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Clinical Decision Support Tools in IntelliVue Patient Monitors

Philips Healthcare, Monitors & Measurements
September 2012

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Contents

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Clinical Decision Support

Why CDS?

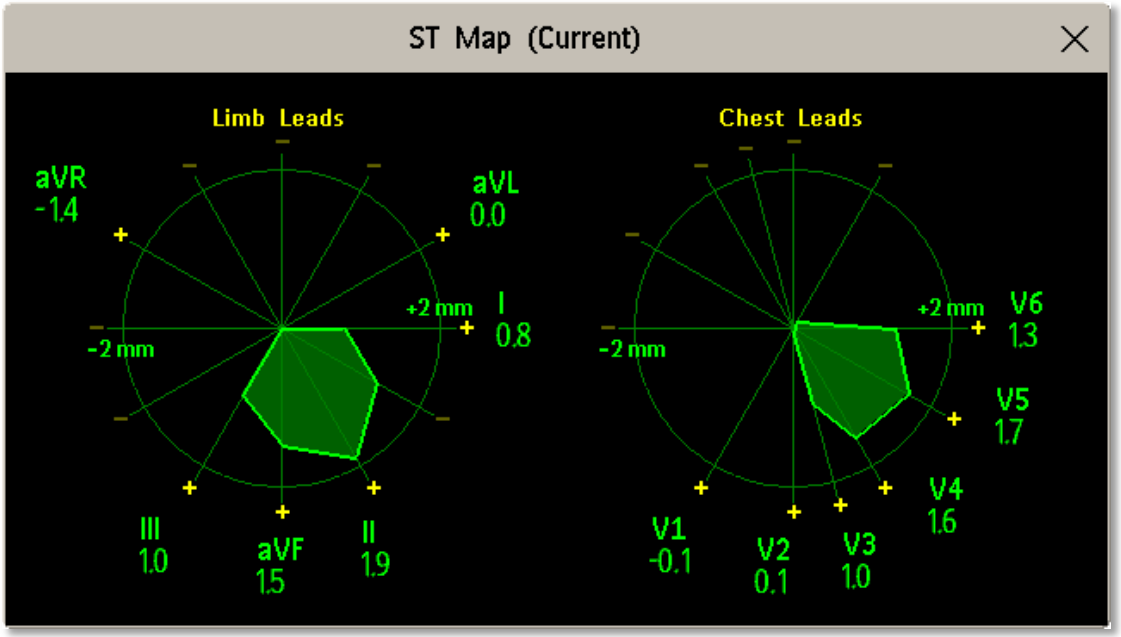
- CDS turns data into information
  - Smarter presentation of data reduces information overload
- CDS helps to improve clinicians' workflow and economics associated with health care
- CDS helps detect critical conditions earlier
- CDS supports healthcare providers by helping to:
  - Enhance workflow
  - Improve financial outcomes
  - Save and improve patient lives

ST Map

What is it?

- Invented by Philips in 2004
- Philips' exclusive ST Map is a graphical representation of a patient's ST values in an easy to read multi-axis diagram
- Display ST values measured by the ST/AR algorithm from the frontal (limb leads) and horizontal (chest leads) planes
- Provides trend information with intervals from 12 seconds to 30 minutes

ST-I	0.9
ST-II	1.9
ST-III	1.0
ST-aVR	-1.3
ST-aVL	0.0
ST-aVF	1.5
ST-V1	0.0
ST-V2	0.1
ST-V3	1.0
ST-V4	1.6
ST-V5	1.8
ST-V6	1.3



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ST Map

Key benefits for clinicians

- Non-invasive tool that provides information to help to identify ischemic events
- Intuitive even for caregivers who are unfamiliar with diagn. ECG
  - Graphical format consistent with 2009 AHA/ACC guidelines
- Helps monitoring patients at risk for ischemia or myocardial infarction, e.g.
  - OR: Intra- and post-operatively for cardiac and high-risk surgical procedures
  - ED/CCU/Chest Pain Center: Chest pain patients
- Helps the clinicians to determine whether the intervention is having the desired effect
  - Evaluate reperfusion after thrombolytic therapy
  - Monitor re-occlusions after angioplasty (PCI)

"ST Map provides a non-invasive approach to monitoring patients who are at risk of myocardial ischemia. Inexperienced staff have a clear visual display which prompts them to seek expert advice sooner."

Mrs. Margaret Eaton, Matron Critical Care Services, Royal Surrey County Hospital, Guildford, England

ST Map

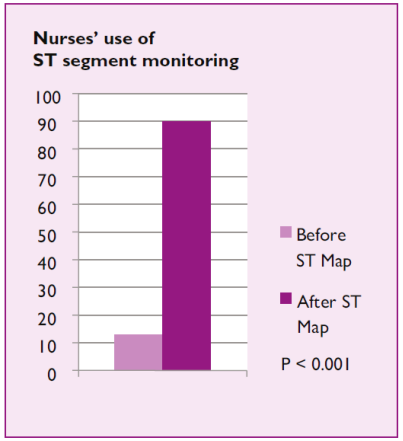
Available studies

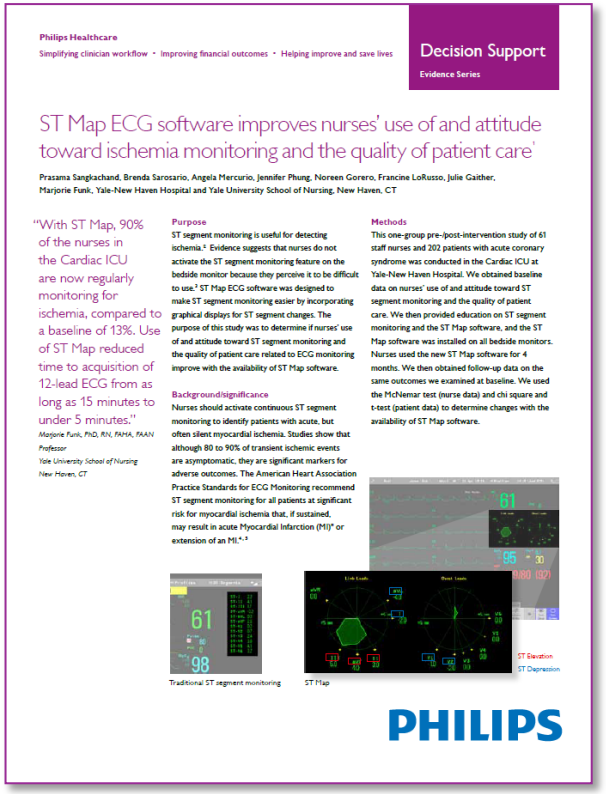
- Yale University, US: ST Map ECG software improves nurses' use of and attitude toward ischemia monitoring and the quality of patient care

  Sangkachand P, Sarosario B, Mercurio A et al. Poster RES 41 presented at American Association of Critical Care Nurses 2009 National Teaching Institute and Critical Care Exposition. May 2009

"With ST Map, 90% of the nurses in the Cardiac ICU are now regularly monitoring for ischemia, compared to a baseline of 13%. Use of ST Map reduced time to acquisition of 12-lead ECG from as long as 15 minutes to under 5 minutes."

Dr. Marjorie Funk, PhD, RN, FAHA, FAAN
Professor Yale University School of Nursing
New Haven, CT, US

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Decision Support
Evidence Series

ST Map ECG software improves nurses' use of and attitude toward ischemia monitoring and the quality of patient care

Prasama Sangkachand, Brenda Sarosario, Angela Mercurio, Jennifer Phung, Noreen Gorero, Francine LoRusso, Julie Gaither, Marjorie Funk, Yale-New Haven Hospital and Yale University School of Nursing, New Haven, CT

"With ST Map, 90% of the nurses in the Cardiac ICU are now regularly monitoring for ischemia, compared to a baseline of 13%. Use of ST Map reduced time to acquisition of 12-lead ECG from as long as 15 minutes to under 5 minutes."

Purpose
ST segment monitoring is useful for detecting ischemia.[1] Evidence suggests that nurses do not activate the ST segment monitoring feature on the bedside monitor because they perceive it to be difficult to use.[2] ST Map ECG software was designed to make ST segment monitoring easier by incorporating graphical displays for ST segment changes. The purpose of this study was to determine if nurses' use of and attitude toward ST segment monitoring and the quality of patient care related to ECG monitoring improve with the availability of ST Map software.

Background/significance
Nurses should activate continuous ST segment monitoring to identify patients with acute, but often silent myocardial ischemia. Studies show that although 80 to 90% of transient ischemic events are asymptomatic, they are significant markers for adverse outcomes. The American Heart Association Practice Standards for ECG Monitoring recommend ST segment monitoring for all patients at significant risk for myocardial ischemia that, if sustained, may result in acute Myocardial Infarction (MI)* or extension of an MI.*,[3]

Methods
This one-group pre-/post-intervention study of 61 staff nurses and 202 patients with acute coronary syndrome was conducted in the Cardiac ICU at Yale-New Haven Hospital. We obtained baseline data on nurses' use of and attitude toward ST segment monitoring and the quality of patient care. We then provided education on ST segment monitoring and the ST Map software, and the ST Map software was installed on all bedside monitors. Nurses used the new ST Map software for 4 months. We then obtained follow-up data on the same outcomes we examined at baseline. We used the McNemar test (nurse data) and chi square and t-test (patient data) to determine changes with the availability of ST Map software.

Traditional ST segment monitoring
ST Map

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Download the document at www.philips.com/evidence
or from Philips Incenter (4522 962 60641)

ST Map

Available studies

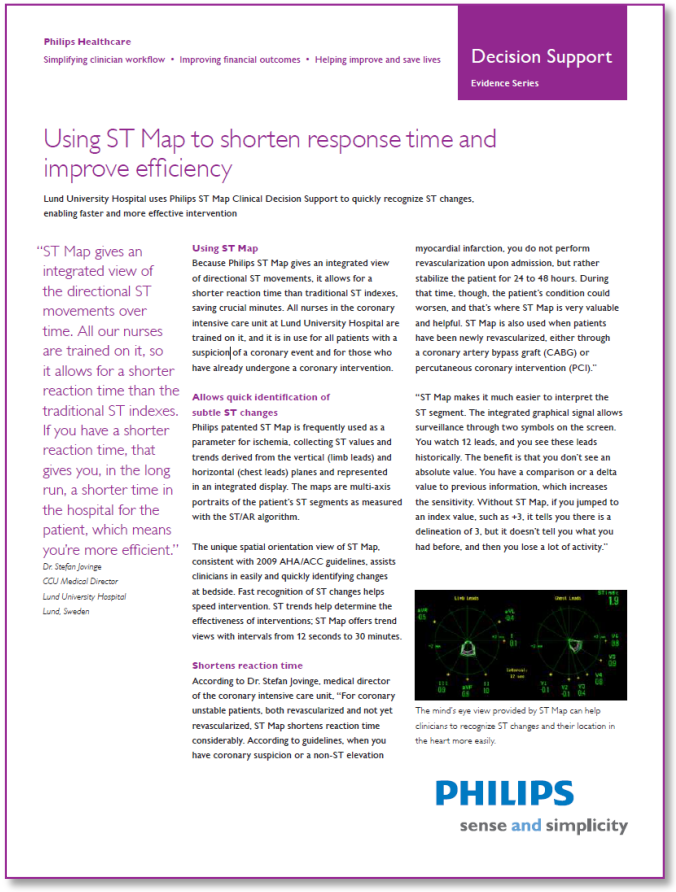
- Lund University Hospital, Sweden: Using ST Map shortens response time and improves efficiency

  Dr. Jovinge, April 2010

  "ST Map gives an integrated view of the directional ST movements over time. All our nurses are trained on it, so it allows for a shorter reaction time than the traditional ST indexes. If you have a shorter reaction time, that gives you, in the long run, a shorter time in the hospital for the patient, which means you are more efficient."

