Attitudes and Practices Related to Clinical Alarms: A Follow-up Survey

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Background Alarm fatigue is a widely acknowledged patient safety concern in hospitals. In 2013, The Joint Commission issued a National Patient Safety Goal on Alarm Management, making addressing alarm management a priority. To capture changes in attitudes and practices related to alarms, the Healthcare Technology Foundation conducted and reported findings from national online surveys in 2006 and 2011 and completed a third survey in 2016.

Objectives The goal of the 2016 survey was to identify how hospital practices and clinicians' perceptions of alarms have changed since 2006.

Methods The online survey was distributed via national health care organizations during a 2-month period. Results of the 2016 survey (N = 1241) were compared with results of the 2006 and 2011 surveys by using χ^2 and Kruskal-Wallis analyses.

Results Responses were significantly different for almost all items across the 3 surveys. Respondents in 2016 were more likely to agree that nuisance alarms occur frequently and disrupt patient care and were less likely to agree that clinical staff responds quickly to alarms. Compared with respondents in 2011, those in 2016 were almost twice as likely to report that their hospitals had experienced adverse events related to alarms in the past 2 years. However, in 2016 a much higher proportion of respondents indicated that their hospitals had implemented alarm improvement initiatives.

Conclusions Although survey findings show disappointing trends in the past 10 years, including worsening perceptions of nuisance alarms and more alarm-related adverse events, the increase in alarm improvement initiatives is encouraging. (*American Journal of Critical Care.* 2018;27:114-123)

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Alarm fatigue" occurs when clinicians become desensitized to the numerous false and nonactionable clinical alarms in health care settings. Alarm fatigue has received increasing attention as a patient safety risk in the past decade and is now considered a high-priority issue for health care organizations.[1,2] For the past 6 years, clinical alarms have been included on the ECRI Institute list of the top 10 health technology hazards. General medical device alarm hazards were listed as the number 1 hazard[3-6] from 2012 to 2015 and the number 2 hazard[7] in 2016. By 2017, only missed ventilator alarms remained on the list,[8] at number 3. The changing status of alarm hazards on the ECRI Institute list may in part reflect evolving perceptions of alarms, including hospitals' acceptance and prioritization of clinical alarms as a patient safety risk.

Prioritization of alarm management by health care organizations is due in large part to The Joint Commission's National Patient Safety Goal (NPSG) on Alarm Management[9] issued in 2013, phase II of which[10] went into effect in January 2016. In accordance with this goal, hospitals are now required to implement alarm management policies and procedures. Most work on interventions to reduce the number of false and nonactionable alarms has been published in the past 5 years, demonstrating increased awareness and effort to address the problem of alarm fatigue in the wake of the NPSG.[11] Most publications have reported on quality improvement initiatives,[12-18] although at least 2 randomized trials have been described.[19,20] These initiatives have included interventions such as changing alarm configurations,[14-18] including widening alarm parameter limits and increasing delay times, as well as educating nurses on customizing alarm parameter settings for individual patients.[12,16] Other interventions for improving alarm management have been proposed, including secondary notification systems (eg, pagers and cell phones),[21] monitor watchers,[22,23] and smart alarm algorithms.[24-27] However, little has been published on these interventions' real-world effectiveness at addressing alarm fatigue.

In 2004 the Healthcare Technology Foundation (HTF) established a clinical alarms improvement program, which includes nationwide surveys of health care personnel's perceptions and practices regarding clinical alarms. To capture the changes and progress that have been made regarding alarm management in the United States, the HTF Clinical Alarms Survey has been distributed every 5 years, beginning in 2005. The first survey was completed in 2006, the second survey was completed in 2011, and the third, in 2016. In a comparison of findings from the 2006 and 2011 surveys, Funk et al[28] found that although no significant differences were apparent in participants' responses to many items, respondents in 2011 were significantly less likely to agree that "nuisance alarms occur frequently" and "disrupt patient care" than were respondents in 2006. Honan et al[29] performed a content analysis of comments from nurse respondents to the 2011 survey, revealing concerns about how alarm fatigue affects patients and nurses and highlighting nurses' unique position in managing alarms.

Alarm fatigue is a high-priority issue for health care organizations.

