Evidence suggests that the majority of monitor alarms are clinically-insignificant or 'nuisance' alarms that cause unnecessary disruption to patient care and may lead to 'alarm fatigue', which can result in clinically significant alarms being ignored, often with tragic results.\(^1\)

In response to this growing problem, the Joint Commission has released a Sentinel Event Alert and a National Patient Safety Goal on alarm management that requires hospitals to “establish alarms as an organization priority and identify the most important alarms to manage based on their own internal situations”\(^1,2\) by January 2014. The Joint Commission also stated that hospitals will be expected to develop and implement specific components of policies and procedures by January 2016.

As a market leader, Covidien is dedicated to the development of Smart Alarm Management technologies that are designed to reduce the number of nuisance alarms while alerting caregivers to clinically-significant events.
**Smart Breath Detection™**

A proprietary filter and pattern recognition algorithm screens out low-amplitude “non-breath” etCO$_2$ excursions like snoring, talking or crying, to provide a more accurate respiratory rate. (Figure 1)

Without SBD, these shallow excursions would be counted as breaths, resulting in a falsely elevated respiratory rate and potentially a false high respiratory rate alarm. With SBD, only the entire cycle is counted as a breath.

**Figure 1:** Smart BDA rejects traditional breath detection of shallow etCO$_2$ excursions. With SBD = 5 breaths (blue triangles). Without SBD = 10 breaths (red triangles).

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**Smart Alarm for Respiratory Analysis™ (SARA)**

Reducing distractions from clinically insignificant alarms helps preserve caregiver alarm vigilance, leading to improved patient safety. Functioning in combination with the SBD algorithm, the SARA algorithm is proven to reduce clinically insignificant respiratory rate alarms by dynamically adjusting the respiratory rate averaging algorithm during periods of breath-to-breath cycle variability. (Figure 2)

**Figure 2:** Comparison of alarm events both with and without SARA/SBD. Fifty six monitoring periods on multiple patients at 2 hours with the low respiratory rate alarm set at 8 breaths per minute.
**Integrated Pulmonary Index™ (IPI)**

IPI incorporates four real-time respiratory measurements into a single number, displayed on a scale from 1 to 10, representing an inclusive respiratory profile. (Figure 3)

Helpful in busy clinical environments, IPI provides a simple and comprehensive indication of respiratory status and trends, promoting early awareness of changes to a patient's breathing.

<table>
<thead>
<tr>
<th>IPI</th>
<th>Patient Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Normal</td>
</tr>
<tr>
<td>8-9</td>
<td>Within normal range</td>
</tr>
<tr>
<td>7</td>
<td>Close to normal range; requires attention</td>
</tr>
<tr>
<td>5-6</td>
<td>Requires attention and may require intervention</td>
</tr>
<tr>
<td>3-4</td>
<td>Requires intervention</td>
</tr>
<tr>
<td>1-2</td>
<td>Requires immediate intervention</td>
</tr>
</tbody>
</table>

*Figure 3: IPI measurements*

**Apnea-Sat Alert™ Algorithm***

Apnea-Sat Alert (ASA) tracks and reports apneas per hour (A/hr); apnea is defined as no breath for 10 seconds or longer, and the oxygen desaturation index (ODI), which indicates the 'dips' in SpO₂ (number of times the SpO₂ value dropped 4 percent or more from baseline and returned to baseline in 240 seconds or less). A visual alert appears if the A/hr exceed a preset threshold over user-selectable time periods of 2, 4, 8 or 12 hours. A/hr and ODI are displayed in real time on the monitor home screen, and the data is available in trend reports, in print outs and through data export.

ASA identifies and quantifies recurrent apnea and oxygen desaturation events. ASA measurements inform clinicians that adjustments to patient management may be required. A/hr and ODI are displayed in real time on the monitor home screen, and the data is available in trend reports, in print outs and through data export. A visual alert appears if the A/hr has exceeded the threshold set by the clinician (2, 4, 8 or 12 hours).

*Apnea-Sat Alert is FDA cleared for adults 22 years of age or older.

*Asterisk indicates apnea count has exceeded set threshold during a pre-defined time frame (default is 12 hours) and clinician should view trend data.*

*Figure 4: ASA trend screen displays an analysis of A/hr by length of the apneas.*
Nellcor™ SatSeconds Alarm Management

Nellcor™ SatSeconds alarm management is a clinician-controlled feature that differentiates between serious hypoxemia and minor transient events by adapting the criteria to deploy an alarm based on severity and duration of the event. Data shows that SatSeconds alarm management enables clinicians and nurses to respond to alarms that are clinically relevant and reduces the number of clinically insignificant alarms. In a study with 30 NICU patients, 29 were monitored for two hours each with the study monitor. Alarm events were recorded while the SatSeconds feature was set at 0, 10, 25, 50 and 100. With the use of the SatSeconds alarm management feature, total alarms were reduced by 40 percent.

The SatSeconds feature analyzes desaturation events by multiplying their duration, in seconds, by the number of percentage points the patient drops below the low SpO₂ alarm limit. As a safety precaution, when three or more SpO₂ alarm violations occur within 60 seconds, an alarm will sound even if the SatSeconds limit has not been reached.

Figure 6: Nellcor™ SatSeconds analyzes desaturation events by multiplying their duration, in seconds, by the number of percentage points the patient exceeds the alarm limit.

SPD Alert*

The SPD or “saturation pattern detection” alert detects patterns of repetitive reduction in airflow (RRiA) indicative of desaturation, which may be seen in patients with deteriorating airway stability. The SPD algorithm continuously reviews SpO₂ patterns and quantifies them based on several variables, including severity, shape, frequency and duration. The SPD alert uses a triangle icon that when “full” triggers an alarm to alert staff about these worrisome patterns.

The alert occurs even if the SpO₂ levels do not fall below alarm limits. For an OxiMax™ SPD alert to sound, the pattern recognition algorithm must identify five discrete desaturation/resaturation cycles within two minutes of each other.

The SPD alert can show a caregiver that although a patient’s current SpO₂ snapshot may be acceptable, the patient has developed troubling patterns of recurring desaturation.

*SPD alert is intended for adult, in-hospital use only. Do not use SPD alert with pediatric or neonatal patients.