  Dr. Stefan Jovinge,
  CCU Medical Director, Lund University Hospital,
  Lund, Sweden

Download the document at www.philips.com/evidence
or from Philips Incenter (4522 962 56601)



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Evidence Series

Using ST Map to shorten response time and improve efficiency

Lund University Hospital uses Philips ST Map Clinical Decision Support to quickly recognize ST changes, enabling faster and more effective intervention

"ST Map gives an integrated view of the directional ST movements over time. All our nurses are trained on it, so it allows for a shorter reaction time than the traditional ST indexes. If you have a shorter reaction time, that gives you, in the long run, a shorter time in the hospital for the patient, which means you're more efficient."

Dr. Stefan Jovinge
CCU Medical Director
Lund University Hospital
Lund, Sweden

Using ST Map

Because Philips ST Map gives an integrated view of directional ST movements, it allows for a shorter reaction time than traditional ST indexes, saving crucial minutes. All nurses in the coronary intensive care unit at Lund University Hospital are trained on it, and it is in use for all patients with a suspicion of a coronary event and for those who have already undergone a coronary intervention.

Allows quick identification of subtle ST changes

Philips patented ST Map is frequently used as a parameter for ischemia, collecting ST values and trends derived from the vertical (limb leads) and horizontal (chest leads) planes and represented in an integrated display. The maps are multi-axis portraits of the patient's ST segments as measured with the ST/AR algorithm.

The unique spatial orientation view of ST Map, consistent with 2009 AHA/ACC guidelines, assists clinicians in easily and quickly identifying changes at bedside. Fast recognition of ST changes helps speed intervention. ST trends help determine the effectiveness of interventions; ST Map offers trend views with intervals from 12 seconds to 30 minutes.

Shortens reaction time

According to Dr. Stefan Jovinge, medical director of the coronary intensive care unit, "For coronary unstable patients, both revascularized and not yet revascularized, ST Map shortens reaction time considerably. According to guidelines, when you have coronary suspicion or a non-ST elevation myocardial infarction, you do not perform revascularization upon admission, but rather stabilize the patient for 24 to 48 hours. During that time, though, the patient's condition could worsen, and that's where ST Map is very valuable and helpful. ST Map is also used when patients have been newly revascularized, either through a coronary artery bypass graft (CABG) or percutaneous coronary intervention (PCI)."

"ST Map makes it much easier to interpret the ST segment. The integrated graphical signal allows surveillance through two symbols on the screen. You watch 12 leads, and you see these leads historically. The benefit is that you don't see an absolute value. You have a comparison or a delta value to previous information, which increases the sensitivity. Without ST Map, if you jumped to an index value, such as +3, it tells you there is a delineation of 3, but it doesn't tell you what you had before, and then you lose a lot of activity."

The mind's eye view provided by ST Map can help clinicians to recognize ST changes and their location in the heart more easily.

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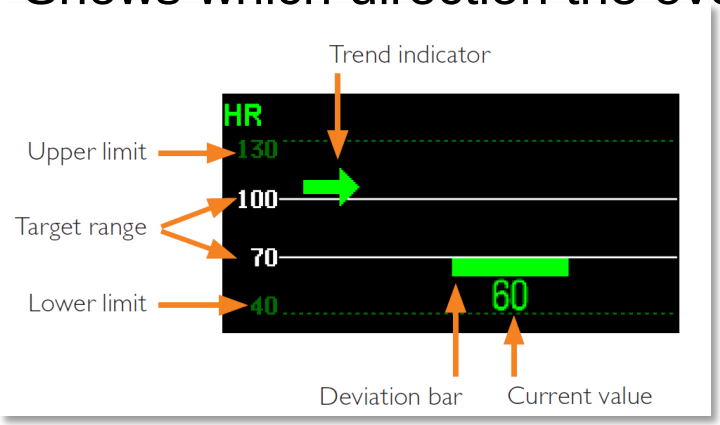
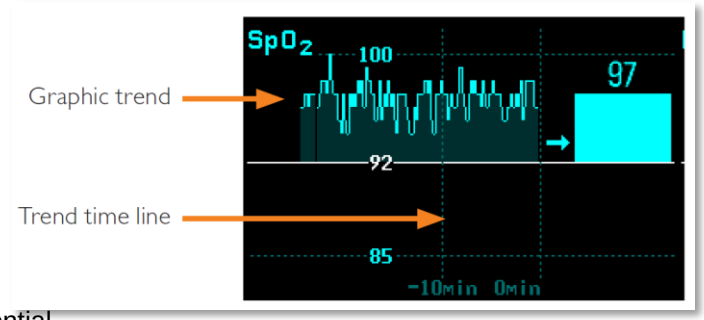
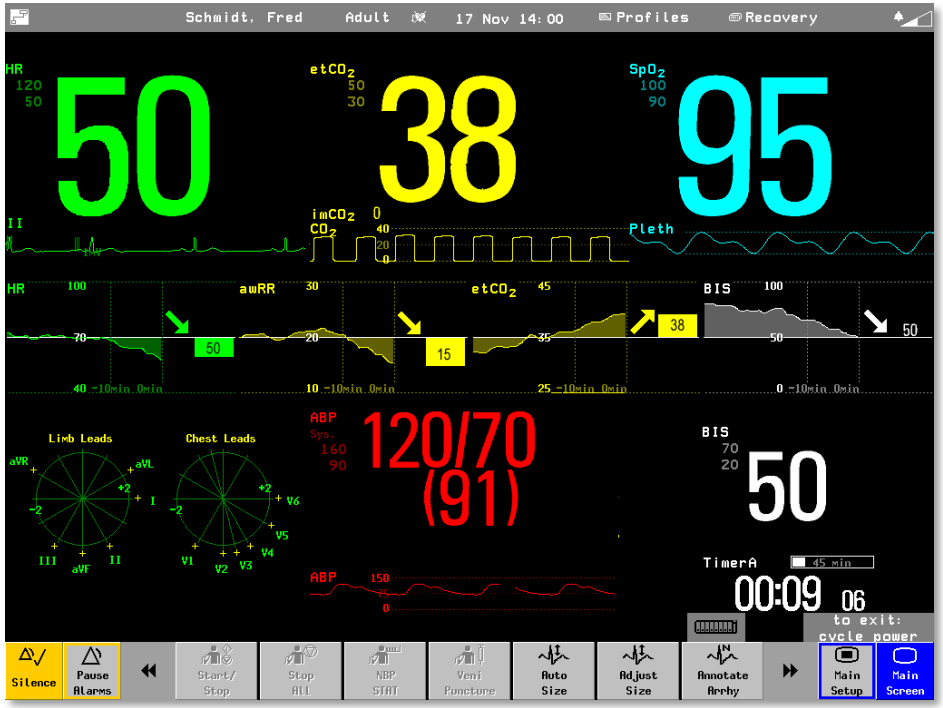
Horizon Trends

What is it?

- Invented by Philips in 2008
- A graphical representation of changes to a patient's measurements
- An intuitive view of where a patient's measurements stand in relation to a baseline or target values
- Shows which direction the overall trend of measurements is moving in







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Horizon Trends

Key benefits for clinicians

- Philips' exclusive Horizon Trends, make changes easier to see as they occur
- Enables clinicians to see at one glance whether or not a measurement has been maintained within a set range (horizon)
- Makes it easy to determine if a clinical intervention has had the desired effect
- Saves time over comparing current with past measurements in a chart
- Can help with alarm management: Use horizon to detect less severe, unactionable changes. Set alarm limits wider to only alarm on severe conditions

"The use of Horizon Trends helps us visually see how we are doing with IV medication titration in keeping our blood pressures at goal. It is nice being able to see trends with one quick look."

Tara Drew, RN and Jody Case, RN, Clinical Leaders, ICU Concord Hospital, Concord, New Hampshire

Horizon Trends

Available studies

- Concord Hospital, US: Optimization of blood pressure management with vasoactive medications using Horizon Trends

  Karen K. Giuliano, Greg Raber, Jody Case, Tara Drew, Jill Donahue, Critical Care Medicine. 2008, 36(12) Suppl: A 62

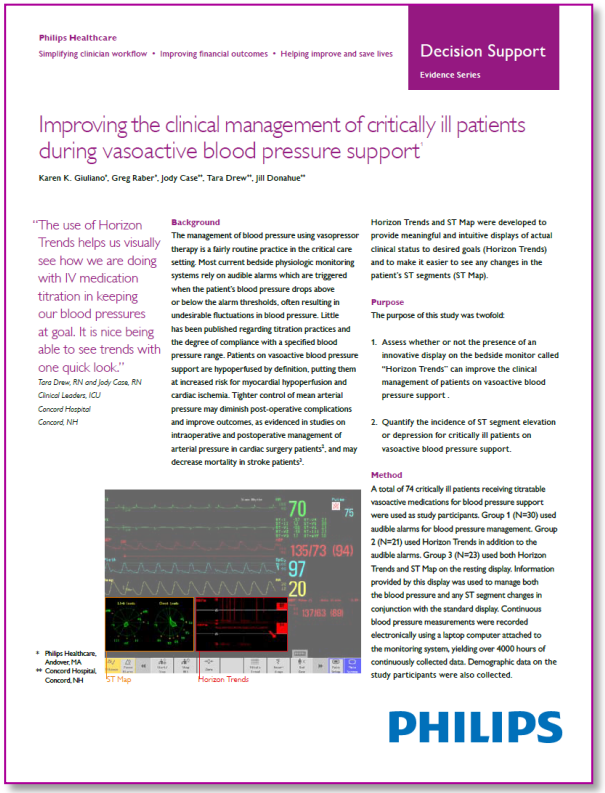
" The use of Horizon Trends helps us visually see how we are doing with IV medication titration in keeping our blood pressures at goal. It is nice being able to see trends with one quick look."

