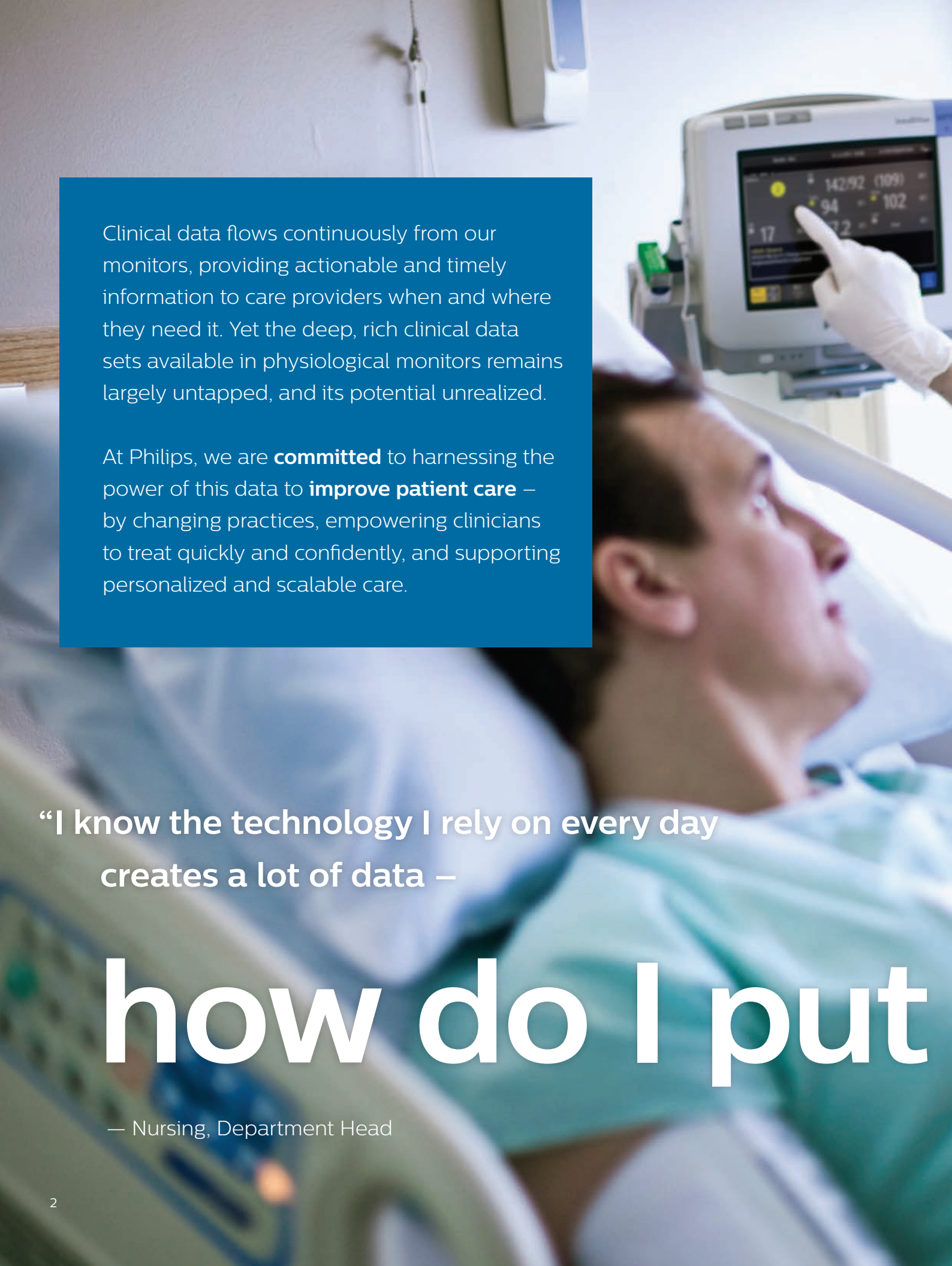
PHILIPS

Patient monitoring

Data Consulting Services

Deeper insights. Advancing care.



Clinical data flows continuously from our monitors, providing actionable and timely information to care providers when and where they need it. Yet the deep, rich clinical data sets available in physiological monitors remains largely untapped, and its potential unrealized.

