PHILIPS

Patient monitoring

Clinical decision support

Effectiveness of Clinical Decision Support tools in clinical practice

Introduction

There is a large body of peer-reviewed research available that provides insight into the benefits of clinical decision support systems in patient monitoring. As a leader in this field, Philips has invested substantially in these applications, which deliver vital bedside visibility into the patient condition. This paper offers an overview of the Clinical Decision Support (CDS) tools developed by Philips, and exemplifies their potential for streamlining clinician workflow.

Careful planning, evaluation, implementation, and maintenance actions can ensure that your healthcare institution, clinicians, and patients obtain the full benefits of CDS tools. Actions that can increase the likelihood of successful implementation of these tools are suggested, and the potential positive outcomes associated with CDS tools are summarized.

What is a clinical decision support tool?
According to one of the studies, it is: "an automated process for comparing patient-specific characteristics against a computerized knowledge base with resulting recommendations or reminders presented to the provider at the time of clinical decision making."[10]

A recurring theme across all the research is the definition: tools to facilitate healthcare providers' efforts to enhance patient care.

Five CDS tools currently available in Philips IntelliVue monitors are reviewed including:

- Advanced Event Surveillance
- Horizon Trends
- ProtocolWatch-Surviving Sepsis Campaign
- Neonatal Event Review
- ST Map

"Clinical decision support needs to be understood as an intervention. It is not a passive system-the whole point is to change practice to improve outcomes."

Critical Care Intensivist

Literature review

As a provider of primary physiologic monitoring systems and clinical informatics, Philips Healthcare has made substantial investments in CDS applications which bring information clarity to clinicians at the point of care. A large body of peer-reviewed research about the benefits of CDS systems exists in medical literature.

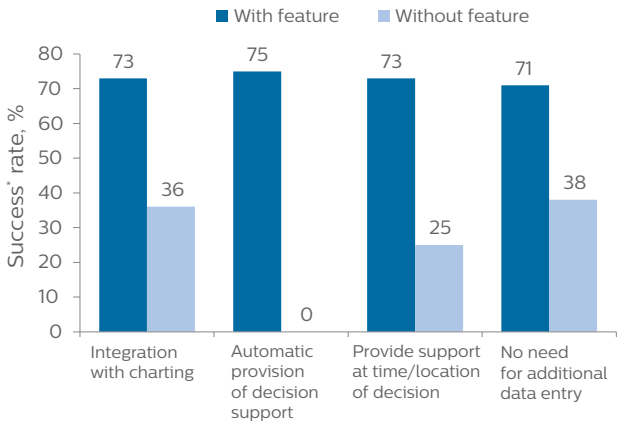
For purposes of this white paper, we have selected a small yet representative sample of those research findings to answer basic questions about the effectiveness of CDS tools in clinical practice. Key attributes of successful CDS systems are highlighted and will provide context when discussing Philips CDS applications.

Do Clinical Decision Support tools assist clinicians?[11]

- Analysis of 70 randomized, controlled studies were assessed for improvements in clinical practice
- Approximately 6000 clinicians and 130,000 patients included in studies
- **Overall, 68% of the CDS systems demonstrated statistically and clinically significant improvements**

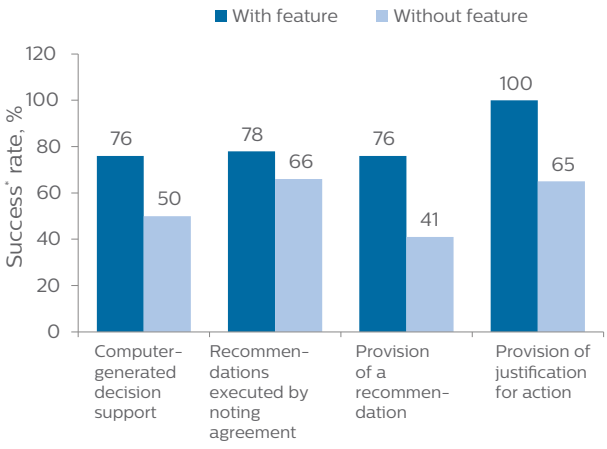
Specific features of CDS systems associated with significant improvements in clinical practice are presented in the following 2 figures.[11]

Specific features of CDS tools associated with significant improvements in clinicians' performance



*Success defined as statistically and clinically significant improvement in clinical practice.