Tara Drew, RN and Jody Case, RN Clinical Leaders, ICU Concord Hospital Concord, NH

	Mean BP mmHg	% of time at or above 65 mmHg
Group 1 (n = 30)	68.1 (6.8)	63.7 (25.3)
Group 2 (n = 21)	70.9 (7.2)	71.1 (21.6)
Group 3 (n = 23)	74.7 (6.4)	81.1 (20.5)
	p = .001*	p = .009

Table 1: means values and standard deviation for BP, % of time ≥ 65 mmHg

* Significant differences between groups 1 & 3



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Decision Support

Evidence Series

Improving the clinical management of critically ill patients during vasoactive blood pressure support*

Karen K. Giuliano*, Greg Raber*, Jody Case**, Tara Drew**, Jill Donahue**

"The use of Horizon Trends helps us visually see how we are doing with IV medication titration in keeping our blood pressures at goal. It is nice being able to see trends with one quick look."

Tara Drew, RN and Jody Case, RN
Clinical Leaders, ICU
Concord Hospital
Concord, NH

Background

The management of blood pressure using vasopressor therapy is a fairly routine practice in the critical care setting. Most current bedside physiologic monitoring systems rely on audible alarms which are triggered when the patient's blood pressure drops above or below the alarm thresholds, often resulting in undesirable fluctuations in blood pressure. Little has been published regarding titration practices and the degree of compliance with a specified blood pressure range. Patients on vasoactive blood pressure support are hypoperfused by definition, putting them at increased risk for myocardial hypoperfusion and cardiac ischemia. Tighter control of mean arterial pressure may diminish post-operative complications and improve outcomes, as evidenced in studies on intraoperative and postoperative management of arterial pressure in cardiac surgery patients[1], and may decrease mortality in stroke patients[2].

Horizon Trends and ST Map were developed to provide meaningful and intuitive displays of actual clinical status to desired goals (Horizon Trends) and to make it easier to see any changes in the patient's ST segments (ST Map).

Purpose

The purpose of this study was twofold:

1. Assess whether or not the presence of an innovative display on the bedside monitor called "Horizon Trends" can improve the clinical management of patients on vasoactive blood pressure support .
2. Quantify the incidence of ST segment elevation or depression for critically ill patients on vasoactive blood pressure support.

Method

A total of 74 critically ill patients receiving titratable vasoactive medications for blood pressure support were used as study participants. Group 1 (N=30) used audible alarms for blood pressure management. Group 2 (N=21) used Horizon Trends in addition to the audible alarms. Group 3 (N=23) used both Horizon Trends and ST Map on the resting display. Information provided by this display was used to manage both the blood pressure and any ST segment changes in conjunction with the standard display. Continuous blood pressure measurements were recorded electronically using a laptop computer attached to the monitoring system, yielding over 4000 hours of continuously collected data. Demographic data on the study participants were also collected.

* Philips Healthcare, Andover, MA
** Concord Hospital, Concord, NH

ST Map

Horizon Trends

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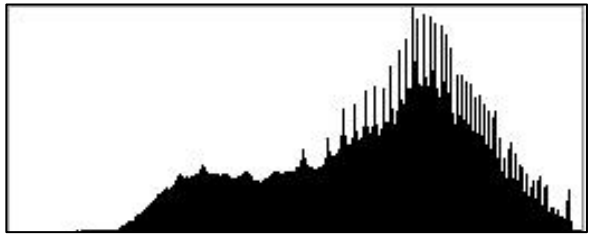
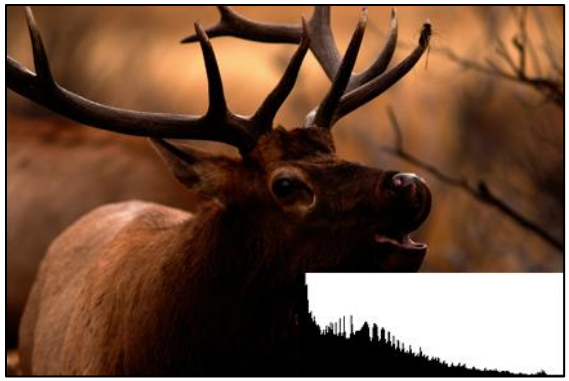
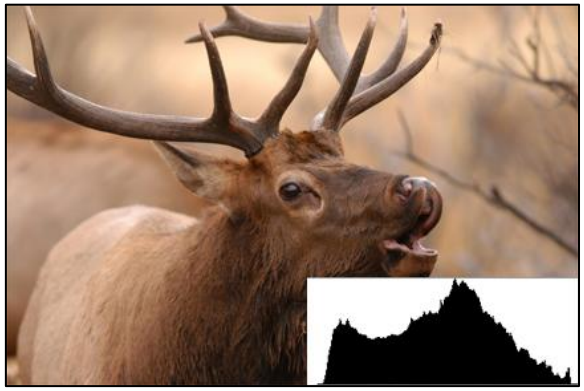
Histogram

What is it?

Histogram in Photography







Histograms

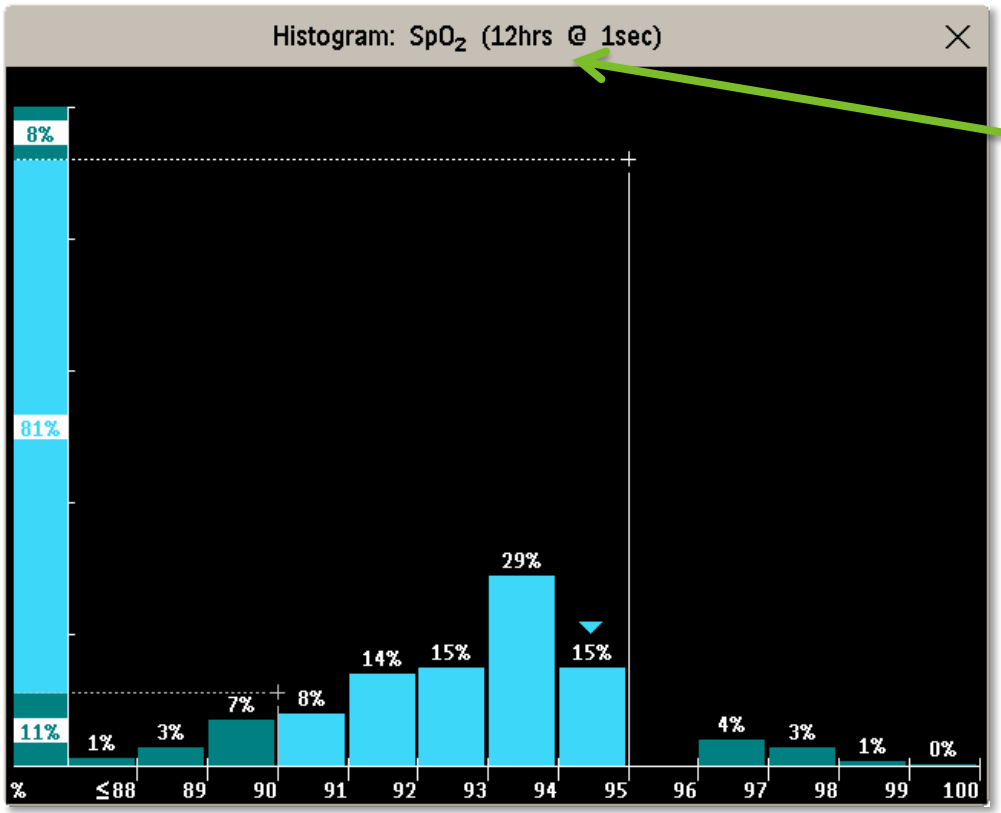
What is it?

- A graphical representation of the distribution of a patient's measurements over an extended time period
- Answers the question: "For how much of a certain period of time was my patient within or outside a certain range of values?"

Y-Axis: Distribution

Upper Cursor

Lower Cursor



Time period & resolution

X-Axis: parameter range

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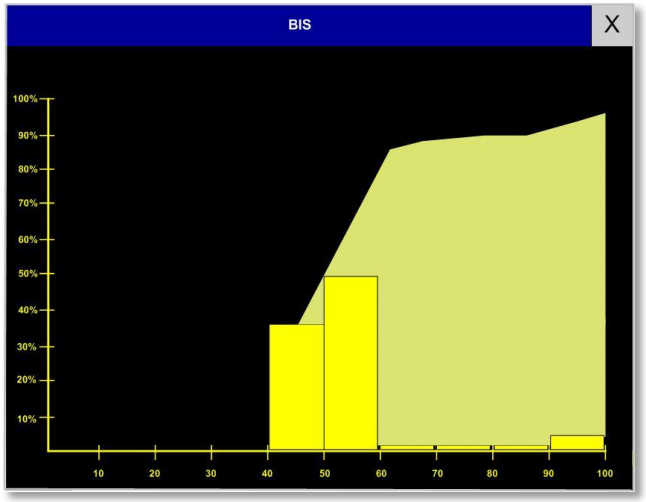
Histograms

Key benefits for clinicians

- See at one glance whether or not a measurement has been maintained within a set range
- Verify if a clinical intervention has had the desired effect
- Predominantly used in neonatolgy, e.g. for evaluation of discharge readiness
- Can be used on any trended measurement parameter, e.g.
  - BIS: Titrating anestetic medication
  - HR: Titrating anti-arrhythmic medication
  - Inv. Pressure: Titrating vaso-active drugs

"Histograms present the distribution over time of vital parameters, enabling significant trends to be seen at a glance, without the risk of being overwhelmed by an excess of information."

Dr. Jürgen Christoph, Assistant Medical Director Neonatology,
„Auf der Bult" Pediatric Hospital Hannover, Germany



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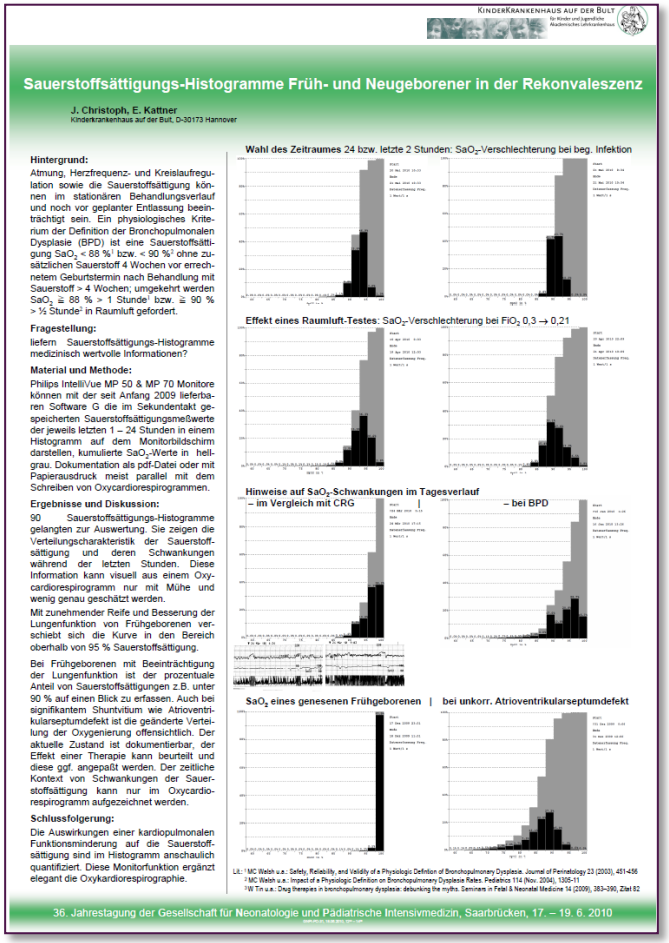
Histograms

Available studies

- Poster: Childrens Hospital “Auf der Bult”, Hannover, Germany: Oxygen saturation histograms in premature babies and neonates in convalescence

  J. Christopher, E. Kattner, Childrens Hospital auf der Bult, Hannover

Conclusion:
The impact of a reduction in cardiopulmonary function on the oxygen saturation in the histogram is clearly quantified. This new monitor function elegantly complements the oxycardiorespirography.



