Alarm Fatigue: Understanding the Problem & Strategies for Reducing Alarm Burden

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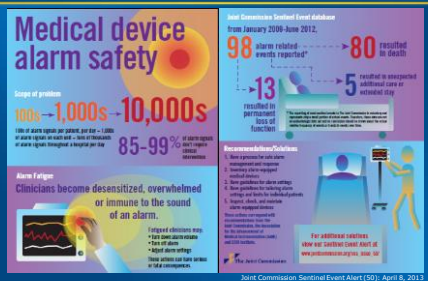
The Problem of Excessive Alarms



Joint Commission Sentinel Event Alert (50): April 8, 2013

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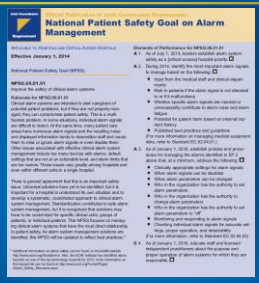
The Problem of Excessive Alarms

Released in 2013

As of July 1, 2014- hospitals must establish alarm system safety as a hospital priority

As of January 1, 2016- have staff education completed and have updated policies implemented



Joint Commission Perspectives 33 (7): July, 2013

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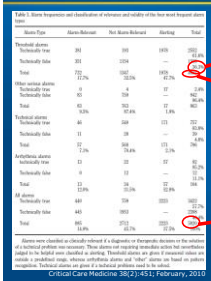

Total Technically False Alarms 1505 (36.3%)

Total Threshold Alarms 4057

Total Alarms 5820

Critical Care Medicine 38(2):451; February, 2010

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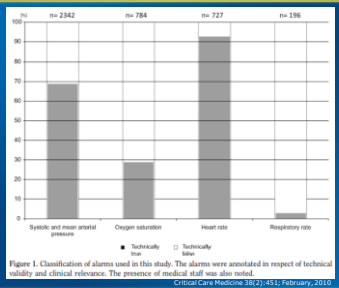

Figure 1. Classification of alarms used in this study. The alarms were annotated in respect of technical validity and clinical relevance. The presence of medical staff was also noted.

Critical Care Medicine 38(2):451; February, 2010

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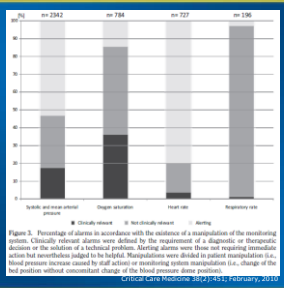

Figure 3. Percentage of alarms in accordance with the existence of a manipulation of the monitoring system. Clinically relevant alarms were defined by the requirement of a diagnostic or therapeutic decision or the solution of a technical problem. Alerting alarms were those not requiring immediate action but nevertheless judged to be helpful. Manipulations were divided in patient manipulation (i.e., blood pressure increase caused by staff action) or monitoring system manipulation (i.e., change of the bed position without concomitant change of the blood pressure dome position).

Critical Care Medicine 38(2):451; February, 2010

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The Problem of Excessive Alarms

Table 1. Alarm Frequency, Duration, and Classification

	No. of alarms (#)	Alarm frequency (#/h)	Alarm duration (s/h)	Effective patient (%)	Effective technical (%)	Ignored (%)	Ineffective (%)
Tidal volume	247	1.24	15.9	7.7	3.6	39.3	49.4
Minute volume	197	0.99	21.0	9.1	7.1	55.8	27.9
Pulse oximeter	188	0.94	36.5	1.1	3.7	32.4	62.8
Infusion pump	147	0.74	42.7	0.0	82.9	17.1	0.0
Heart rate and arrhythmias	134	0.67	14.0	3.7	5.2	50.0	41.0
Blood pressure (arterial and noninvasive)	127	0.64	38.2	7.1	12.6	53.5	26.8
Respiratory rate	75	0.38	10.2	8.0	9.3	37.3	45.3
Peak airway pressure	37	0.19	2.9	13.5	2.7	43.2	40.5
Other	32	0.16	2.3	0.0	18.8	59.4	21.9
Feeding pump	30	0.15	13.7	0.0	90.3	9.7	0.0
Overall	1214	6.07	197.5	5.3	17.8	40.7	36.2

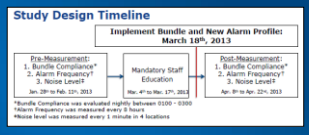
Anesthesia and Analgesia 108(5):1546; May, 2009

Implementation of a Nighttime Noise Reduction Bundle and Modified Alarm Profile to Reduce ICU Noise and Alarms

Hypothesis
Implementing a nighttime noise reduction bundle (NNRB) concurrently with a streamlined patient monitoring alarm profile will reduce Medical Intensive Care Unit (MICU) noise levels and decrease alarm frequency.