Specific features of CDS tools associated with significant improvements in clinicians' performance



*Success defined as statistically and clinically significant improvement in clinical practice.

A 2010 Cochrane Database Systematic Review of CDS tools that provided computerized advice on drug dosage to improve clinicians' prescribing practices reported significant benefits for:[3]

- Increased initial dose
- Increased serum concentrations
- Reductions in time to therapeutic stabilization
- Reduced risk of toxic drug levels
- Reduced hospital length of stay

Do Clinical Decision Support tools improve patient care?

Five CDS systems were associated with statistically and clinically significant improvements in patient care including (Figure below):[5]

- Improved blood pressure control[1]
- Reduced urinary incontinence[15]
- Decreased length of hospital stay for patients with diverse medical diagnoses[16]
- Decreased multi-organ dysfunction and sepsis score in patients with acute respiratory distress syndrome who were mechanically ventilated[4]
- Decreased incidence and severity of overdistension and pressure damage to the lung in patients with acute respiratory distress syndrome who were mechanically ventilated[4]
- Decreased tidal volumes and reduced exposure to high plateau pressures among patients receiving mechanical ventilation[13]
- Decreased patient-reported exacerbations of asthma, emergency use of nebulizers, and need for additional consultations for asthma management[12]

Do Clinical Decision Support tools reduce unnecessary healthcare utilization?[5]

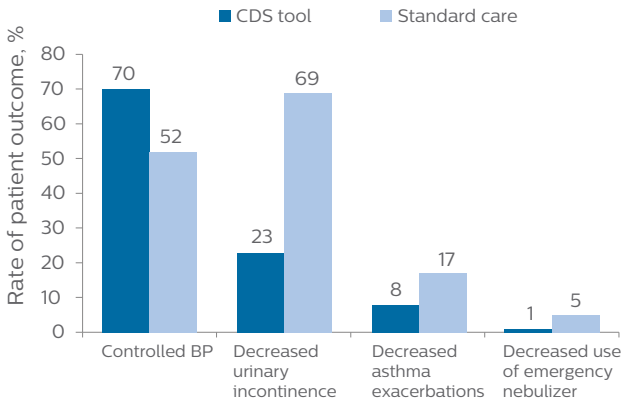
Three of 4 evaluations of CDS tools reported significant reductions in unnecessary healthcare utilization including (Table):[5]

- Frequency of unnecessary testing[18]
- Cost per patient admission[19]
- Rate of hospital readmissions[19]
- Length of hospital stay[19,16]
- Rate of unnecessary admissions[8]
- Rate of redundant ordering of laboratory tests[2]

Statistically and clinically significant evidence of CDS effectiveness is well documented in the literature. Kawamoto's 2005 research provides additional insight into specific characteristics of successful CDS systems, which include these essential features:

- Automated process for delivery of alerts or reminders to clinicians as part of workflow
- Provision of decision support at the time and location of decision making
- Use of a computer to generate the decision support
- Provision of a specific recommendation for intervention rather than just an assessment

Improvements in patient care associated with CDS tools[5]



Factors that influence the success of implementation of CDS tools

"A successful implementation process is critical to gaining the economic and competitive advantages that innovation offers."[7]