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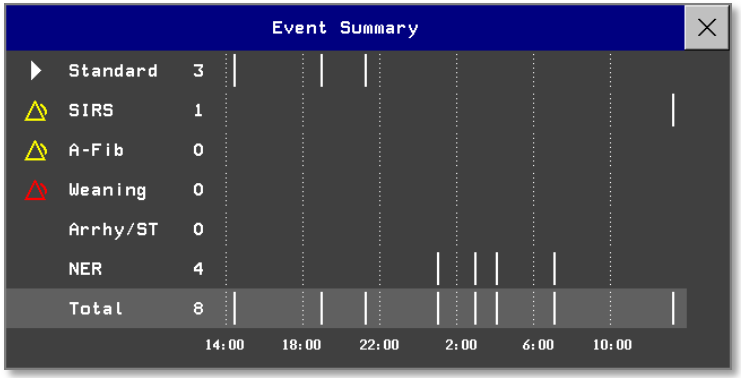
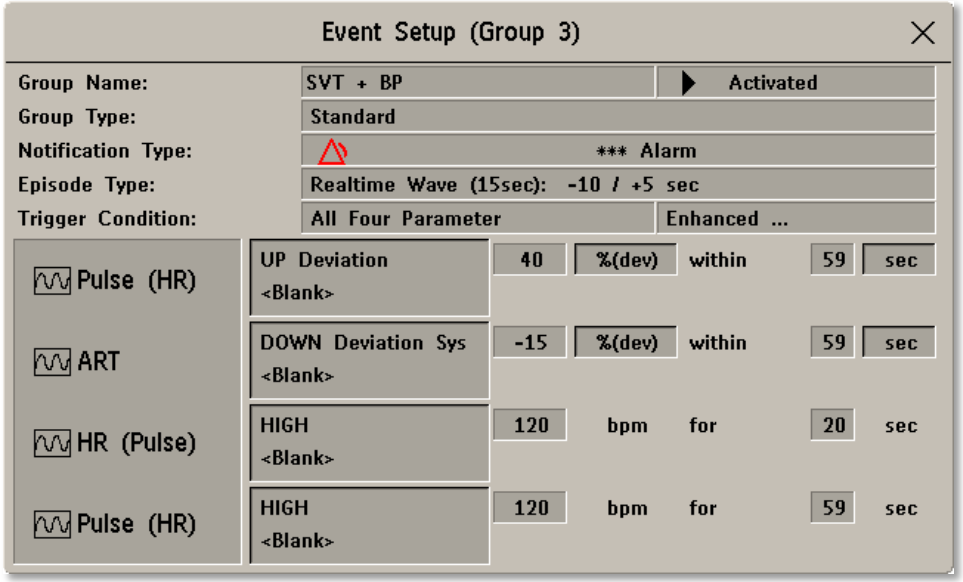
Advanced Event Surveillance

What is it?

- Invented by Philips in 2004
- Monitors for changes happening in up to four clinical parameters in the same time period
- An event is triggered when two, three, or all parameters violate their trigger conditions
- Clinician is notified by either a prompt message or an alarm
- Any event is stored with its surrounding data which can be reviewed
- Fully customizable by clinicians





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Advanced Event Surveillance (AES)

Key benefits for clinicians

- Philips' exclusive AES assists decision making by identifying and documenting clinically significant patient episodes
- Enables clinicians to create their own Smart Alarms
  - Multi-parameter alarming increases specificity of alerting for specific clinical events
  - Potential to reduce alarm fatigue phenomenon
- Possible uses:
  - Sepsis screening
  - Alert for SVT with effect on blood pressure
  - Alert for cardiogenic (left-ventricular) shock

"The configuration of event groups is easy and quick. If configured appropriately, event surveillance is a helpful new tool for monitoring patients. It allows for accurate analysis of changes in the patient's condition and displays related trends. This helps to support and validate clinical decision making."

Johannes Planck, MD, Städtisches Klinikum München, Munich, Germany

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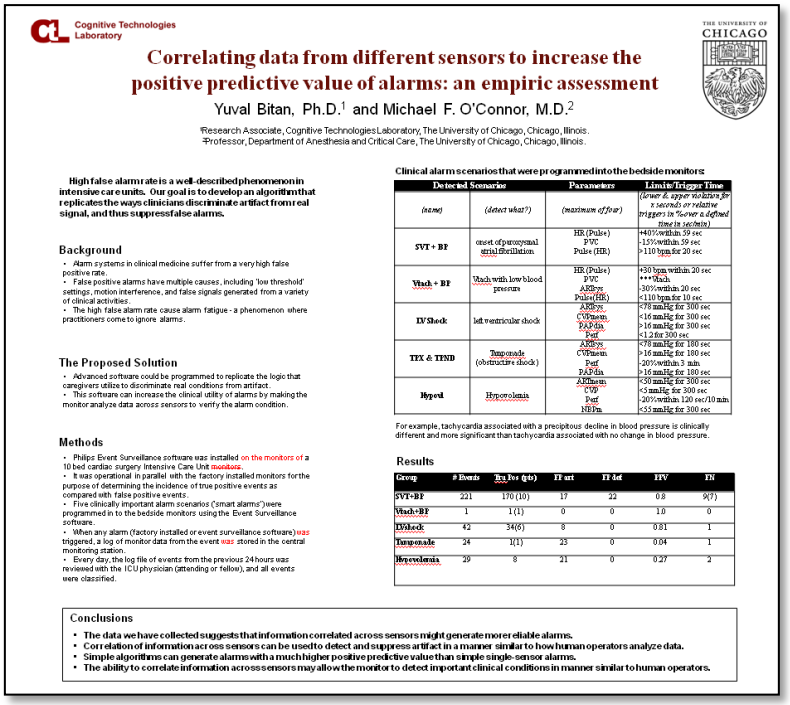
Advanced Event Surveillance

Available studies

- Poster: Univ. of Chicago, US: Correlating data from different sensors to increase the positive predictive value of alarms: an empiric assessment
  Yuval Bitan, Ph.D. and Michael F. O'Connor, M.D.

"The data we have collected suggests that information correlated across sensors might generate more reliable alarms. Correlation of information across sensors can be used to detect and suppress artifact in a manner similar to how human operators analyze data… The ability to correlate information across sensors may allow the monitor to detect important clinical conditions in manner similar to human operators."
Yuval Bitan, Ph.D. and Michael F. O'Connor, M.D.



Cognitive Technologies Laboratory

THE UNIVERSITY OF CHICAGO

Correlating data from different sensors to increase the positive predictive value of alarms: an empiric assessment

Yuval Bitan, Ph.D.[1] and Michael F. O'Connor, M.D.[2]

[1]Research Associate, Cognitive Technologies Laboratory, The University of Chicago, Chicago, Illinois.
[2]Professor, Department of Anesthesia and Critical Care, The University of Chicago, Chicago, Illinois.

High false alarm rate is a well-described phenomenon in intensive care units. Our goal is to develop an algorithm that replicates the ways clinicians discriminate artifact from real signal, and thus suppress false alarms.

Background

- Alarm systems in clinical medicine suffer from a very high false positive rate.
- False positive alarms have multiple causes, including 'low threshold' settings, motion interference, and false signals generated from a variety of clinical activities.
- The high false alarm rate cause alarm fatigue - a phenomenon where practitioners come to ignore alarms.

The Proposed Solution

- Advanced software could be programmed to replicate the logic that caregivers utilize to discriminate real conditions from artifact.
- This software can increase the clinical utility of alarms by making the monitor analyze data across sensors to verify the alarm condition.

Methods

- Philips Event Surveillance software was installed on the monitors of a 10 bed cardiac surgery Intensive Care Unit monitors.
- It was operational in parallel with the factory installed monitors for the purpose of determining the incidence of true positive events as compared with false positive events.
- Five clinically important alarm scenarios ("smart alarms") were programmed in to the bedside monitors using the Event Surveillance software.
- When any alarm (factory installed or event surveillance software) was triggered, a log of monitor data from the event was stored in the central monitoring station.
- Every day, the log file of events from the previous 24 hours was reviewed with the ICU physician (attending or fellow), and all events were classified.

Clinical alarm scenarios that were programmed into the bedside monitors:

Detected Scenarios		Parameters	Limits/Trigger Time
(name)	*(detect what?)*	*(maximum of four)*	*(lower & upper values for x seconds or relative triggers in %over a defined time in sec/min)*
SVT + BF	onset of paroxysmal atrial fibrillation	HR (Pulse) PVC Pulse (HR)	+40% within 59 sec -15% within 59 sec >110 bpm for 20 sec
Vtach + BF	Vtach with low blood pressure	HR (Pulse) PVC ABPsys Pulse (HR)	+30 bpm within 20 sec *** Vtach -30% within 20 sec <110 bpm for 10 sec
LV Shock	left ventricular shock	ABPsys CObmean PAPdia Perf	<78 mmHg for 300 sec <16 mmHg for 300 sec >16 mmHg for 300 sec <1.2 for 300 sec
TPX & TPND	Tamponade (obstructive shock)	ABPsys CObmean Perf PAPdia	<78 mmHg for 180 sec >16 mmHg for 180 sec -20% within 3 min >16 mmHg for 180 sec
Hyped	Hypovolemia	ABPmean CVP Perf NBPsys	<50 mmHg for 300 sec <3 mmHg for 300 sec -20% within 120 sec/10 min <55 mmHg for 300 sec

For example, tachycardia associated with a precipitous decline in blood pressure is clinically different and more significant than tachycardia associated with no change in blood pressure.