In 2016, we conducted the survey again, including most of the original questions from 2006 as well as questions introduced on the 2011 survey. The goal of the 2016 survey was to identify how hospital practices and clinicians' perceptions of alarms have changed since 2006, particularly given the recent Joint Commission NPSG. The purposes of this article are to report the findings of the 2016 HTF Clinical Alarms Survey and to compare those findings with findings from the 2006 and 2011 surveys.

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Table 1
Demographic characteristics of 2016 survey participants (N = 1241)

Characteristic	Number	Percentage
Facility type (n = 1238)		
Acute care hospital	1156	93.38
Long-term care/nursing home	38	3.07
Ambulatory care facility or surgery center	17	1.37
Home care	15	1.21
Other	12	0.97
Hospital department (n = 1211)		
Intensive care unit	500	41.29
Respiratory care	315	26.01
Progressive care/telemetry unit	131	10.82
Health care technology management/clinical engineering	53	4.38
Risk/safety management	34	2.81
General care area	26	2.15
Emergency department	24	1.98
Operating room/anesthesia	13	1.07
Support services	6	0.50
Labor/birth	4	0.33
Nursery	3	0.25
Other	102	8.42
Job title (n = 1235)		
Registered nurse[a]	749	60.65
Respiratory therapist	375	30.36
Clinical engineer	34	2.75
Biomedical equipment technician	17	1.38
Physician	12	0.97
Information technology	5	0.40
Nurse's aide or orderly	2	0.16
Paramedical (eg, radiology/ laboratory/pharmacy	1	0.08
Other	40	3.24

[a] Includes advanced practice registered nurses, such as clinical nurse specialists and nurse practitioners.

Table 2
Comparison of demographic characteristics by survey year

Characteristic	Percentage of respondents In 2006 (n = 1327)	In 2011 (n = 4278)	In 2016 (n = 1241)	P[a]
Facility type				<.001[b]
Acute care hospital	93.82	97.07	93.38	
Other	6.18	2.93	6.62	
Hospital department				<.001
Intensive care unit	31.11	57.56	41.29	
Other	68.89	42.44	58.71	
Job title				<.001
Registered nurse[c]	51.81	33.06	60.65	
Other	48.19	66.94	39.35	
Years of experience				<.001
≤11	34.17	23.16	24.63	
>11	65.83	76.84	75.37	

[a] From χ^2 test.
[b] Facility type did not differ significantly between 2006 and 2016 ($P = .65$).
[c] Includes advanced practice registered nurses, such as clinical nurse specialists and nurse practitioners.

Methods

Methods and results from the 2006 and 2011 surveys have been previously reported.[28,30] To develop the 2016 survey, a group of 7 experts revised the 2011 survey to make it more relevant. We added 4 new items to the 2016 survey and removed 12 that were problematic. We eliminated 9 ranked-order items and 3 Likert scale items from the 2011 survey[28] because they did not result in meaningful data in 2011. The eliminated Likert scale items addressed whether alarms do or should have distinct sounds. The institutional review board at Yale University granted an exemption for the 2016 survey (Protocol #1602017246). We made the survey available online via a survey tool (SurveyMonkey) and distributed it through national organizations to a variety of health care personnel. The following organizations provided the survey link in their newsletters and/or on their websites: American Association of Critical-Care Nurses, American Association for Respiratory Care, American College of Clinical Engineering, Association for the Advancement of Medical Instrumentation, California Medical Instrumentation Association, ECRI Institute, Michigan Society for Clinical Engineering, National Association of Clinical Nurse Specialists, 24x7 Magazine, and the US Food and Drug Administration Medical Product Safety Network (MedSun). The survey was open for 2 months in the spring of 2016.

We analyzed the data downloaded from the survey tool by using SAS 9.4 (SAS Institute Inc). We performed χ^2 analyses to compare demographic data from the 2006, 2011, and 2016 surveys. We used Kruskal-Wallis tests to compare response rankings to the fifteen 5-point Likert scale questions that were asked in all 3 survey years. For these questions, we conducted both across-year and pairwise comparisons, and we used false discovery rate[31] adjustment to account for multiple comparisons. We introduced several new questions on the 2011 survey and repeated these on the 2016 survey. These questions had nominal level response options ("no," "yes," "not sure"), and we used χ^2 analyses to determine differences between response proportions.