At Philips, we are **committed** to harnessing the power of this data to **improve patient care** – by changing practices, empowering clinicians to treat quickly and confidently, and supporting personalized and scalable care.

"I know the technology I rely on every day creates a lot of data –

how do I put

— Nursing, Department Head

it to work?”

Dr. Adam Seiver

A message from our Chief of Medical Affairs

In 1984, my research team became curious about what happened to patients in the time interval inbetween recorded vital signs in the ICU. After all, the physiological monitors made hundreds of measurements per second, but only a small subset of the data could be recorded by hand on the paper flowsheets. With the efforts of a couple undergraduate programmers we connected a personal computer to the digital ports of the bedside ICU devices and collected monitor measurements every couple seconds. The homebrew data collection system led to some interesting insights, but the hardware and software was never able to capture full ECG, pulse oximetry, or ventilator pressure/flow waveforms. So much of this potentially useful patient data radiated out into the ether, never to be seen again.

In many ICUs – even with the ever-increasing use of the Electronic Medical Record – the situation remains the same. The failure to capture the high-resolution, granular physiological data generated by monitors and ancillary equipment like ventilators squanders valuable information. For example, wouldn't it be wonderful if we could capture every cardiopulmonary arrest occurring on a monitored patient and review the vital sign changes that preceded the event? Suppose we could review and readily replay the clinical team response, including rate of chest compressions and ventilator support. What if we could review what alarms were sounding before the event and the values for the alarm limits?

Maybe you have an interest in Big Data and Machine Learning. Suppose the full waveforms could be sent immediately to a workstation running algorithms to analyze and identify patterns immediately? Suppose these algorithms could be deployed to send timely and welcome advice to your bedside clinicians, without large numbers of noisy nuisance alarms.

What if researchers in your institution could study advance dynamic patterns in the data – perhaps linked to history, physical exam, and laboratory data. Would this uncover new mechanisms of pathophysiology and treatment response?

Such are the potential ways in which acquisition, storage, and review of comprehensive, granular monitoring data can contribute to patient care, teaching, and research. And it is not necessary to hire a team of data scientists and engineers to obtain such capability from your Philips monitoring system. The Data Warehouse Connect (DWC) solution developed by talented Philips scientists and engineers represents an ever-increasing set of data acquisition and review tools – together with advanced technical consulting – that can enable the capability for what up to now could only be imagined.

At Philips, we are committed to making data meaningful for care professionals to benefit their patients.

Sincerely,
Adam Seiver, MD, PHD, MBA, FACS, FCCM
Chief Medical Officer

Data Consulting Services

Philips offers specialized technical services to drive high resolution data captured by our Data Warehouse Connect solution and apply it towards research and quality of care improvement projects.

Our principal scientists are at the forefront of transforming raw physiological data into powerful tools to enhance care. With deep experience in research and development of proprietary algorithms, we work in collaboration with leading institutions worldwide in areas of:

Leading the way

Driving toward more predictive and preventative care, managing population health

Partnering for the future

When luminaries work together and share data, great things happen

Making the case for change

Reliable information at the heart of quality, efficient and effective care

Care area: NICU

QT monitoring in the NICU[1]

Challenge

QT prolongation has been implicated in approximately 10% of sudden infant death syndrome cases. Automated QT monitoring for critically ill infants may be beneficial but is challenged due to the prevalence of high heart rates, abnormal T waves, noisy signals and limited available ECG leads.

Goal of study

Test effectiveness of Philips QT Interval monitoring algorithm in neonate and pediatric population (n = 66 critically ill patients from two large teaching hospitals).

Methodology

66 critically ill infants at two major teaching hospitals were monitored with Philips bedside monitors:

- Mean heartrate: 152 beats/min
- ECG recording: 10 min to 2 hours at a rate of 500 samples per sec

Sponsors

- Mayo Clinic, Rochester, MN
- Advanced Algorithm Research Center, Philips, Andover, MA

Potential impact on outcomes

Automated continuous QT interval monitoring in the neonatal intensive care setting is feasible and accurate, and may lead to **earlier recognition of neonates with congenital QT-prolongation or acquired long-QT-syndrome due to medications.**