Results

Group	# Events	Tru Pos (pts)	FP act	FP det	PPV	FN
SVT+BF	221	170 (10)	17	22	0.8	9(7)
Vtach+BF	1	1 (1)	0	0	1.0	0
LVshock	42	34(6)	8	0	0.81	1
Tamponade	24	1(1)	23	0	0.04	1
Hypovolemia	29	8	21	0	0.27	2

Conclusions

- **The data we have collected suggests that information correlated across sensors might generate more reliable alarms.**
- **Correlation of information across sensors can be used to detect and suppress artifact in a manner similar to how human operators analyze data.**
- **Simple algorithms can generate alarms with a much higher positive predictive value than simple single-sensor alarms.**
- **The ability to correlate information across sensors may allow the monitor to detect important clinical conditions in manner similar to human operators.**

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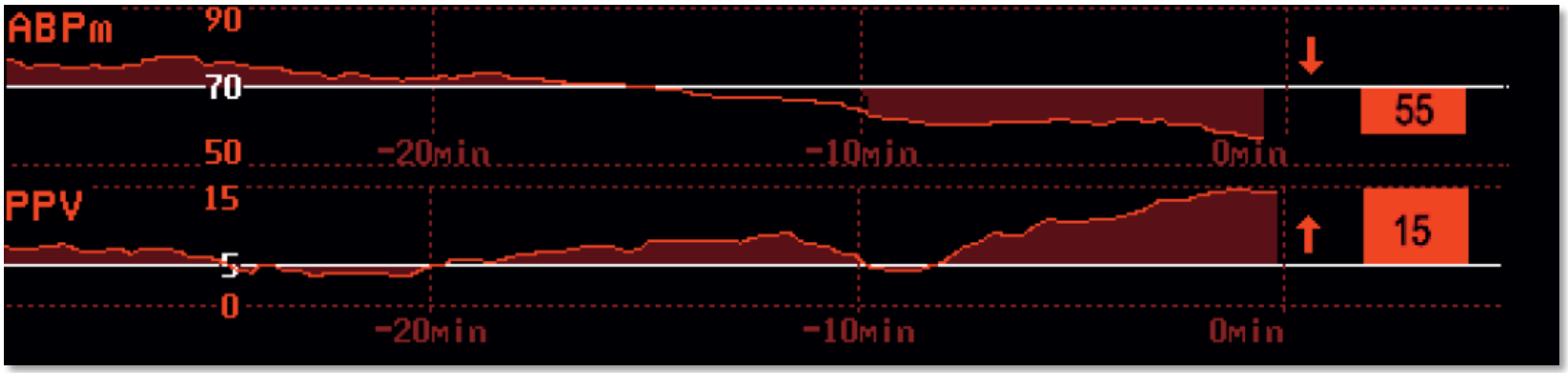
Pulse Pressure Variation

What is it?

- A minimally invasive measurement, designed to help clinicians see and evaluate fluid responsiveness in mechanically ventilated adult patients
- Derived from beat-to-beat arterial pressure and expressed as a percentage
- Should be assessed over a trended time period and in context with other hemodynamic information



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Pulse Pressure Variation

Key benefits for clinicians

- PPV provides a non-invasive way of evaluating whether a patient will respond to fluid administration or not
- Helps to find the important balance between too little and too much fluid
- For predicting fluid responsiveness PPV is more accurate than CVP
- Typical indications:
  - OR: monitor for hypovolemia in trauma or other major surgeries
  - ICU: assess fluid status of patients in hypovolemic or cardiogenic shock

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Pulse Pressure Variation

Available studies

- Univ of California, Irvine, US: The ability of a novel algorithm for automatic estimation of the respiratory variations in arterial pulse pressure to monitor fluid responsiveness in the operating room.

  Cannesson M, Slieker J, Desebbe O, Bauer, C, Chiari P, He´naine R. et al. Room. Anesthesia & Analgesia Vol. 106, No. 4, pg 1195-1200, April 2008.

"The results of this study show that ΔPP_{auto} can be displayed continuously and can predict fluid responsiveness in mechanically ventilated patients in the operating room. This index allows for ΔPP monitoring from the arterial pressure waveform alone and has potential for goal-directed intraoperative fluid administration in the operating room."
Dr. Maxime Cannesson, MD PhD
HS/Associate Clinical Professor University of California – Irvine, Department of Anesthiology and Perioperative Care

Source: The Ability of a Novel Algorithm for Automatic Estimation of the Respiratory Variations in Arterial Pulse Pressure to Monitor Fluid Responsiveness in the Operating Room.

REQUESTED A PERMISSION – 26 11 2012
TO USE THIS REFERENCE. http://www.anesthesia-analgesia.org/content/106/4/1195.full

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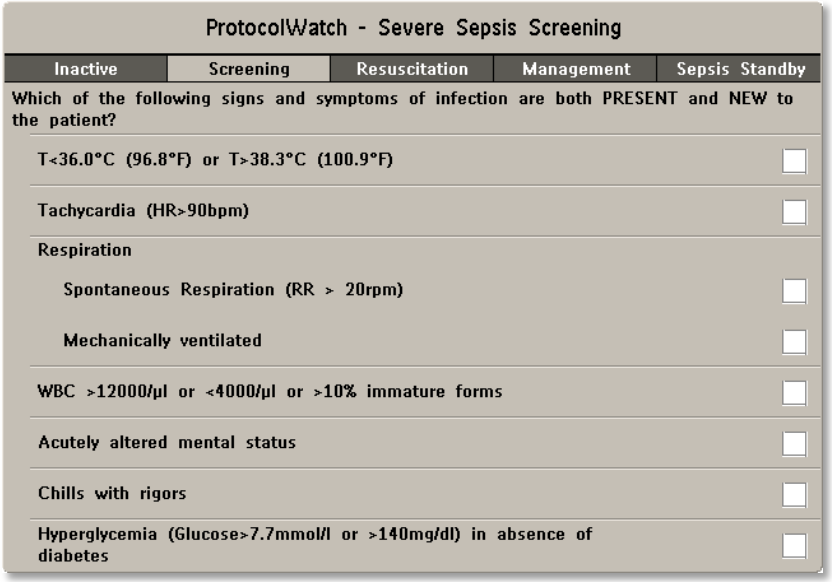
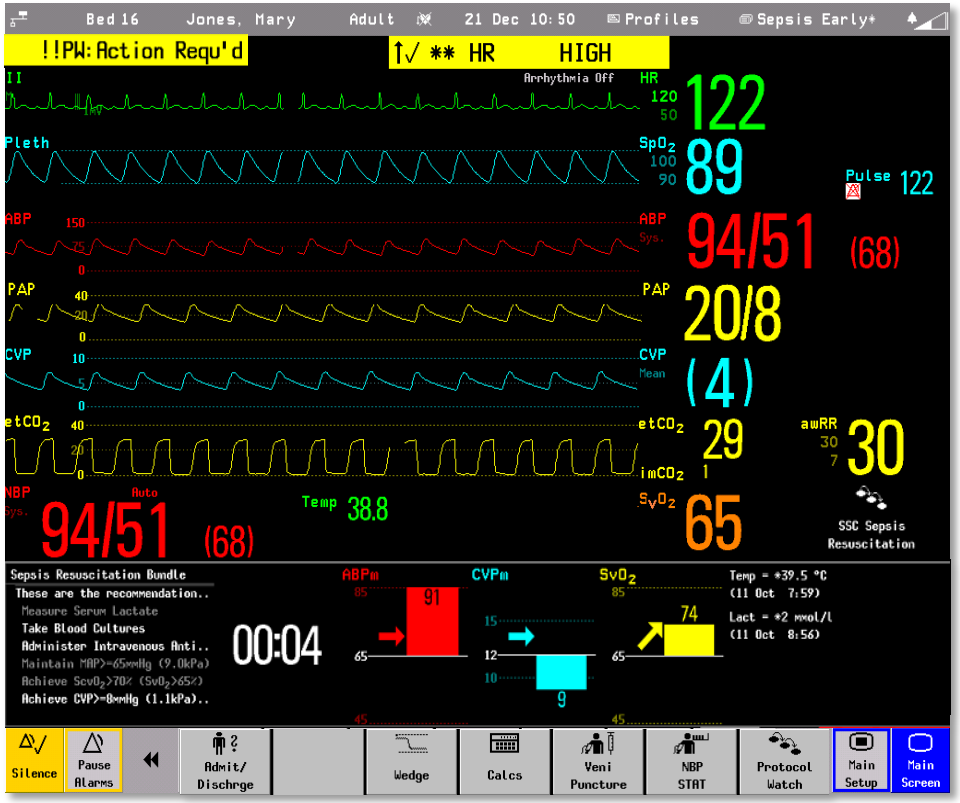
ProtocolWatch Sepsis

What is it?

- Automated detection system for early signs of sepsis
- Treatment that helps determine when the patient has been stabilized
- First ever application to reside on a patient bedside monitor that continuously screens patients for sepsis and guides clinicians through treatment protocol





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ProtocolWatch Sepsis

Key benefits for clinicians

- Philips' exclusive ProtocolWatch Sepsis helps with the early detection of sepsis, which is difficult – subtle changes in vital signs are easily missed
- Delayed detection leads to severe sepsis
- Currently* 30% of patients who develop severe sepsis die within the first month
- Delay in starting antibiotics increases mortality by 10-15%**
- ProtocolWatch Sepsis facilitates early detection of sepsis
- With J.0 now fully configurable

- Differentiators
  - Endorsed by the Surviving Sepsis Campaign (SSC)
  - Default configuration compliant with SSC guidelines
  - Provides access to protocol status and action list where it matters most - at the bedside

*Angus DC, et al. Epidemiology of severe sepsis in the United States: analysis of incidence, outcome, and associated costs of care. Crit Care Med 2001; Jul29(7):1303-1310.
** Lyseng-Williamson KA & Perry CM. Drugs. 2002; 62: 617-30

ProtocolWatch Sepsis

Available studies

- Using clinical decision support to improve the care of patients with sepsis

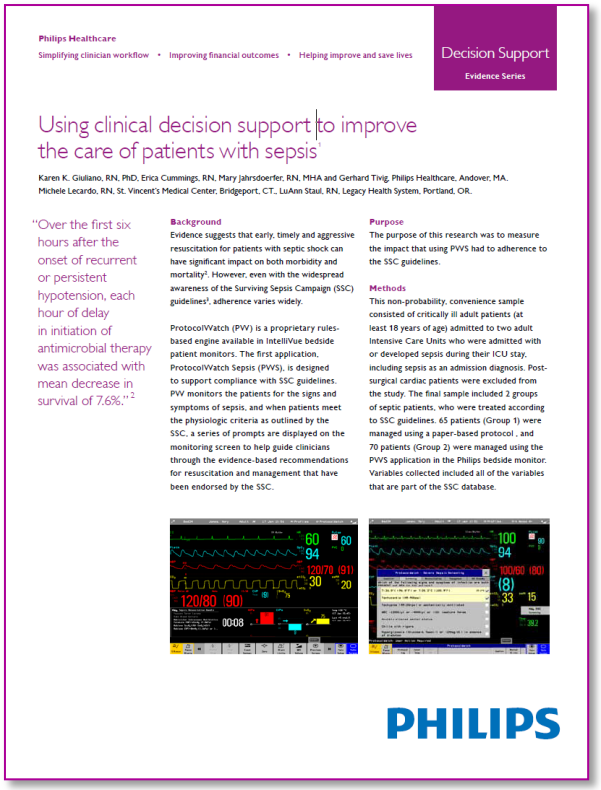
Karen K. Giuliano, RN, PhD, Erica Cummings, RN, Mary Jahrsdoerfer, RN, MHA and Gerhard Tivig, Philips Healthcare, Andover, MA.
Michele Lecardo, RN, St. Vincent's Medical Center, Bridgeport, CT., LuAnn Staul, RN, Legacy Health System, Portland, OR.