Results

Demographic characteristics of the 2016 survey participants are in Table 1, and a comparison of participant characteristics across the 3 surveys (2006, 2011, and 2016) is shown in Table 2. There were 1241 respondents to the 2016 survey, the fewest of any of the 3 surveys. The 2006 survey had 1327 respondents and the 2011 survey had 4278 respondents. A larger proportion of respondents in 2016 were nurses (60.65%) than in the previous surveys

(51.81% in 2006 and 33.06% in 2011). The mean (SD) experience of respondents to the 2016 survey was 22.75 (12.49) years. Mean years of experience differed significantly across the 3 surveys ($P<.001$), but in each of the surveys the greatest proportion of respondents had more than 11 years of experience. In 2016, 93.38% of respondents worked in acute care hospitals and 41.29% worked in intensive care units. Although the 3 surveys revealed significantly different facility types, no significant difference was evident between the 2006 and 2016 surveys when 2011 was excluded from the analysis ($P=.65$).

We asked respondents to report their level of agreement with 16 statements about alarms and alarm management (Table 3). Only 3 questions did not show statistically significant differences across the 3 survey years: (1) "The alarms used on my floor/area of the hospital are adequate to alert staff of potential or actual changes in a patient's condition" ($P=.58$), (2) "There have been frequent instances where alarms could not be heard and were missed" ($P=.44$), and (3) "When a number of devices are used with a patient, it can be confusing to determine which device is in alarm condition" ($P=.64$). We indicate survey years that were not significantly different in pairwise comparisons in the rightmost column in Table 3. The 4 questions with nominal response options ("yes," "no," and "not sure") that were first introduced on the 2011 survey are presented in Table 4. All 4 demonstrated significant differences between 2011 and 2016.

Several of the 2016 responses showed a negative trend from the previous survey years, particularly regarding opinions about nuisance alarms and safety. Respondents in 2016 were more likely than those in the previous survey years to feel that nuisance alarms occur frequently and disrupt care. Respondents were less likely to agree that "clinical staff is sensitive to alarms and responds quickly" in 2016 than in 2011 or 2006. In both 2011 and 2016, we asked participants whether their institutions had experienced adverse patient events related to clinical alarm problems in the past 2 years (Table 4). The proportion of participants indicating yes nearly doubled, from 17.94% in 2011 to 30.25% in 2016. Despite these findings, no significant difference across the survey years were found in level of agreement with the statement, "Alarms used on my floor/area of the hospital are adequate to alert staff of potential or actual changes in a patient's condition." About 72% of participants agreed or strongly agreed with this statement in each survey year.

The purpose of several questions in the survey was to assess how alarm management interventions like monitor watchers ("central alarm management staff"), secondary notification systems (eg, pagers and cell phones), and smart alarms (eg, those in which multiple parameters, rate of change of parameters, and signal quality are automatically assessed in their entirety) are used to help manage alarms. In 2011 and 2016, we asked respondents whether their hospitals used monitor watchers to observe monitors and communicate alarm conditions to staff. The proportion of respondents indicating use of monitor watchers changed slightly between 2011 and 2016. Respondents' perceptions of monitor watcher helpfulness did not differ significantly between 2011 and 2016. Compared with the previous 2 surveys, fewer respondents in 2016 thought that secondary notification systems were useful or that smart alarms would be effective for improving alarm response.

A group of 7 experts revised the 2011 survey to make it more relevant.

We asked 4 questions regarding institutional alarm management initiatives, policies, and procedures. In 2006 and 2011, more respondents thought that alarm management policies and procedures were used effectively than in 2016. In 2011 and 2016 (Table 4), we also asked whether institutions had developed clinical alarm improvement initiatives in the past 2 years, and we saw a large increase in the proportion of respondents replying yes in 2016 (62.41% in 2016 vs 21.09% in 2011). In 2011 and 2016, we also asked whether institutions had implemented new technological solutions to improve clinical alarm safety. In the 2016 survey, 42.03% responded yes, whereas only 18.89% responded yes in 2011. We also asked whether institutions required staff to document that alarms were set appropriately for the patient. For clarity, in 2016 we changed the response format from a 5-point Likert scale to 3 response options: "yes," "no," and "not sure." In the 2016 survey, 67.91% indicated that their institutions required this documentation. This percentage is slightly lower than the proportion of participants who agreed or strongly agreed with the same statement in 2006 (75.77%) and 2011 (71.06%).

The 2016 survey had a higher proportion of nurses responding than prior surveys did.