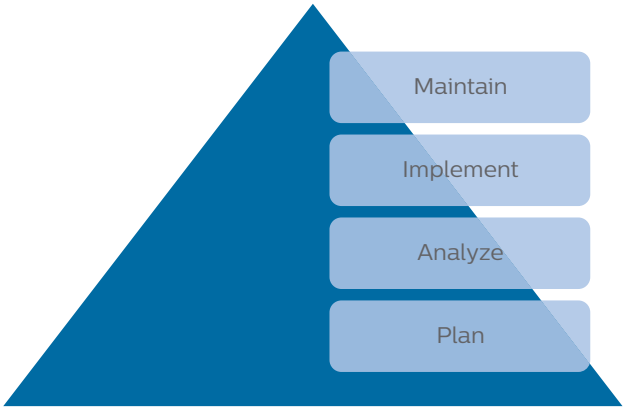
Healthcare organizations expend significant resources to acquire, develop, and implement clinical information systems such as CDS tools. However, many organizations fail to attain the full benefits of their CDS tools.

A systematic review of research literature summarized factors associated with the success and failure of CDS system implementation. This analysis was based on a cycle of 4 steps during implementation of CDS tools including Planning, Analysis, Implementation, and Maintenance (Figure).[7]

Factors associated with each step of the process of successful implementation of CDS tools are summarized in the following table.

7. Gruber D, Cummings GG, LeBlanc L, Smith DL.. Factors influencing outcomes of clinical information systems implementation: a systematic review. Comput Inform Nurs. 2009;27:151-63.

Process for implementation of CDS tools7



Factors associated with successful implementation of CDS tools at each step in the process

Plan	Analyze	Implement	Maintain
Leadership by clinicians (physicians, nurses, other clinical staff)	Assess availability of resources for implementation	Communication	Performance measurement of CDS tool with feedback to staff
Staff and physician empowerment	Ensure broad representation	Training for technical support staff	Competency testing at completion of training
Buy-in by administration	Involve peer trainers in testing	Manage process of change by assessing staff satisfaction with and acceptance of CDS tool	Ongoing, adequate technical support
Financial commitment	Proactive management of process of change	Initial and ongoing staff training	Vendor support
Partnership with vendor	Access to vendor for customization of CDS tool	Management involvement and support	Assess staff satisfaction on a regular basis
Manage change including emotional reactions such as anxiety and resistance	Adequate documentation to demonstrate logic underlying the CDS tool	Testing of CDS tool by knowledgeable clinicians	Provide ongoing training
Define new processes early in choice/development of CDS tool	Extensive testing	Go-live, on-site support from vender	Tailor training to individual learning curves
Slow initiation of automation		Ensure CDS tool is time-sensitive and practical	Re-engineering/ customization of CDS tool post-launch to make changes that will meed the needs of users
Clear criteria for evaluation			Establish process to manage change requests
Adequate amount of hardware/software			

In addition, the following are associated with the success of implementation of CDS tools.[7]

System outcomes	Management outcomes	Clinician outcomes	Patient outcomes
User-friendly	Use of data and reports for benchmarking, decision-making, and quality control	Acceptance/motivation to use CDS system	Improved satisfaction with relationships with physicians and nurses
Meaningful information presented on screens and lists	Use of CDS system to meet regulatory, clinical, and financial requirements	Confidence/self-efficacy/ preparedness to use CDS system	Reduced frustration associated with multiple requests for same information by different staff members
Quality of system performance	Leadership and a willingness to invest in staff development and training to use the CDS tool	Satisfaction with CDS tool	
Integration between CDS and other systems	Evidence of increased efficiency of care processes such as worker productivity and operational efficiencies	Access to support from IT and administration	
Access to decision tools		Integrity, validity, quality, and accuracy of data provided by CDS tool	
Ease of data availability		Improved ability to manage patients	
Reductions in duplication of effort/work		Improved speed of communication about patients	