	Years	APACHE II (points)	Resuscitation bundle completion (%)	Time to completion (hrs)	Management bundle completion (%)	Time to completion (hrs)	Time to antibiotic administration (min)
Group 1 (N=65) Prior to PW	67.6 (15.2)	21.4 (7.2)	57.6 (19.8)	13.8 (20.8)	84.5 (19.3)	22.2 (21)	181.9 (150.6)
Group 2 (N=70) After PW	69.1 (17.5)	22.3 (7.2)	68 (20) p=.003	12.7 (17.3)	86.8 (17.4)	19.2 (9.7)	112.3 (90.5) p=.002

Table 1: Mean and standard deviation values for age, APACHE II, and resuscitation/management and antibiotic administration bundle completion for initial subjects

Completion of resuscitation bundle significantly increased from 57.6% to 68% (p=.003). Time to antibiotic administration was significantly reduced from 181.9 minutes to 112.3 minutes (p=0.02), representing more than a one hour improvement (Table 1).

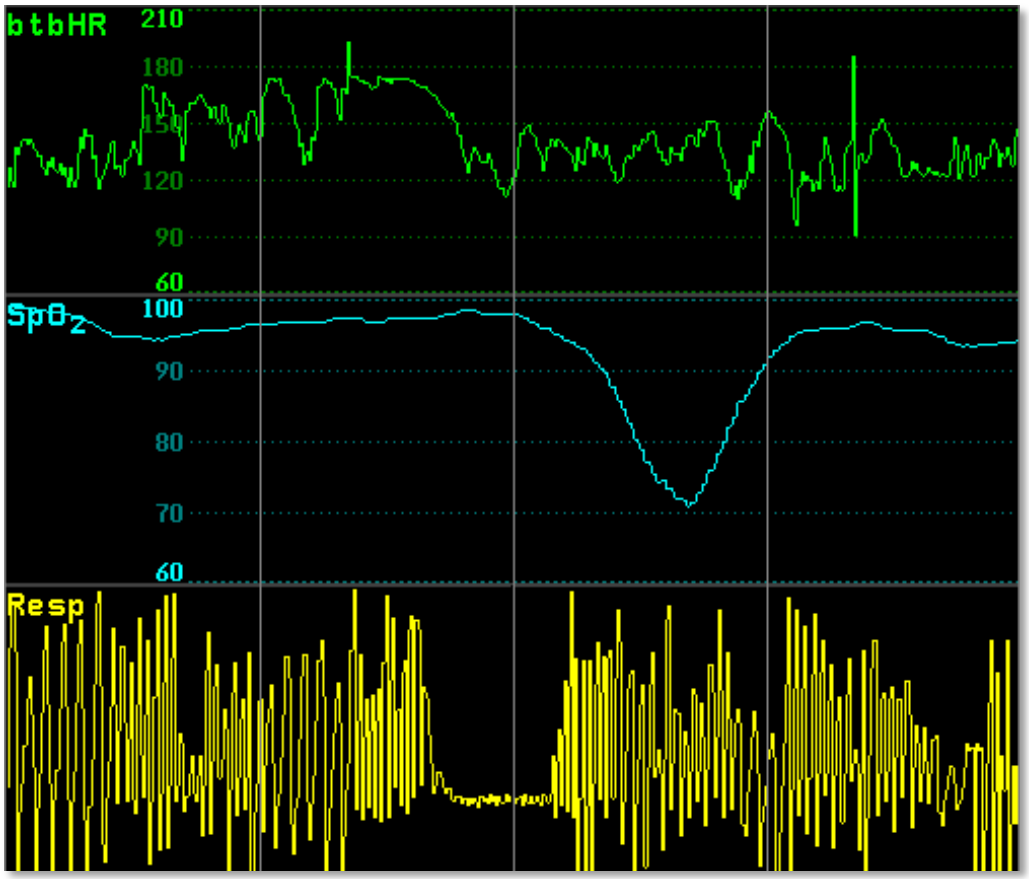
Download the document at www.philips.com/evidence
or from Philips Incenter (4522 962 56591)



Neonatal CDS Package – Oxy-CRG

What is it?

- Available in Philips (HP) monitors since 1978
- A comprehensive view of a neonate's cardiac and respiratory status
- Combines compressed trends of the most important parameters for evaluating apneas and desaturations with neonates
  - Heart Rate
  - Oxygen Saturation
  - Respiration Rate



Desaturation

Apnea

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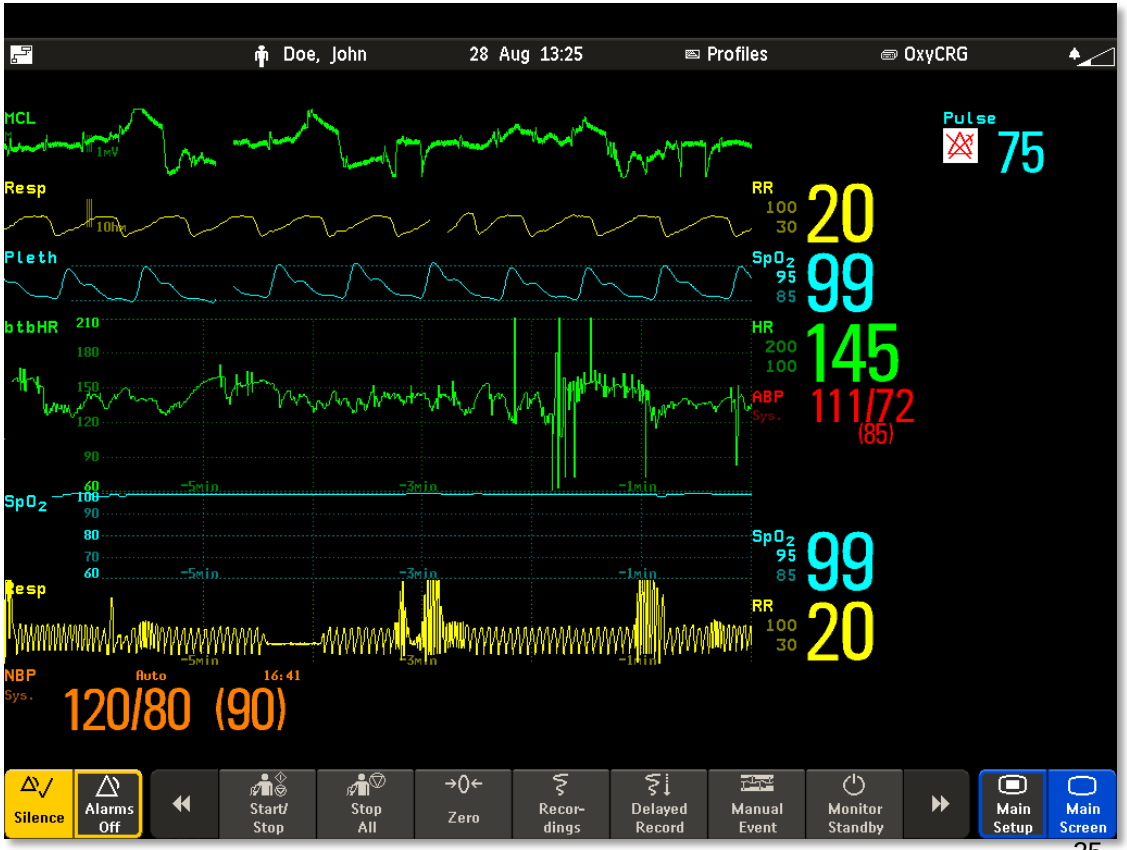
Neonatal CDS Package – Oxy-CRG

Key benefits for clinicians

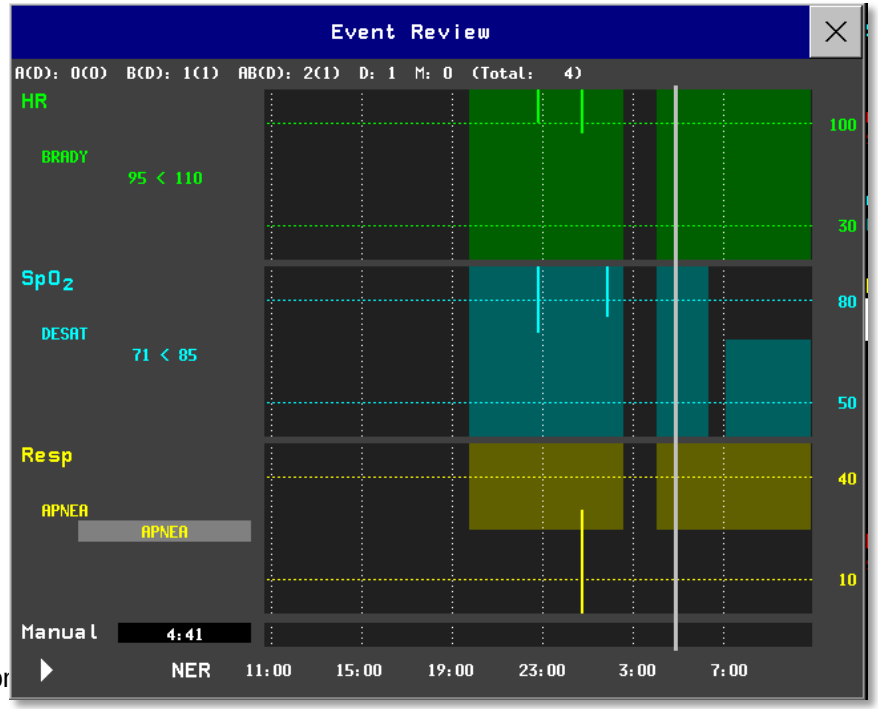
- Helps monitor and document apnea, bradycardia and hypoxia in neonates
- Helps monitor other critical conditions, including periodic and disturbed breathing
- Oxy-CRG is a well established indicator of breathing efficiency and brain maturity