Methods
ALARM PROFILE: The new profile was designed with the goal of reducing nuisance alarms by applying more stringent criteria. Proposed changes were presented to and approved by the institutional Critical Care Quality Council before implementation. The final alarm profile was active 24 hours per day.

Study Design Timeline



E. Kate Valcin and Anne Marie Mattingly, MD
Co-investigators JoAnn Eldred, RN, CCRN, Janice Keating, RN, Phyllis Tomeck, RN, CCRN, and Amy Wanck, RN, CCRN

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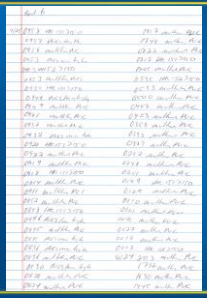


Multiform PVC 38/56 Alarms

HR 151>150 or 152>150 10/56 Alarms

8-1600 Alarm Rates:
- An alarm occurs every 3 minutes
- A red alarm occurs every 10.8 minutes
- A yellow alarm occurs every 4.8 minutes

Strategies for Managing Alarms

What We Need to Do
- Individualize Alarm Parameters
- Optimize Signal Quality
  - ECG electrodes
  - O2 Sat Monitoring
  - BP Cuff Positioning

How We Need to Do It
- Interprofessional Teams
- Measurement
- Human Factors Engineering

AACN Advanced Critical Care 24 (4): 378-386

Alarm Reduction Protocols

Outcome Measures	Pre	Post
Total Number of Alarms	16,953	9,647
Nurse Ratings of Noise Level	4.0	3.5
Nurse Ratings of Noise From Monitor Alarms	3.1	2.97

American Journal of Critical Care, 19(1):28; January, 2010.

Changing an Alarm Profile

Table 2 Heart and respiratory rate alarms for medical-surgical unit population with no severe adverse events. *n* = 317 patients; time = 780·7 days of monitoring (246 days/patient)

Alarm limits	Number of patients with alarms	Percentage of patients with alarms per day	Percentage of patients with alarms per shift	Number of alarms for total time	Number of alarms per patient per day	Number of alarms per patient per shift
HR high						
120	50	6·4	2·1	1023	1·31	0·44
125	34	4·4	1·5	430	0·55	0·18
130	23	2·9	1·0	110	0·14	0·05
135	16	2·0	0·7	53	0·07	0·02
140	12	1·5	0·5	21	0·03	0·01
145	9	1·2	0·4	27	0·03	0·01
150	6	0·8	0·3	7	0·01	0·00
HR low						
35	0	0·0	0·0	0	0·00	0·00
40	9	1·2	0·4	125	0·16	0·05
45	26	3·3	1·1	1789	2·29	0·76
50	75	9·6	3·2	4378	5·61	1·87
55	140	17·9	6·0	10,384	13·30	4·43
60	200	25·6	8·5	23,922	30·64	10·21

Journal of Advanced Nursing 65(9):1844; September, 2009

Changing an Alarm Profile

Reduction in Alarm Frequency

Low SpO_2 Alarm Threshold (%)	Alarm Delay 0 sec	5 sec	10 sec	15 sec
90	Reference	32%	57%	70%
89	27%	51%	69%	79%
88	46%	64%	78%	85%
87	58%	74%	84%	89%
86	68%	80%	87%	91%
85	75%	85%	87%	91%
84	80%	89%	93%	95%
83	84%	91%	95%	97%
82	87%	93%	96%	97%
81	89%	95%	97%	98%
80	90%	96%	97%	98%

Table 1. Percent reduction in alarms at various low SpO_2 alarm thresholds and alarm notification delays, compared to a 90% low SpO_2 threshold at a zero-second delay.