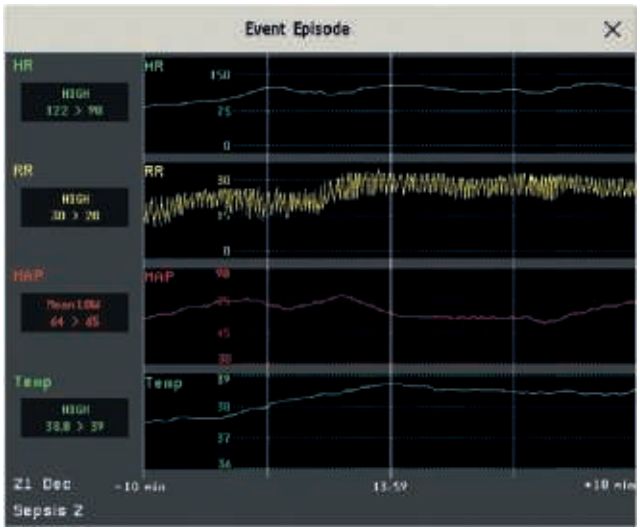
With these results in mind, we will highlight **five Philips IntelliVue Clinical Decision Support applications** which generate alerts or reminders, provide support to clinicians at the point of care, are embedded in the bedside patient monitor's user interface and in the case of ProtocolWatch Sepsis, provide recommendations based on Surviving Sepsis Campaign Guidelines.

An overview of **Clinical**

Philips Advanced Event Surveillance

Objective: Improve overall efficiency and support decision-making by identifying and documenting clinically significant patient episodes for clinician review.
Philips Event Surveillance correlates up to 4 parameters from IntelliVue patient monitors into a clinician-defined "event".

- Event creation provides context for variations from baseline values. For example, a slightly elevated heart rate may not seem significant. However, when the elevation occurs with a drop in blood pressure and an increase in respiratory rate, the level of concern may be higher.
- Events can use high and low parameters, or can be customized for individuals by specifying a % change from baseline and/or specifying an event that exceeds a specified time parameter. So, a marathon runner with a normal heart rate of 50 bpm won't have continual alarms because the heart rate is lower than the "normal" adult standard of 60-100 bpm.
- A high number of clinically irrelevant alarms can lead to "alarm fatigue" characterized by reduced trust in alarms by staff, disabling of alarms, disruptions in patient care, failures to respond to relevant alarms, and decreased clinical sensitivity of the alarm system.[6,17]
- The ability to customize alarms helps to develop "smart" alarms and to decrease the number of "nuisance" alarms that contribute to alarm fatigue.
- The Event Surveillance database provides a summary of clinician-specified events.



Philips Advanced Event Surveillance

Philips IntelliVue
Decision Support tools

Horizon Trends

Objective: Provide real-time graphical displays of changes in vital signs to help clinicians quickly identify deviations and aid decision-making.

- Horizon Trends is built into every IntelliVue monitor and can be configured to viewer preferences, either horizontally or vertically to clearly present clinical measurements.
- The graphical display of vital signs makes it easier to quickly identify clinically significant changes, in other words, where the patient has been and where they're going.
- The visual presentation also shows how a patient's measurements relate to baseline or target values and alerts clinicians to any trends in measurements.
- Horizon Trends allows clinicians to compare current measurements with information documented in the medical chart.
- Horizon Trends parameters include:
  - A deviation bar that displays current measurements compared with a baseline level set by clinicians.
  - A trend indicator that displays the trend of measurements over the past 2, 5, or 10 minutes.
  - An optional graphic trend that displays trends during the past 30 minute to 12 hours.

Horizon Trend with ventilation parameters

Horizon Trends next to waveforms

ProtocolWatch – Sepsis

Objective: Simplify and speed the implementation of evidence-based care parameters such as the Surviving Sepsis Campaign (SSC) guidelines.