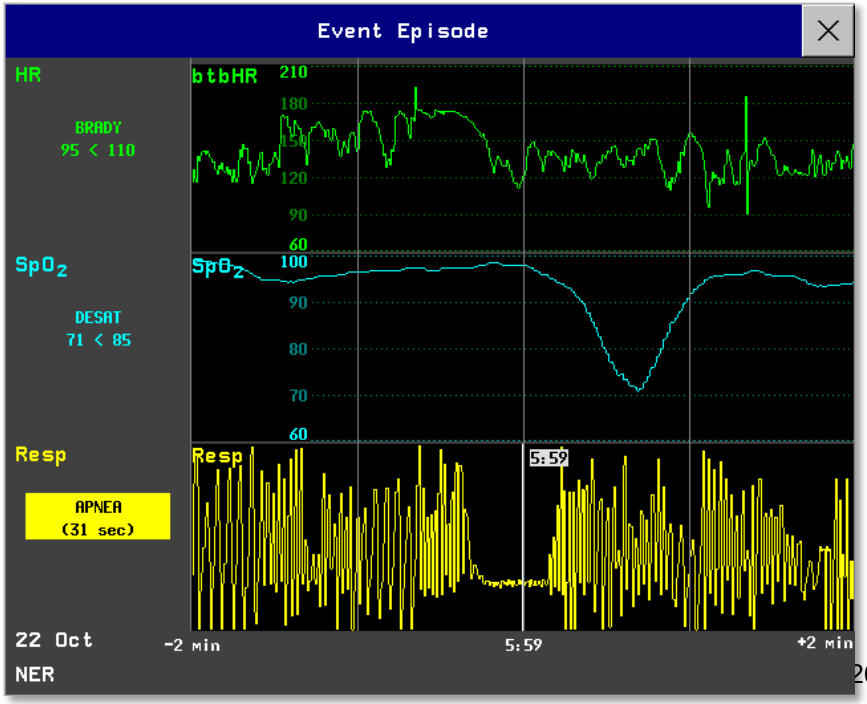


Neonatal CDS Package – Neonatal Event Review

What is it?

- A tool that captures and stores clinically significant events in neonates
- Invented by Philips (HP) in 1997
- Documents number, severity and distribution of events over the last 24hours
- Clinicians can step through the list of events, reviewing the Oxy-CRG trend data associated with each event





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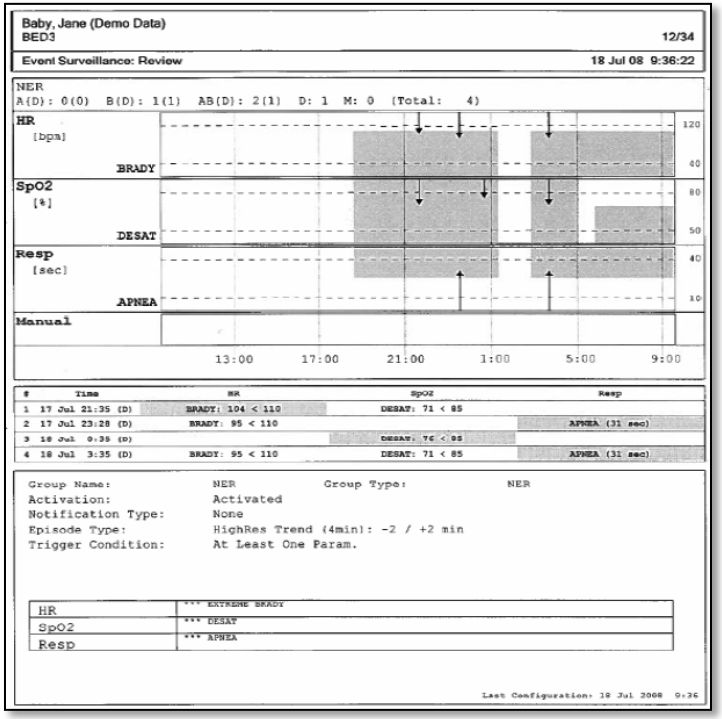
Neonatal CDS Package – Neonatal Event Review

Key benefits for clinicians

- Helps identify significant events and their underlying condition
- Contributes to overall efficiency by
  - Displaying changes in neonate status from one day to the next
  - Automating the daily documentation of neonatal events

"The key benefit of Neonatal Event Review is that it is possible for clinicians to assess the number and severity of apnea episodes objectively and accurately."

Prof. Toshio Yamazaki, MD, PhD, Department of Pediatrics, School of Medicine, Fujita Health University Hospital, Tokyo, Japan



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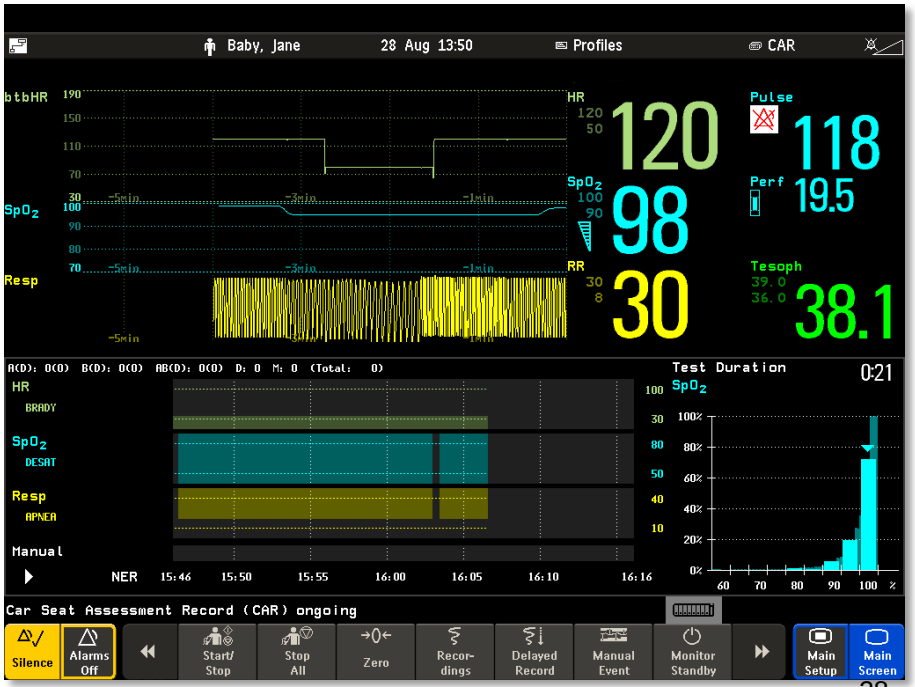
Neonatal CDS Package - **C**ar Seat **A**ssessment **R**ecord (CAR)

What is it?

- To evaluate discharge readiness of preterm babies – in many hospitals a car seat challenge test is performed
- Baby is put in a semi-reclining car safety seat for a selected period of time and is monitored for bradycardia, apnea and desaturation events

- CAR application supports this procedure by
  - Providing an optimized view for evaluating discharge readiness
  - Providing a special report that contains all findings and offers ability to add annotations



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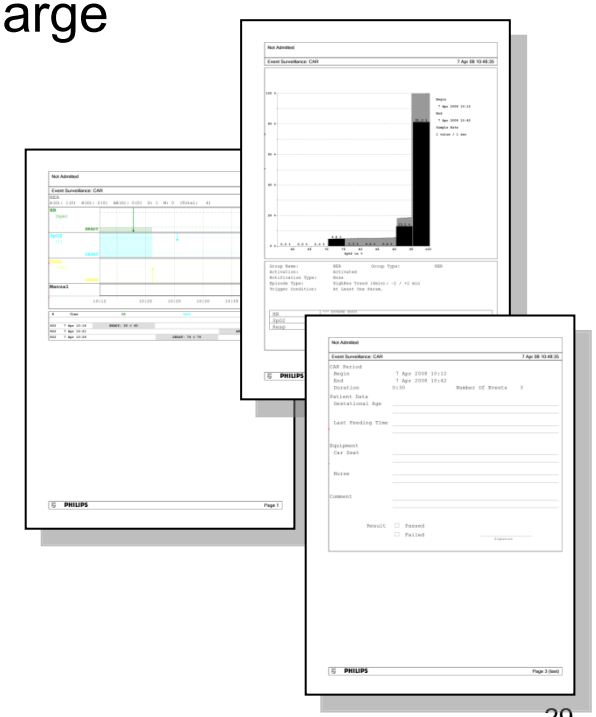
Neonatal CDS Package - **C**ar Seat **A**ssessment **R**ecord (CAR)

Key benefits for clinicians

- CAR helps with detecting events during the test
- Enables quick, comprehensive and standardized documentation
- Supports hospitals in instituting the car seat challenge procedure as recommended by the American Association of Pediatrics[1,2]
- Can be easily tailored to the hospital's own discharge criteria



1. American Academy of Pediatrics, Committee on Injury and Poison Prevention. Safe transportation of premature and low birth weight infants. Pediatrics. 1996;97:758-760
2. American Academy of Pediatrics, Committee on Injury and Poison Prevention. Safe transportation of newborns at hospital discharge. Pediatrics. 1999;104:986-987

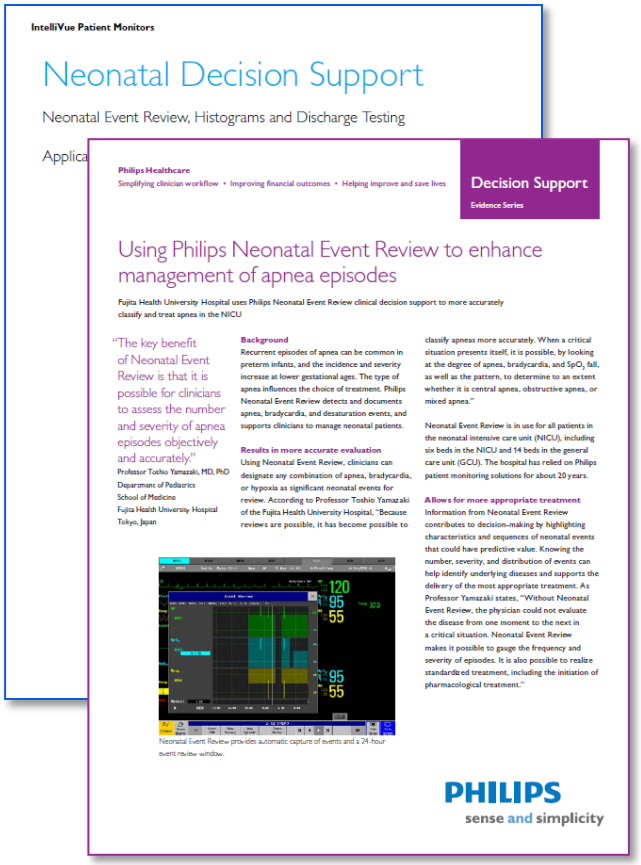
Neonatal CDS Package

Available studies

- Fujita Health University Hospital, Tokyo Japan: Using Philips Neonatal Event Review to enhance management of apnea episodes

"Without Neonatal Event Review, the physician could not evaluate the disease from one moment to the next in a critical situation. …By using Neonatal Event Review, it was possible to get objective and highly reliable data."

