The role of advanced alarm filtering in reducing alarm notification messages and maximizing clinical efficiency

This exploratory case study shows how a major southern California hospital leveraged Ascom technology to reduce alarm fatigue for its clinical staff, deploying alarm filtering rules designed to send only clinically relevant information to caregivers.

**Challenge**
Patient-monitoring alarms occur for a variety of reasons, including important patient events, improperly set parameters, patient movement, low-battery signals, device malfunction or temporary conditions that automatically reset on their own.

The resulting alarm overload can create an “alarm flood” for caregivers, who may not be able to determine, from audible alarms only, whether the notification is important. As monitoring technology has advanced, so has the number of alarms sent to caregivers, adding to the deluge of alerts received daily and creating an environment that can have detrimental impact on both clinical efficiency and patient safety.

**Objective**
Understand and measure the impact of alarm filtering in reducing alarm message notifications received by caregivers for patient monitoring.

**Outcome**

- **32%** Reduction in alarm notification messages sent to caregivers through basic filtering rules.
- **38%** Further reduction in alarm notification messages achievable by utilizing 10 second delay filter.
Scope of study
Focused on measuring the impact of patient monitor alarm filtering, this study included the GE CARESCAPE® patient monitoring system integrated with the Ascom Mobile Monitoring Gateway (MMG) to deliver message alert notifications from the monitoring system to mobile devices carried by caregivers. The study was carried out in a Cardiac Intensive Care Unit (CICU) with 27 beds and a Cardiology Unit with 34 beds.

Patient monitoring activity data was collected and analyzed over 20 days for these two units. Custom software was then used to correlate patient alarms to alert messages. Results were analyzed from two perspectives: 1) alarms sent from the patient monitoring system to an Ascom MMG, and 2) alert messages sent from the Ascom MMG to caregiver mobile devices. The analysis was completed comparing these two alarm transmission steps to determine specifically what impact alarm filtering had on reducing alarm notification messages sent to a caregiver’s mobile device.

During the 20-day study, the total number of alarms received from the GE CARESCAPE monitoring system totaled 49,810 for the CICU and 41,151 for Cardiology (Figure 1).

Breaking down alarms per bed/per day, the CICU averaged 92 alarms per bed/per day, while Cardiology averaged 61 alarms. On average, the CICU generated 51 percent more alarms than Cardiology with fewer patient beds (Figure 2).

It is understandable, after looking at this data, why caregivers can be impacted by alarm volume. If each alarm potentially represents a work routine interruption, then efficiency will suffer.

Customizing alarm filters
It is estimated by the US Joint Commission that 85%−99% of alarm signals do not result in the need for clinical intervention or require a change in patient care. The ability to customize and select specific alarms for forwarding to a caregiver is essential to minimizing alarm flood conditions and reducing alarm fatigue.

Determining what alarms are sent
In configuring the Ascom MMG, one of the most important determinations is selecting what patient monitor alarms are critical for caregivers to receive on their mobile devices. Patient monitoring systems can generate a high volume and variety of alarms, and depending on the specific care Unit, some alarms are typically deemed more critical than others.

Figure 3 indicates these two Units took somewhat different approaches in selecting their alarms. In the CICU only five alarms were selected for forwarding to caregivers, focused on physiological anomalies, like VFIB or VTACH, that may precede a critical patient event.

In Cardiology six alarms were selected. Since Cardiology utilizes telemetry monitors and patients are more mobile, CHANGE BATTERY, LEAD FAIL and NO TELEMETRY alarms were deemed important technical events to ensure reliable operational performance.

<table>
<thead>
<tr>
<th>CICU</th>
<th>Cardiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>VTACH</td>
<td>CHANGE BATTERY</td>
</tr>
<tr>
<td>VFIB/VTACH</td>
<td>LEAD FAIL</td>
</tr>
<tr>
<td>VFIB</td>
<td>NO TELEMETRY</td>
</tr>
<tr>
<td>PAUSE</td>
<td>VFIB/VTAC</td>
</tr>
<tr>
<td>ASYSTOLE</td>
<td>ASYSTOLE</td>
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<tr>
<td></td>
<td>PAUSE</td>
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</table>
Alarm filtering helps identify actionable alarms

One of the most fundamental aspects of alarm management is ensuring that caregivers are aware of all actionable alarms – those alarms necessitating clinical intervention. On the other hand it’s important that caregivers are not flooded with alarms which can constantly interrupt work routines and negatively impact efficiency.

To help identify actionable alarms, filter settings in the Ascom MMG were set and customized by Unit. The MMG software utilizes advanced filtering options including a group filter, delay filter and stop filter. Filtering software also provides another important activity, the elimination of transient alarms. Transient alarms are alarms that appear for a few seconds, then disappear on their own.