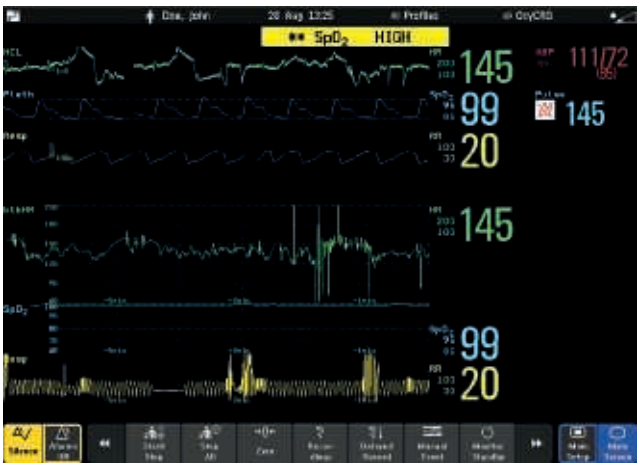
- ProtocolWatch Sepsis on IntelliVue patient monitors integrates guidelines from the Surviving Sepsis Campaign (SSC) into bedside monitoring to assist clinicians in identifying and treating sepsis.
- The rules-based ProtocolWatch engine has three distinct phases associated with SSC guidelines: sepsis screening, sepsis resuscitation bundle and sepsis management bundle. When criteria are met for systemic inflammatory response syndrome (SIRS), and validated by the clinician, ProtocolWatch Sepsis simplifies the care of patients by activation of the Sepsis Resuscitation Bundle.
- A reminder list of SSC treatment and goal recommendations is provided to clinicians. Timers are employed to prompt clinicians to address time-sensitive treatment recommendations like administration of antibiotics.
- Key measurements are displayed in the Horizon Trends view during the Sepsis Resuscitation bundle.
- When clinicians confirm that all recommendations of the SSC guidelines have been implemented, the Sepsis Management bundle provides a checklist of recommendations to stabilize the patient.

ProtocolWatch – Sepsis

Neonatal Event Review

Objective: Detect and document information to support the diagnosis and management of neonatal intensive care patients.

- Neonatal Event Review monitors apnea, bradycardia, and hypoxia as significant neonatal events that could have implications for treatment.
- Oxy-cardiorespirography (Oxy-CRG) combines information about heart rate, respiration, and oxygenation levels and displays these parameters in an easy-to-interpret user interface.
- Provides automatic documentation of up to 50 events in a 24-hour period, which could potentially save time and decrease errors that might occur during manual documentation.
- Specific features of Neonatal Event Review include:
  - Automatic capture of events.
  - 24-hour event review window.
  - Storage of 4 minutes of an Oxy-CRG episode for up to 50 events per 24 hours to allow retrospective review.
  - Event documentation with a bedside recorder or printer or a central printer that can be used to support hospital release criteria and included in the patient's medical record.

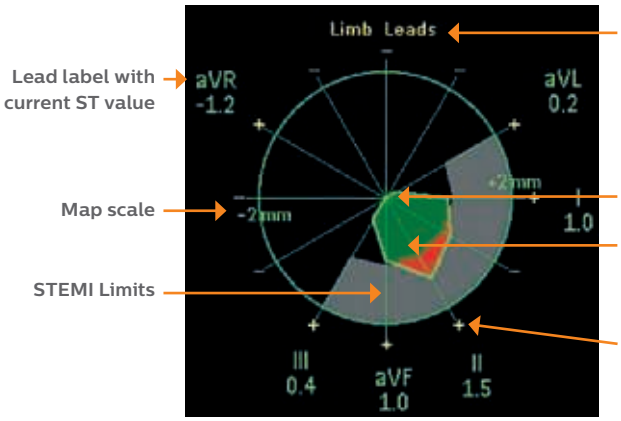


Neonatal Event Review

ST Map

Objective: Rapid identification and location of subtle changes in the ST segment.

- ST Map collects ST values and trends derived from the limb and chest leads and provides an integrated display of ST segment data.
- A reference baseline (displayed in yellow) illustrates patients' ST values, over time, helping to detect possible myocardial ischemic events and to understand patient response to revascularization therapy.
- The visual representation of ST segment helps clinicians recognize ST changes and their location in the heart.
- ST Map offers trend views in intervals ranging from 12 seconds to 30 minutes.
- ST Map reports can be printed and included in the patient record.
- ST Map can be used in conjunction with Advanced Event Surveillance to provide intelligent alarms about significant changes.
- ST Map supports the American Heart Association Practice Standards for ECG Monitoring recommendation to implement 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.*