Care area: ED ICU

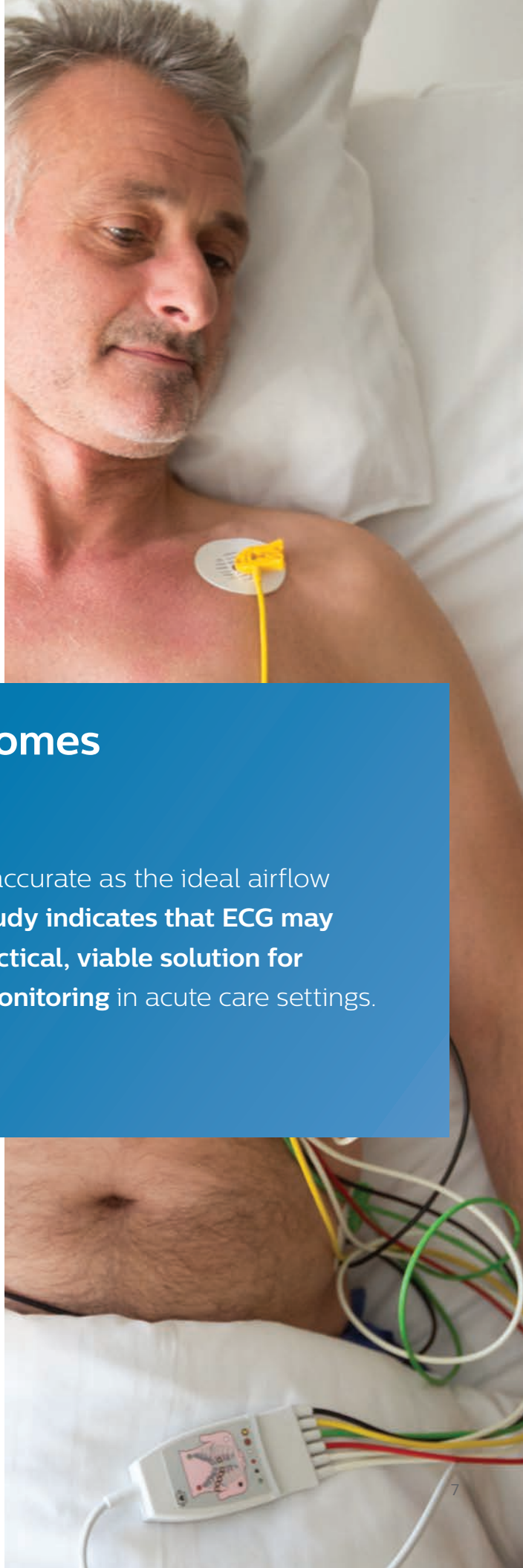
ECG in acute care settings[2]

Challenge

Respiratory rate is a key indicator of both subtle and acute change (such as apnea) in a patient's condition. Impedance-based respiration measurements can sometimes be inaccurate, and does not measure effort-of-breathing.

Goal of study

Test the viability of collecting accurate respiratory rates via ECG waveform. The team developed and evaluated three alternate methods for derivation of continuous respiration signals, based upon: ECG vector projection, heart-rate variability and muscle electromyogram activity.



Potential impact on outcomes

ECG-derived respiration can deliver an accuracy rate as high as

90%

While not as accurate as the ideal airflow sensor, **the study indicates that ECG may provide a practical, viable solution for respiratory monitoring** in acute care settings.

Methodology

The team conducted seven evaluation studies of various methods, identifying the pros and cons of each.

Sponsors

Philips Advanced Algorithm Research Center, Andover, MA

Care area: NICU

Predictive algorithm for preterm infant assessment[3]

Challenge

Physiological data is routinely recorded in intensive care settings, but its use for rapid assessment of illness severity or long-term morbidity prediction has been limited.

Goal of study

Test the viability of a new physiological assessment score for preterm newborns — akin to an electronic Apgar score — based upon on standard signals recorded noninvasively by Philips monitors upon admission to a neonatal intensive care unit.

Methodology

Newborn infants admitted to the NICU of Lucile Packard Children's Hospital over a 12-month period were eligible for enrollment in the study. A total of 145 preterm infants met inclusion criteria: gestational age ≤ 34 completed weeks, birth weight ≤ 2000g. Philips data scientists developed a vital sign monitoring data collection system for use by Stanford and Packard researchers.