We introduced 4 new questions on the 2016 survey, 3 of which are displayed in the Figure. First, 37.33% of respondents indicated that their institutions used secondary notification systems to communicate alarm conditions, and 19.12% of respondents said that they used systems that employ smart alarms.

Table 3
Opinions about alarms

Item	Percentage of respondents			Median (interquartile range)[a]				Pairs not significantly different
	In 2006	In 2011	In 2016	In 2006	In 2011	In 2016	P[b]	
Nuisance alarms occur frequently.				2 (1-2)	2 (1-2)	2 (1-2)	<.001	
Strongly agree	39.03	30.84	44.63					
Agree	41.91	44.69	42.62					
Neutral	12.13	15.16	7.10					
Disagree	6.35	9.00	5.33					
Strongly disagree	0.58	0.32	0.32					
Nuisance alarms disrupt patient care.				2 (1-2)	2 (1-3)	2 (1-2)	<.001	
Strongly agree	38.04	28.75	37.93					
Agree	39.46	42.62	47.86					
Neutral	13.85	16.75	10.01					
Disagree	7.56	11.03	3.87					
Strongly disagree	1.09	0.85	0.32					
Nuisance alarms reduce trust in alarms and cause caregivers to inappropriately turn alarms off at times other than setup or procedural events.				2 (1-2)	2 (1-2)	2 (1-2)	.002	2006/2011 2006/2016
Strongly agree	42.13	38.37	42.25					
Agree	35.70	39.05	40.31					
Neutral	9.32	10.04	8.16					
Disagree	11.13	10.62	8.16					
Strongly disagree	1.73	1.91	1.13					
Properly setting alarm parameters and alerts is overly complex in existing devices.				3 (2-4)	4 (3-4)	4 (2-4)	<.001	2006/2016
Strongly agree	6.81	4.51	7.02					
Agree	21.01	15.99	21.31					
Neutral	23.17	22.62	18.16					
Disagree	42.69	48.69	44.71					
Strongly disagree	6.31	8.18	8.80					
Newer monitoring systems (eg, <3 years old) have solved most of the previous problems we experienced with clinical alarms.				3 (2-4)	3 (2-3)	3 (3-4)	<.001	2006/2011
Strongly agree	3.57	3.39	2.28					
Agree	27.14	25.80	15.13					
Neutral	39.25	45.86	46.22					
Disagree	24.15	21.64	30.51					
Strongly disagree	5.89	3.31	5.86					
The alarms used on my floor/area of the hospital are adequate to alert staff of potential or actual changes in a patient's condition.				2 (2-3)	2 (2-3)	2 (2-3)	.58	2006/2011 2006/2016 2011/2016
Strongly agree	18.87	17.24	16.41					
Agree	53.39	54.95	55.48					
Neutral	14.90	14.38	13.97					
Disagree	10.43	11.61	11.70					
Strongly disagree	2.40	1.81	2.44					
There have been frequent instances where alarms could not be heard and were missed.				4 (2-4)	4 (2-4)	4 (2-4)	.44	2006/2011 2006/2016 2011/2016
Strongly agree	5.74	5.43	7.91					
Agree	23.65	23.71	25.91					
Neutral	17.22	17.15	14.04					
Disagree	46.43	44.19	39.87					
Strongly disagree	6.96	9.53	12.27					
Clinical staff is sensitive to alarms and responds quickly.				2 (2-3)	2 (2-3)	3 (2-4)	.001	2006/2011
Strongly agree	13.58	13.14	8.57					
Agree	49.35	52.86	39.85					
Neutral	18.28	18.09	23.77					
Disagree	16.54	13.88	23.28					
Strongly disagree	2.26	2.03	4.53					

