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# Utility of Failure Mode and Effect Analysis to Improve Safety in Suctioning by Orotracheal Tube.

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ORIGINAL ARTICLE

# Utility of Failure Mode and Effect Analysis to Improve Safety in Suctioning by Orotracheal Tube

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**Objective:** *The objective of the study was to use the Failure Mode and Effect Analysis (FMEA) tool to analyze the technique of secretion suctioning on patients with an endotracheal tube who were admitted into an intensive care unit.*

**Materials and Methods:** *Brainstorming was carried out within the service to determine the potential errors most frequent in the process. After this, the FMEA was applied, including its stages, prioritizing risk in accordance with the risk prioritization number (RPN), selecting improvement actions in which they have an RPN of more than 300.*

**Results:** *We obtained 32 failure modes, of which 13 surpassed an RPN of 300. After our result, 21 improvement actions were proposed for those failure modes with RPN scores above 300.*

**Conclusions:** *FMEA allows us to ascertain possible failures so as to later propose improvement actions for those which have an RPN of more than 300.*

**Keywords:** *patient safety, FMEA, orotracheal suctioning, ETT, improvement actions, RPN.*



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**PATIENT SAFETY HAS** taken on a strategic value in health care organizations. Improvement of patient safety by using numerous resources may decrease errors and adverse events during hospital stays. Owing to the fact that "error" is an intrinsic characteristic of human beings and processes, the consequences of errors must be minimized. An error may cause anything from an incident of little importance to a patient's death.

Poorly designed or executed processes may lead to increased risk to patient safety. An improvement in patient health and patient safety is the most important objective of quality in health care. A significant interest in this topic has developed over the last century. Various international[1] and national[2,3] publications took on the task of increasing awareness about its importance in the health care world. Safety has become a fundamental objective for our society. Different tools which are used, such as the Failure Mode and Effect

Analysis (FMEA) tool, are applied to critical patient care in this report.

The objective of FMEA is to identify and prioritize any problems which may arise in a process even before such problems can arise. It consists of determining each of the possible failures to evaluate how serious their effects are and how often the causes which lead them to occur, establishing a prioritization of the actions to be performed to improve their design. Acquired from the US aerospace industry and applied to many fields in the industrial world, it has gradually been implemented in the world of health care.[4]

Critical patients constitute a safety challenge. Their status makes them more vulnerable to any error and its consequences. In Intensive Care Medicine, FMEA may be useful, although there are not many prior studies in the field of critical patients.[5] Critical patients may be sedated with a decrease in reflexes and are subject to very aggressive therapeutic treatments. There is interaction with a great deal of devices, and the patient is alone and suffers a prolonged time of being bedridden.[6] To this vulnerability we add error as a characteristic of human nature, which is accentuated by such an aggressive environment as an intensive care unit (ICU). Stress, working conditions, high complexity of tasks, and time constraints in providing care are the factors which promote the occurrence of errors among ICU staff members.

The health care system makes huge efforts to guarantee safety, although adverse events continue to arise. One "adverse event" is nondeliberate injury caused by actions/treatments performed in the health care system which results in measurable disability.[2,3] Symptoms of this would be "damaging effect to health," "adverse consequences," and "negative impact." The adverse events prolonged the hospitalization, produced a disability at the time of discharge, or both.[7] They may be preventable or nonpreventable, those which are preventable being those of most interest to us because they may be avoided.

FMEA makes it possible to prioritize potential failures in accordance with risk, probability of occurrence, and the likelihood of detection and can result in corrective actions to eliminate or reduce the probability that they will occur. FMEA allows for the identification of the weakest parts of the processes being studied. Because it is preventive, the error need not occur to be studied. FMEA can improve health care quality, and it identifies and eliminates procedural failures in advance, prioritizing any deficiencies, strengthening problem prevention, providing an orientation toward the improvement of controls and development while decreasing costs and promoting work in a multidisciplinary team. FMEA, with demonstrated benefits in other fields, may decrease such errors, and when they are not prevented, it can minimize their consequences. If the error is inevitable, FMEA may be a solution.

Periodic suctioning of secretions is essential when patients are intubated with an endotracheal tube (ETT ) to avoid bronchial aspirations and infections and to improve ventilation and oxygenation. Suctioning intubated patients requires very careful monitoring.

## Hypothesis

Proposals for improving patient safety in the ICU are possible during the process of suctioning secretions by ETT with the help of FMEA by analyzing potential risks and proposing improvement actions in a systematic manner.

## Objective and Aims

The overall objective is to use FMEA to detect possible failures in the selected process. The specific aims are as follows:

1. To identify which points in the critical patient care process may fail (failure modes) and specify for each of them the means and procedures for detection.
2. To carry out the quantitative evaluation of each failure mode.
3. To recommend actions which reduce the likelihood of failures in critical patient care processes for those failures which have an RPN of more than 300. The chosen RPN is superior to 300 because of the complexity of the critical patient.

## Materials and Methods

The FMEA tool was used in the ICU of the Hospital General Universitario Gregorio Marañón (HGUGM; Madrid, Spain).

In the next sections, FMEA stages followed for its design were discussed.

### *Team Selection*

The team is made up of personnel from the ICU of HGUGM. Doctor and nurses compose this team.

### *Process Analysis*

The stages of the process are shown in Table 1.

### *Risk Evaluation*

"Brainstorming" was carried out with the team. The potential failures and effects which could arise throughout the process were listed and agreed on, and then they were given a numerical value: the RPN.

