By Step Approach

- Event detected by medical provider through continuous monitoring by either
  - **Continuous transmission** to dedicated station (WiFi)
    - Inpatients
    - Nursing homes
  - **Continuous recording** and periodic transmission to caregiver (WiFi or Bluetooth)
    - In case of symptoms allow for patient triggered transmission of pre- and post-event ECG
    - More suitable for remote monitoring