Based on selecting a subset of alarms for forwarding to mobile devices (Figure 3), the 90,000 plus alarms was reduced to 7,412 for both units. After applying basic filtering rules 5,028 alarm notification messages were delivered to caregivers, a reduction of 32% attributed directly to alarm filtering (Figure 4).

Achieving balance

In order to make sensible decisions on how to apply alarm filtering rules, alarm data should be analyzed to achieve the best balance in minimizing alarm fatigue and ensuring a safe patient environment.

Figure 5 shows the number of alarms received from the patient monitoring system for the both Units. Amazingly 77% of these alarms were technical alarms indicating a potential equipment issue – either a CHANGE BATTERY, LEAD FAIL or NO TELEMETRY alarm. The LEAD FAIL alarms alone accounts for 49% of the total alarms received.

Selective use of delay filters

Even though this hospital chose not to use delay filters, a “what if” analysis was performed analyzing how varying alarm message delay timers, from 5 seconds to 30 seconds, would impact the number of messages sent. Delay timers are helpful in reducing transient problems, like LEAD FAIL, as these alarms sometimes disappear on their own within a few seconds.

Adding just a 10 second delay filter to all alarms resulted in further reducing alarm notification messages by 38% (Figure 6). For technical alarms like LEAD FAIL the reduction was substantial, going from 2,379 alarm messages after basic filtering to 1,384 with a delay filter applied, a further 42% reduction. For the three technical alarms in Cardiology, alert messages were reduced by 40%, eliminating 1,536 potential work interruptions.

32% Reduction
Basic alarm filtering substantially reduces volume of alerts sent to caregivers

38% Reduction
Implementing just a 10 second delay filter can deliver substantial reductions in alert messages
Reducing cost

Work interruptions can negatively impact workflow efficiency. When a nurse interrupts their work routine, responding to a low priority patient event requiring no action, they lose valuable time. To analyze this from a cost perspective, note that the average hourly pay for a US registered nurse is $32.66 per hour. A four minute interruption, occurring just 6 times a day, costs $3110 annually per nurse. Reducing alert messages, that require no action, can help avoid this cost and increase efficiency.

There is tangible evidence in this study that selective alarm filtering can effectively reduce alert messages sent to caregivers (Figure 6). For a unit utilizing telemetry monitoring with a need for technical alarms, the study demonstrates how applying delay filters can effectively reduce non-clinical alert messages being sent to a caregiver. Since technical alarms accounted for 77 percent of all alarms in this study, particular attention should be paid to applying reasonable delay filters to minimize these alert messages.
Addressing alarm fatigue among caregivers is challenging, but alarm filtering can play an important role in preventing caregivers from being overwhelmed with alarm notification messages. As shown in Figure 7, a 32-percent reduction in alarm notification messages sent to caregivers was achieved using basic filtering rules. A further reduction of 38% is possible by adding a 10-second delay filter for all alarms. If both basic and delay filters are utilized, the study indicates a 58% overall reduction in alarm notification messages is possible. Alarm filtering can be an effective tool to helping reduce alarm fatigue by reducing the number of alert messages sent to caregivers.

Alarm filtering rules must be applied thoughtfully. Individual hospital units should make filtering decisions based on the type of patients, critical nature of patient condition, treatment needs and other key medical factors. In some cases, receiving an alert notification message results in a need for a caregiver to take some clinical action; in other cases, the alert message serves to notify the caregiver of changing patient conditions that may require no immediate intervention. In either case, this is a valid use of alarm notifications.

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**Fig. 7 Alarm filtering rules application – percent of alert messages eliminated**

<table>
<thead>
<tr>
<th>Filtering Rule</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Alarm Filtering Rules Applied</td>
<td>32%</td>
</tr>
<tr>
<td>10 Second Delay Filter Applied (on all alarms)</td>
<td>38% Additional Reduction</td>
</tr>
<tr>
<td>Both Basic Alarm Filtering &amp; 10 Second Delay Filter Applied</td>
<td>58% Combined Reduction</td>
</tr>
</tbody>
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**Overall alert notification messages should focus a caregiver’s attention to something that is important – not interrupt an important work activity with something less important**

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**Conclusion**

**Addressing alarm fatigue among caregivers is challenging, but alarm filtering can play an important role in preventing caregivers from being overwhelmed with alarm notification messages. As shown in Figure 7, a 32-percent reduction in alarm notification messages sent to caregivers was achieved using basic filtering rules. A further reduction of 38% is possible by adding a 10-second delay filter for all alarms. If both basic and delay filters are utilized, the study indicates a 58% overall reduction in alarm notification messages is possible. Alarm filtering can be an effective tool to helping reduce alarm fatigue by reducing the number of alert messages sent to caregivers.**

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3. Calculation: $32.66 (avg. pay per hour) divided by 60 minutes equals $.54 (pay per minute). 6 (interruptions per day), times 4 (minutes per interruption), times 240 (work days per year), times $.54 (pay per minute) equals $3110 annually per nurse.

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