Sponsors

Stanford University Dept. of Computer Science and School of Medicine Dept. of Pediatrics.

Potential impact on outcomes

The study suggests that the assessment score developed at Stanford can **accurately and reliably estimate the probability of an individual preterm infant's risk of severe morbidity** on the basis of noninvasive measurements.

Care area: ICU OR ED

QT monitoring in acute adult patients[4]

Challenge

In-hospital acute care patients may have risk factors for acquired (non-hereditary) long-QT syndrome; but how many meet the AHA indications for QT monitoring? How many actually have long QT episodes? Is continuous QT monitoring practical?

Goal of study

Test the potential value of continuous QT interval monitoring in acute-care adults patients.

Methodology

QT in Practice (QTIP) Study: a prospective, observational study includes all patients admitted to six (6) critical care units at a Level 1 academic medical center over a 2-month period. All critical care beds were upgraded to (Philips) continuous QT monitoring system.

Sponsors/research partner

University of California, San Francisco
Stanford University Medical Center
Philips Advanced Algorithm Research Center

Potential impact on outcomes

24%
acute care patients had episodes of long QT

In this study, 69% of acute care patients had AHA indications for QT monitoring. 89% of patients with long QT were identified by the AHA criteria, suggesting Philips automated continuous QT monitoring has the potential to reduce in-hospital mortality from TdP.

The more indications that are present correlate exponentially with increased risk of QT prolongation. AHA indicators demonstrate:

31.2% **had QT prolongation episodes**

(Almost 1/3 of people with indicators for QT monitoring actually had episodes of QT prolongation)

91.3% **negative predictive value**

(if someone has no AHA indicators, they are unlikely to have QT prolongation)

The study also noted that more women had indications than men.

Care area: ICU PCU

Root cause analysis to reduce unnecessary alarms[5]

Challenge

Visual and auditory alarms alert clinical staff to changes in patient status. Yet in many hospitals, the rate of false alarms remains quite high, leading to alarm fatigue and apathy. Lack of insight into which physiological parameters trigger the majority of alarms (especially false alarms) can hinder efforts to reduce those alarms that do not require a clinical intervention.

Goal of study

Identify the main culprits that trigger the bulk of alarms – as a starting point to prioritize strategies for reducing alarm volume

Methodology

- Analyze a large, real-world database of monitoring alarms to determine the culprit physiologic parameters that contribute to the bulk of the alarms.
- Perform a retrospective analysis of 60 days of continuous cardiac monitoring data on all patients treated in six adult intensive care and progressive care units at a university medical center.

Sponsor

University of San Francisco School of Nursing

Potential impact on outcomes

The study showed that ECG monitors contribute the largest number of alarms of any physiologic parameter in adult critical care units, with an average of 39 ECG alarms per hour. Among ECG, PVC alarms were most prevalent, contributing 38% of the total number of alarms. Although the CAST data reduced the practice of treating PVCs, few hospitals deactivate PVC alarms.