Continued

Table 3
Continued

Item	Percentage of respondents			Median (interquartile range)[a]			P^b	Pairs not significantly different
	In 2006	In 2011	In 2016	In 2006	In 2011	In 2016		
When a number of devices are used with a patient, it can be confusing to determine which device is in an alarm condition.				2 (2-4)	2 (2-4)	2 (2-4)	.64	2006/2011 2006/2016 2011/2016
Strongly agree	10.32	9.17	11.56					
Agree	41.02	41.29	40.91					
Neutral	14.14	14.35	10.27					
Disagree	32.52	32.00	32.26					
Strongly disagree	1.99	3.19	5.01					
Environmental background noise has interfered with alarm recognition.				3 (2-4)	3 (2-4)	2 (2-4)	<.001	2006/2011
Strongly agree	7.73	7.32	10.36					
Agree	35.45	35.09	40.78					
Neutral	16.59	15.51	13.43					
Disagree	37.01	38.05	31.88					
Strongly disagree	3.21	4.03	3.56					
Central alarm management staff responsible for receiving alarm messages and alerting appropriate staff is helpful.				3 (2-3)	2 (2-3)	2 (2-3)	<.001	2011/2016
Strongly agree	12.15	15.14	18.74					
Agree	37.15	37.53	34.58					
Neutral	33.74	36.07	38.14					
Disagree	13.11	8.95	6.72					
Strongly disagree	3.85	2.31	1.82					
Alarm integration and communicationsystems via pagers, cell phones, and other wireless devices are useful for improving alarms management and response.				2 (2-3)	2 (2-3)	3 (2-3)	<.001	2006/2011
Strongly agree	14.40	17.30	12.73					
Agree	40.40	38.33	34.86					
Neutral	29.84	30.88	37.14					
Disagree	12.65	10.94	12.00					
Strongly disagree	2.71	2.56	3.27					
Smart alarms (eg, where multiple parameters, rate of change of parameters, and signal quality are automatically assessed in their entirety) would be effective to use for reducing false alarms.				2 (2-2)	2 (2-2)	2 (2-3)	<.001	2006/2011
Strongly agree	21.17	22.05	17.13					
Agree	59.23	55.79	47.78					
Neutral	17.06	19.05	32.21					
Disagree	2.27	2.77	2.55					
Strongly disagree	0.26	0.34	0.33					
Smart alarms (eg, where multiple parameters, rate of change of parameters, and signal quality are automatically assessed in their entirety) would be effective to use for improving clinical response to important patient alarms.				2 (2-2)	2 (2-2)	2 (2-3)	<.001	2006/2011
Strongly agree	21.40	23.10	17.02					
Agree	59.39	54.69	51.64					
Neutral	16.40	18.85	29.11					
Disagree	2.46	2.93	1.81					
Strongly disagree	0.35	0.42	0.41					
Clinical policies and procedures regarding alarm management are effectively used in my facility.				2 (2-3)	2 (2-3)	2 (2-3)	<.001	
Strongly agree	14.00	10.66	10.94					
Agree	51.53	44.57	39.38					
Neutral	19.77	26.96	25.85					
Disagree	12.16	14.98	19.37					
Strongly disagree	2.54	2.84	4.46					

Continued

Table 3
Continued

Item	Percentage of respondents			Median (interquartile range)[a]				Pairs not significantly different
	In 2006	In 2011	In 2016	In 2006	In 2011	In 2016	P^b	
There is a requirement in your institution to document that the alarms are set and are appropriate for each patient.[c]			Yes: 67.91					
Strongly agree	33.94	29.70	No: 25.51					
Agree	41.83	41.36						
Neutral	12.52	14.38	Not sure: 6.58					
Disagree	9.98	11.68						
Strongly disagree	1.72	2.88						

[a] Score: 1, strongly agree; 2, agree; 3, neutral; 4, disagree; 5, strongly disagree.
[b] *P* value is for Kruskal-Wallis test with false discovery rate adjustment.
[c] Response options were changed to "Yes," "No," and "Not sure" on the 2016 survey.

Table 4
Questions included on the 2011 and 2016 surveys

Item	Percentage of respondents		P^a
	In 2011	In 2016	
Does your institution use "monitor watchers" in a central viewing area to observe and communicate alarm conditions to caregivers?			.01
Yes	46.77	47.8	
No	44.50	46.17	
Not sure	8.73	6.03	
Has your institution developed clinical alarm improvement initiatives over the past 2 years (eg, policies and procedures, education, special projects, new technology)?			<.001
Yes	21.09	62.41	
No	31.42	20.91	
Not sure	47.50	16.68	
Has your institution instituted new technological solutions to improve clinical alarm safety?			<.001
Yes	18.89	42.03	
No	35.39	38.86	
Not sure	45.72	19.11	
Has your institution experienced adverse patient events in the last 2 years related to clinical alarm problems?			<.001
Yes	17.94	30.25	
No	33.05	29.28	
Not sure	49.01	40.47	

[a] From χ^2 test.