Biomedical Instrumentation & Technology - Spring Supp 45; Spring, 2011

Changing an Alarm Profile

Threshold Alarms:

Alarm Parameter	Current Limit	New Limit
Heart Rate – Low	60	**50**
Heart Rate – High	120	**130**
Mean Arterial Pressure - Low	60	**55**
Mean Arterial Pressure – High	110	110 * default BP parameter
Systolic BP – Low	90 *default BP parameter	**85**
Systolic BP – High	160	**180**
Diastolic BP - Low	50	50
Diastolic BP - High	90	90
SpO2 (yellow alarm)	90% with 5 second delay	**88% with 15 second delay**
Desaturation (red alarm)	85% for 20 seconds	no change

Red Arrhythmia Alarms:

Alarm Parameter	Current Limit	New Limit
Asystole	no activity for > 4 seconds	no change
Ventricular Fibrillation	sinusoidal wave for > 4 seconds	no change
Ventricular Tachycardia	5+ consecutive PVCs at HR > 100	5+ consecutive PVCs at HR > **130**
Extreme Tachycardia	HR > 20 above threshold OR > 240	HR > **50** above threshold OR > 240
Extreme Bradycardia	HR < 20 below threshold OR < 40	HR < 20 below threshold OR < **30**

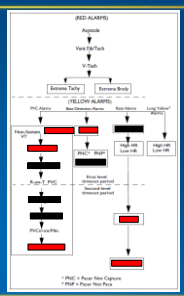
Changing an Alarm Profile

Yellow Arrhythmia Alarms:

Alarm Parameter	Current Limit	New Limit
Non-sustained Ventricular Tachycardia	PVCs at VT rate, but not enough beats for VT alarm	No change (**VT alarm changed**)
Ventricular Rhythm	>14 PVCs not at VT rate	**turn off**
Run of PVCs	>2 consecutive PVCs	**turn off**
Pair of PVCs	already off	no change
R on T PVC	PVC < 1/3 R-R with pause	no change
Ventricular Bigeminy	already off	no change
Ventricular Trigeminy	already off	no change
PVC Rate	>10 PVCs/minute	no change
Multiform PVC	> 2 PVC types recurring	**turn off**
Pause	no activity for >2 seconds	**turn off**
Pacer Not Capturing	no QRS with pacer spikes	no change
Pacer Not Pacing	no QRS or pacer spikes	no change
Missed Beat	already off	no change
SVT	already off	no change
Atrial Fibrillation	irregular with variable PR	**turn off**
Irregular Heart Rate	other irregular rhythm	**turn off**

Miscellaneous:

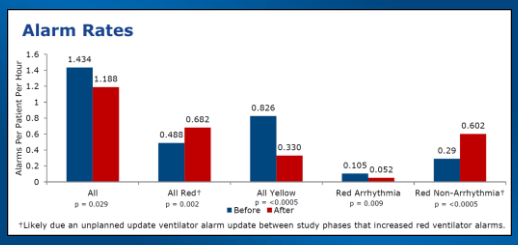
Alarm Parameter	Current Limit	New Limit
2nd Tier Alarm Delay	3 minutes	**15 minutes**
Yellow Alarm Volume	6	**4**
Red Alarm Volume	Yellow + 2 (8)	Yellow + 2 (**6**)



Changing an Alarm Profile

	Hours of Patient Monitoring	Total Alarms	Total Yellow	Total Red	Red Arrhythmia Alarms	Red Non-Arrhythmia Alarms
Pre-Measure	3504.5	5747 17.1/hr Every 3.5 min.	3976 11.83/hr Every 5 min.	1771 5.2/hr Every 11.5 min.	489 1.46/hr Every 41 min.	1282 3.82/hr Every 15.7 min.
Post-Measure	3629.5	4480 13.33/hr Every 4.5 min.	1506 4.82/hr Every 12.44 min.	2974 8.85/hr Every 6.78 min.	322 0.98/hr Every 61.22 min.	2652 7.89/hr Every 7.6 min.

Changing An Alarm Profile



†Likely due an unplanned update ventilator alarm update between study phases that increased red ventilator alarms.

Summary

- The frequency of alarms in ICU's today is putting patients at risk
- Alarm management is a priority set by the Joint Commission
- Analyzing current alarm levels and types is the first step in alarm reduction
- Eliminating false and/or clinically irrelevant alarms reduced alarm burden and improves effectiveness of remaining alarms
- A systematic, interprofessional approach is needed for success
- The issue of alarm management requires on-going monitoring to maintain reductions in alarm levels

A Special Thanks

Critical Care Symposium Committee

Anne Marie Mattingly, MD

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