Prof. Toshio Yamazaki, MD, PhD, Department of Pediatrics, School of Medicine, Fujita Health University Hospital, Tokyo, Japan



Download the document at www.philips.com/evidence or from Philips Incenter (4522 962 61811 and 4535 641 15651)

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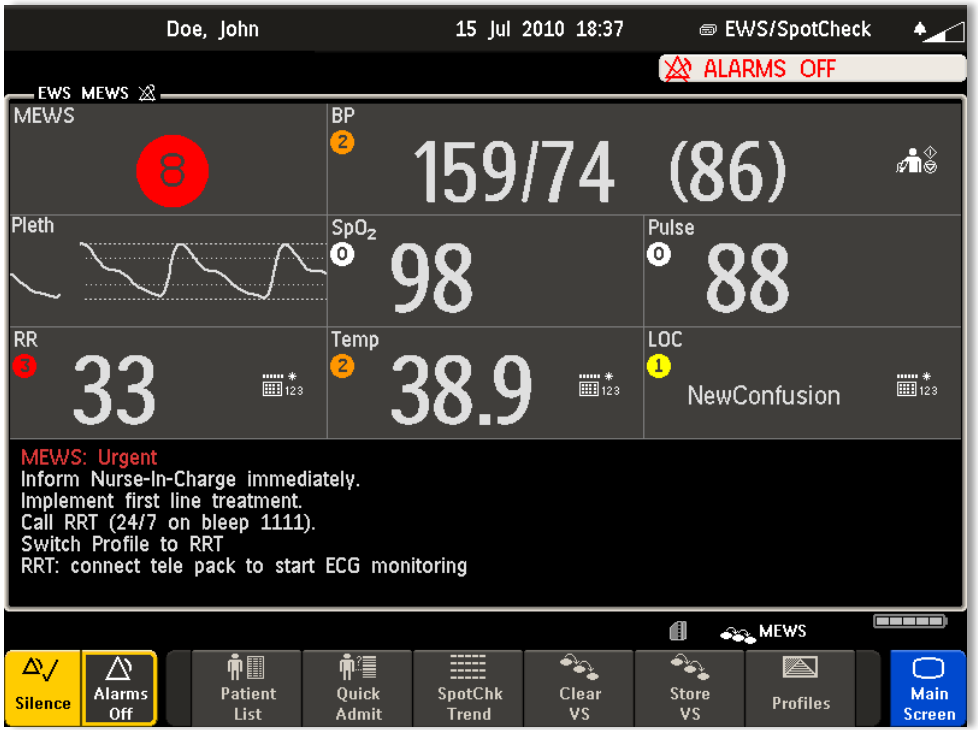
Early Warning Scoring

What is it?

- A CDS application residing on a spot-check monitor that
  - Combines vital signs acquisition with Early Warning Scoring (EWS)
  - Aids in early detection and intervention of patients at risk of deterioration
  - Is highly customizable to match the hospital's EWS criteria
  - Can help standardize care across an institution's facilities



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Early Warning Scoring

Key benefits for clinicians

- Philips EWS system meets a growing need for more vigilant monitoring on the general floor
- Provides caregivers on the general floor with an automated scoring system potentially reducing calculation and transcription errors
- Allows caregivers to automatically acquire vital signs, automate EWS scoring calculations, detect early signs of deterioration, and inform responsible clinicians for early, effective intervention.
- Empowers caregivers to make valid calls to the Rapid Response Team, when calling criteria are met
- Supports rapid response team programs. The use of these teams is gaining popularity due to their success in reducing unexpected ICU transfers.[1]

"The MP5SC [with EWS] is a new generation monitor that presents data in a way that helps nurses and doctors at the bedside identify patients at risk. By calculating an early warning score and providing pictorial clues to the need to respond, it transforms monitoring to a combination of detection and advice. In my opinion such advisory monitoring is the future of ward monitoring."

Rinaldo Bellomo, M.D., Ph. D., director of Intensive Care Research, Austin Hospital, Heidelberg, Australia

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1. Sharek PJ, Parast LM, Leong K, et al. Effect of a rapid response team on hospital-wide mortality and code rates outside the ICU in a children's hospital. JAMA. 2007;298(19)2267-2274.

Early Warning Scoring

Available studies

- A Controlled Trial of Electronic Automated Advisory Vital Signs Monitoring in General Hospital Wards

  Bellomo R, Jimenez E, Konrad D, Hvarfner A et al. A Controlled Trial of Electronic Automated Advisory Vital Signs Monitoring in General Hospital Wards, Crit Care Med 2012, Vol. 40, No. 8.

  - Multi-centre, multi-national, before and after, controlled study
  - 10 hospitals, 5 countries, 3 continents
  - 18305 patients, 9617 patients before and 8688 after deployment of the IntelliVue MP5SC

"Early identification of deteriorating patients through vital signs monitoring and analysis carries no conceivable risk but has a significant upside"

Rinaldo Bellomo, M.D., Ph. D., director of Intensive Care Research, Austin Hospital, Heidelberg, Australia

A controlled trial of electronic automated advisory vital signs monitoring in general hospital wards*

Rinaldo Bellomo, MD, FRACP, FCICM; Michael Ackerman, RN, PhD; Michael Bailey, PhD, MSc; Richard Beale, MB, BS, MD, FRCA; Greg Clancy, RN, MSN; Valerie Danesh, PhD; Andreas Hvarfner, MD, PhD; Edgar Jimenez, MD; David Konrad, MD, PhD; Michele Lecardo, RN, BSN, CCRN; Kimberly S. Pattee, RN, BSN; Josephine Ritchie, RN; Kathie Sherman, RN; Peter Tangkau, MD; The Vital Signs to Identify, Target, and Assess Level of Care Study (VITAL Care Study) Investigators

Objectives: Deteriorating ward patients are at increased risk. Electronic automated advisory vital signs monitors may help identify such patients and improve their outcomes.

Setting: A total of 349 beds, in 12 general wards in ten hospitals in the United States, Europe, and Australia.

Patients: Cohort of 18,305 patients.

Design: Before-and-after controlled trial.

Intervention: We deployed electronic automated advisory vital signs monitors to assist in the acquisition of vital signs and calculation of early warning scores. We assessed their effect on frequency, type, and treatment of rapid response team calls; survival to hospital discharge or to 90 days for rapid response team call patients; overall type and number of serious adverse events and length of hospital stay.

Measurements and Main Results: We studied 9,617 patients before (control) and 8,688 after (intervention) deployment of electronic automated advisory vital signs monitors. Among rapid response team call patients, intervention was associated with an increased proportion of calls secondary to abnormal respiratory vital signs (from 21% to 31%; difference [95% confidence interval] 9.9 [0.1–18.5]; $p = .029$). Survival immediately after rapid response team treatment and survival to hospital discharge or 90 days increased from 86% to 92% (difference [95% confidence interval] 6.3 [0.0–12.6]; $p = .04$). Intervention was also associated with a decrease in median length of hospital stay in all patients (unadjusted $p < .0001$; adjusted $p = .09$) and more so in U.S. patients (from 3.4 to 3.0 days; unadjusted $p < .0001$; adjusted ratio [95% confidence interval] 1.03 [1.00–1.06]; $p = .026$). The time required to complete and record a set of vital signs decreased from 4.1 ± 1.3 mins to 2.5 ± 0.5 mins (difference [95% confidence interval] 1.6 [1.4–1.8]; $p < .0001$).

Conclusions: Deployment of electronic automated advisory vital signs monitors was associated with an improvement in the proportion of rapid response team-calls triggered by respiratory criteria, increased survival of patients receiving rapid response team calls, and decreased time required for vital signs measurement and recording (NCT01197326). (Crit Care Med 2012; 40:2349–2361)

Key Words: early warning score; intensive care; monitoring; rapid response team; vital signs

Among hospital patients, serious adverse events (SAEs) are relatively common (1–3). Many may be preventable (4–6). Accordingly, attempts have been made to better identify deteriorating patients and rapidly respond to their condition (5–10).

As part of these preventive systems, hospital personnel (nurses, doctors, and/or respiratory therapists) can activate a rapid response team (RRT) using predefined criteria based on vital signs (9). Unfortunately, RRT activation depends on the accuracy of staff observations (9), judgment about the patient's condition (8), diligence in the measurements of vital signs (8–11), vigilance during the entire 24-hr period (11), and, finally, willingness to call for help in a timely fashion (12, 13). These factors lead to system shortcomings, including nonactivation or delayed activation (14–16). Nonactivation and delayed activation are associated with increased mortality (14, 15, 17, 18).

A system that assists in the acquisition, completion, and display of vital signs and provides prompts to escalate level of care might improve the identification of deteriorating patients. In these patients, rapid escalation to higher level of care might achieve better clinical outcomes. We hypothesized that such a system might affect the identification of deteriorating ward patients, their

*See also p. 2509.

From the Department of Intensive Care (RB), Austin Health, Melbourne, Australia; Division of Nursing (MA), University of Rochester Medical Center, Rochester, NY; Department of Biostatistics (MB), Australian and New Zealand Intensive Care Research Center, Melbourne, Australia; Department of Critical Care Medicine (RB), St. Thomas' Hospital, London, UK; Department of Nursing (GC, KSP), Mercy Hospital, Iowa City, IA; Department of Medical Intensive Care (VD, EJ), Orlando Regional Medical Center, Orlando, FL; Department of Intensive Care Medicine (AH), University of Lund Hospital, Lund, Sweden; Department of Intensive Care Medicine (DK), Karolinska Hospital, Stockholm, Sweden; Division of Nursing (ML), Norwalk Hospital, Norwalk, CT; Department of Critical Care Medicine (JR), Norwalk Hospital, Norwalk, CT; Department of Nursing (KS), Reinier Melrose-Wakefield Hospital, Melrose MA; Department of Intensive Care Medicine (PT), Reinier de Graaf Hospital, Delft, The Netherlands.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (http://journals.lww.com/ccmjournal).

Dr. Bellomo acts as paid consultant for Philips Medical, the manufacturers of the MP5 monitors used in this study. Dr. Bellomo takes responsibility for the integrity and accuracy of the data. Drs. Bellomo and Bailey take responsibility for the statistical analysis of the data.

Dr. Tangkau received a study grant from Philips International. The remaining authors have not disclosed any potential conflicts of interest.

For information regarding this article, E-mail: rinaldo.bellomo@austin.org.au

DOI: 10.1097/CCM.0b013e318255d9a0

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Early Warning Scoring

Available studies

The multi-center trial found that:

- The multi-center trial found that using the MP5SC with EWS allowed care givers to complete vital signs taking and score calculations for Early Warning Scoring faster.
- The multi-center trial found the addition of the MP5SC with EWS to the hospitals' existing protocol was associated with a 6.3% increase in survival rate at the end of the RRT call

- For the participating US hospitals, incorporating the MP5SC with EWS into their system was associated with a reduction of length of stay by 3 percent for all patients admitted to the study wards *.

**3rd bullet may only be used in USA*


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