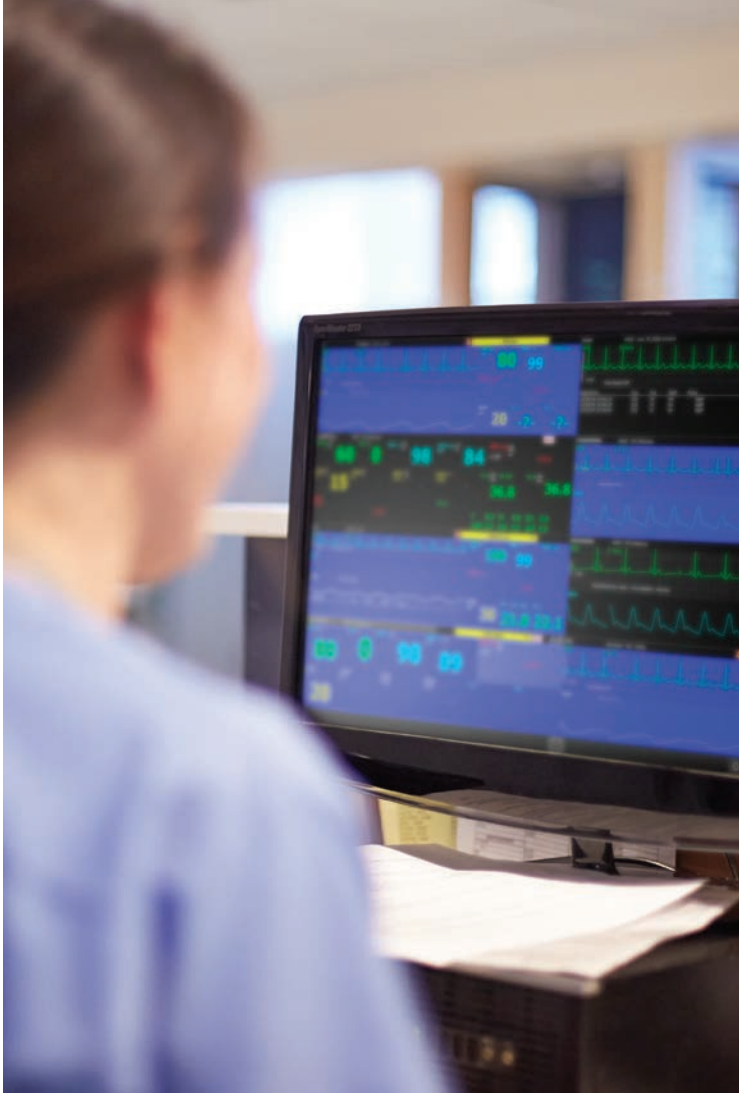
In the unit in which PVC alarms were deactivated, 31,259 fewer alarms occurred during the 90-day period compared with a comparable size/type unit with PVC alarms activated. Since PVCs can initiate TdP when QT is long, one potential approach to improve outcomes is to activate PVC alarms only when QT is long.

31,259

fewer alarms occured during the 90 day period

Care area: NICU PICU ED

Pediatric resuscitation chest compression rate via ECG[6]



Challenge

Optimal neonatal/ped CPR guidelines still need further development. Obtaining accurate CPR metrics during cardiac/ pulmonary resuscitations can be difficult.

Goal of study

Determine if compression artifact in routinely monitored ECG waveforms can be used in addition to defibrillators in computing CPR metrics, esp. during the initial minutes.

Methodology

Review continuous waveforms from 75 neonates/peds from two tertiary care pediatric hospitals. Detect and measure chest compression artifact to determine CPR rate.

34%

of CPR compression rate episodes **met current AHA interim consensus recommendations;**

51% were above the 120 CC/minute limit.

Potential impact on outcomes

The study indicated CPR compressions are routinely administered too quickly. Metrics from monitored waveforms can help determine optimal pediatric guidelines and have the potential to improve resuscitation outcomes.

1. 2007. Philips Healthcare, Mayo Clinic. Eric D. Helfenbein, MS,a , Michael J. Ackerman, MD, PhD,b Pentti M. Rautaharju, MD, PhD,a; Sophia H. Zhou, PhD,a Richard E. Gregg, MS,a James M. Lindauer, MD,a; David Miller, BMET,b John J. Wang, MS,a Scott S. Kresge, BS, Saeed Babaeizadeh, PhD,a; Dirk Q. Feild, MA,a Francis P. Michaud, MSa

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3. 2010. Lucille Packard Children's Hospital. Suchi Saria, Anand K. Rajani, Jeffrey Gould, Daphne Koller, Anna A. Penn

4. University of Calif. San Francisco, Philips Advanced Algorithm Research Center, Stanford University, Yale University; Advanced Algorithm Research Center. David Pickham, RN, PhD,a, Eric Helfenbein, MS,b Julie A. Shinn, RN, MA,c; Garrett Chan, RN, PhD,a Marjorie Funk, RN, PhD,d Barbara J. Drew, RN PhDa

5. University of San Francisco. Rich Fidler, Eric Helfenbein (Philips), David Pickham, and Barbara Drew

6. 2016. Philips Advanced Algorithm Research Center. Eric Helfenbein, Reza Firoozabadi, Richard Gregg, Saeed Babaeizadeh. Christopher Newth , Reza Firoozabadi, Richard Gregg, and Saeed Babaeizadeh

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