Most respondents (86.01%) indicated that they had been educated on the purpose and operation of alarm systems. Finally, we asked participants whether they believed that The Joint Commission's NPSG on Alarm Management (effective 2014) had reduced adverse patient events. Although most respondents were neutral (55.21%), 32.25% agreed or strongly agreed with this statement, and only 12.54% disagreed or strongly disagreed.

Discussion

Overall, results of the 2016 HTF Clinical Alarms Survey suggest that few improvements in perceptions of clinical alarm safety and management occurred in the past 10 years, and several positive trends noted between the 2006 and 2011 surveys were reversed on the 2016 survey. The results also indicate that health care organizations are most likely increasing initiatives to address alarms. We generally found statistically significant differences across the 3 surveys. In addition to large sample sizes, another explanation for the significant differences may be variation in facility type, hospital department, profession, and years of experience of participants across the 3 survey years. For example, the 2011 survey had a smaller proportion of nurse respondents than the other surveys. Nurses most likely have more exposure to alarms than other participants do, which many have influenced their responses. Future analyses of the data from these surveys could provide additional insight and may include analysis of responses by profession (eg, nurse, respiratory therapist) or years of experience.

From 2006 to 2016, we noted a concerning increase in agreement with statements about the high frequency of nuisance alarms and inappropriate silencing of alarms, and a decrease in agreement that clinical staff are sensitive to alarms. Most concerning was the near doubling of respondents indicating that their institutions had experienced an adverse patient event related to clinical alarms. Some of these trends may reflect an increased awareness of alarm fatigue and an environment where increased reporting is encouraged, rather than a true increase in the prevalence, disruptiveness, and risk of alarms. The increased awareness may be attributed to The

Joint Commission's NPSG[9,10] and the subsequent efforts by health care organizations to address alarms. In 2016, a proportion of respondents much higher than in 2011 indicated that their institutions had new clinical alarm management initiatives and/or instituted new alarm management technology. In 2011, many respondents were not sure about initiatives or new technologies, whereas a larger proportion responded yes to this question in 2016. However, these findings may also indicate that alarm management initiatives and technologies have been largely unsuccessful in reducing alarms and addressing alarm fatigue.

In 2016, we asked respondents about their hospitals' use of interventions such as secondary notification systems, monitor watchers, and smart alarms to help with clinical alarm management. The use of monitor watchers was the most frequently reported intervention. In the present survey, about 48% reported using monitor watchers, whereas in a recent national survey focused on monitor watcher practice, about 60% of respondents reported that their hospitals used monitor watchers.[22] Given that the national monitor watcher survey most likely attracted participants who worked with monitor watchers, the present survey may be a more accurate reflection of the use of monitor watchers.

More research is needed to determine the effectiveness, cost, and implementation challenges for interventions such as secondary notification systems, monitor watchers, and smart alarm technology. Not only are these interventions costly and complex, but they can also result in increased interruptions and missed true alarms if not designed or implemented properly. The No. 4 hazard on the ECRI Institute's list of top 10 technology hazards for 2018 is "missed alarms may result from inappropriately configured secondary notification devices and systems."[32] Monitor watchers and secondary notification systems can result in redundant interruptions by creating additional notifications for the same event. Researchers in one study [33] also found that monitor watchers missed about 18% of cases in which an arrhythmia alarm occurred in the hour before activation of the rapid response team. If nursing staff become overreliant on monitor watchers to alert them to serious patient events or if monitor watchers are tasked with intercepting alarms before they reach the nurse,[34] inappropriate action by the monitor watchers could have serious consequences.

When implementing secondary notification systems, a delay may be added to eliminate alarms that quickly self-correct.[21] However, implementing an inappropriately long delay could result in slower responses to important alarms and subsequent adverse outcomes for patients. Smart alarm algorithms use more than 1 parameter to assess changes in the patient's status and determine whether to suppress or accept the potential alarm condition. In several studies using existing databases, false asystole alarm suppression rates of 86% to 94% have been achieved with no suppression of true alarms.[24,25] Further improvements in the design of alarm circuitry and in smart alarm algorithms must be validated in real-world clinical settings. However, almost 20% of respondents to the 2016 survey indicated that their institutions used smart alarm systems.