ST Map vertical plane (limb leads)

STEMI Limit Map (STE Map):

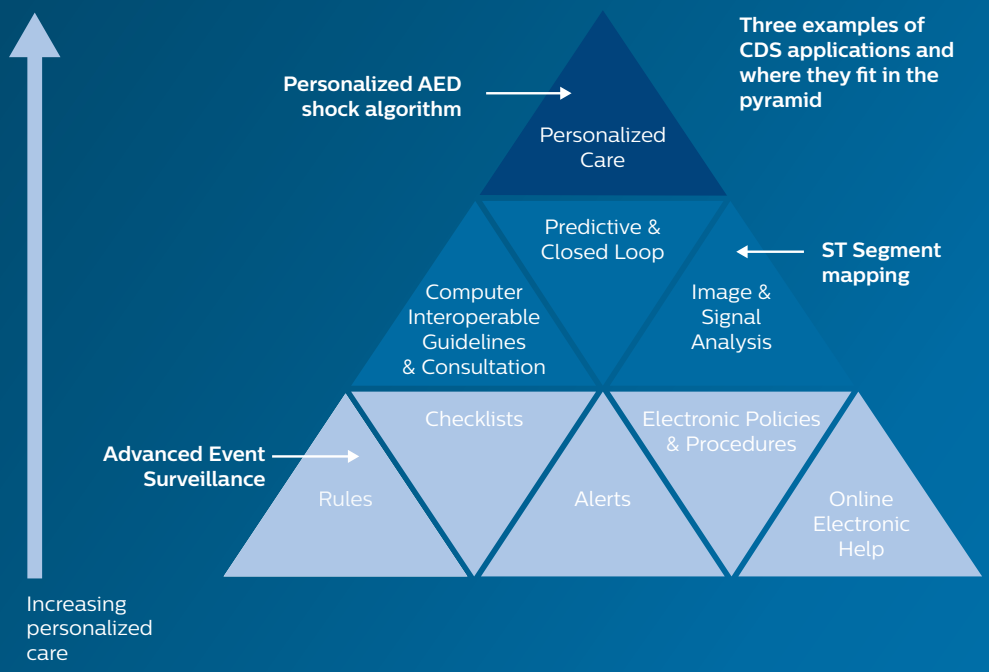
- Combines ST Map with STEMI (ST Elevation Myocardial Infarction) limits.
- Helps clinicians quickly detect at-risk patients
- Complies with the AHA/ACCF/HRS recommendations for the Standardization and Interpretation of the Electrocardiogram (Part IV: Acute Ischemia/Infarction)

* Drew B, Califf R, Funk M et al. Practice standards for electrocardiographic monitoring in hospital settings. An American Heart Association scientific statement from the councils on cardiovascular nursing, clinical cardiology, and cardiovascular disease in the young. Circulation. 2004;110:2721-2746.

Summary

When properly used, CDS tools can simplify clinician workflow, improve financial outcomes, and help enhance patient care. This paper presents information about five CDS tools that are currently available through specific IntelliVue monitors and manufactured by Philips Healthcare. Important factors associated with the successful implementation of CDS tools are presented, as well as actions that can increase the likelihood of successful CDS implementation. Positive outcomes for patients, clinicians, management, and the healthcare system associated with successful implementation of CDS tools are summarized. In closing we present The Philips Clinical Decision Support Pyramid which represents our vision for clinical tools that we believe will help our clinicians caring for their patients.

Clinical Decision Support @work
Delivering actionable clinical intelligence that positively impacts patient care, workflow, and/or financial outcomes



Clinical Decision Support comes in a number of forms. The CDS pyramid is a framework for discussing the various categories of CDS, and the applications within each. At the foundation are the most frequently used and today are the most recognized applications.

Further up the CDS Pyramid, the applications become increasingly smart, and at the top are the most patient-specific. This paper has reviewed CDS applications on Philips IntelliVue Patient Monitors.

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