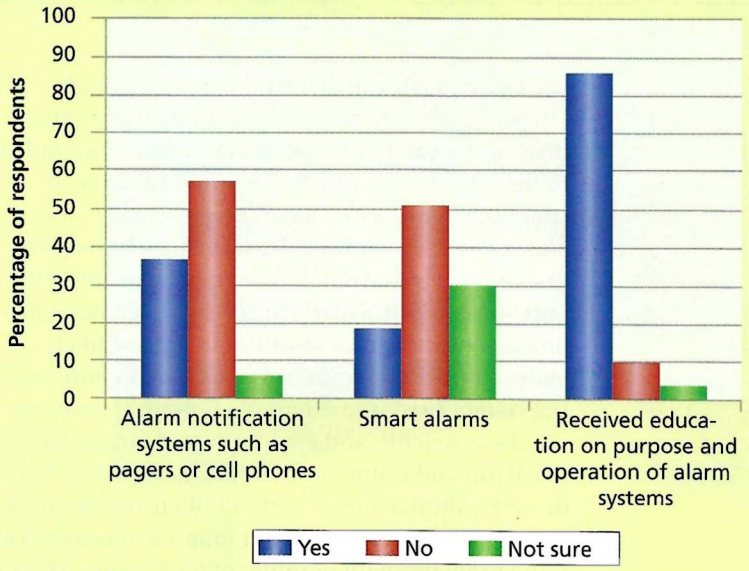

Figure New questions included on the 2016 survey.

Several factors limit this survey. The number of respondents to the survey declined between 2011 and 2016, and we suspect that this decrease may be related to some level of "survey fatigue." With the advent of online survey services (eg, SurveyMonkey), surveys are easy to develop and disseminate. Busy professionals are inundated with online surveys on a multitude of topics and have limited time to devote to their completion. Moreover, the issue of alarm fatigue has received such intense attention in recent years that clinicians may have felt less interested in engaging in a survey on this topic. Also, participants were probably those most interested in the topic of alarms and alarm fatigue, which may have influenced responses.

> Results may have been influenced by increasing awareness of alarm fatigue.

Nurses were the largest proportion of respondents to the 2016 survey, and they most likely

engage with clinical alarms the most regularly. However, a larger proportion of respiratory therapists and a smaller proportion of nurses responded to the 2011 survey, which may limit the value of comparing data across these surveys. Finally, although the survey provides some insight into the general trends in clinical alarm management in the past 10 years, particularly in acute care settings, variation among individual institutions is most likely wide, depending on variables such as the monitoring system used, the extent of clinician training to use these systems, and environmental factors affecting alarm audibility. For example, Sowan et al[35] conducted a similar survey with 39 intensive care unit nurses at their institution and found that nurses had more problems with usability of monitoring systems than was demonstrated in the national HTF surveys on clinical alarms. We are unable to determine how many unique institutions were represented in our sample, and multiple individuals from the same institution may have responded.

Conclusion

The 2016 HTF Clinical Alarms Survey provides new insights into progress made toward improving clinical alarm management. Although the results suggest little improvement since 2006, we suspect that the results have been influenced by participants' increased awareness of the issue of alarm fatigue. In 2016, a higher proportion of respondents indicated that their institutions have clinical alarm initiatives and/or alarm management technologies, but a higher proportion also reported that "nuisance alarms occur frequently," "disrupt patient care," and "reduce trust in alarms." A higher proportion of respondents also noted adverse patient events in the past 2 years.

About half of respondents indicated that their hospitals currently use monitor watchers, whereas fewer respondents said that their institutions are using interventions such as secondary notification systems and smart alarms. Additional research is required to determine the safety and effectiveness of these interventions. The results of this survey suggest that we still have a long way to go toward the widespread use of effective interventions for alarm management. Perhaps a similar survey 5 years from now would reveal progress in addressing false and nonactionable alarms and their patient safety consequences.

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FINANCIAL DISCLOSURES

None reported.

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Correction

In the January 2018 article by Ruppel et al, "Measurement of Physiological Monitor Alarm Accuracy and Clinical Relevance in Intensive Care Units," *Am J Crit Care,* 2018;27(1):11-21, on page 14, the first line in the Proportions of Inaccurate and Clinically Irrelevant Alarms section should have read, "Overall, most studies indicated consistently low proportions of patient alarms that were clinically relevant (5%-13%).[5,26]" We regret the error.

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