Included among the collected data were the following:

- Problems with devices.
- Frequency and length of activity (suctioning).
- Risk of suction and ventilator-associated pneumonia.
- Problems with the ETT.
- Not following aseptic techniques.
- Increased intracranial pressure or hemodynamic instability.
- New onset atelectasis.

We eliminated those not related to patient safety, and for those remaining we asked the following questions:

- Failure: What might go wrong?
- Failure modes: How can it fail?
- Causes: Why can it fail?
- Effects: What consequences may the failure have?
- Severity: What repercussion can this failure have on patients?
- Frequency: How often is the failure likely to occur?
- Likelihood of detection: What is the probability that the failure will be detected?

Severity, probability, and likelihood of detection will indicate the RPN, which we can use to prioritize improvement actions. Each parameter is scored from 1 to 10, and then they are multiplied by each other.

The "severity" may be quantified as follows:

- Low (1 to 2): No consequences; does not cause injury to the patient or increase the hospital stay; does not require increased monitoring.
- Moderate (3 to 4): Increases the hospital stay or requires greater surveillance for a limited amount of time.
- High (5 to 8): Produces injury or permanent loss of some function; may require some extra treatment; increases the hospital stay, or requires an increase in care due to hemodynamic instability.
- Catastrophic (9 to 10): The patient's life is put at risk (cardiorespiratory arrest, death or major loss of a physical motor, or mental function by the patient).

The "frequency" (probability that the error will occur) may be quantified as follows:

- Very low (1 to 2): It is unlike to occur; no occurrence is known.
- Not very frequent (3 to 4): Its occurrence is possible; at least one case has occurred in the last 5 years.
- Occasional (5 to 8): Probable occurrence; several cases have occurred in the last 2 years.
- Very Frequent (9 to 10): Probable that it will occur immediately; several cases have occurred in recent years.

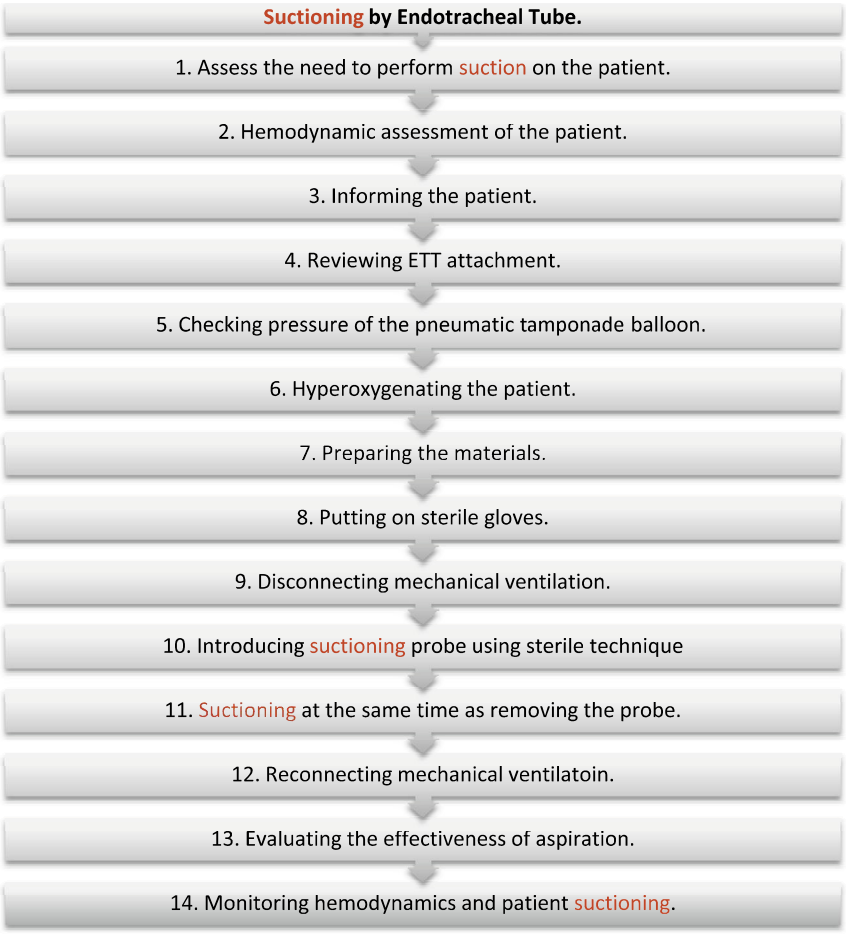
The likelihood of detection[8] (our ability to identify the error in advance, so as to avoid its consequences before they are aggravated) may be quantified as follows:

- High (1 to 4): Error detected immediately always.
- Occasional (5 to 6): Error detected early always.
- Moderate (7 to 8): Error almost always not detected early.
- Low or none (9 to 10): Error is always undetectable.

### *Completion of the FMEA Tables*

Once all the above data were analyzed, the FMEA tables were produced (Table 2) and are included in the results.

**Table 1. Stages in the Process of Suctioning by ETT[10-13]**




ETT, endotracheal tube.

## Results

Once the tables were completed[9] (Table 2), 36 failure modes were included, and we describe the improvement actions proposed for those subprocesses with RPN values of more than 300. The chosen RPN is superior to 300 because of the complexity of the critical patient. These improvement actions will modify the process and add barriers which are useful for preventing the detected risks.

The RPN values range from 648 to 24; 13 were greater than 300, amounting to 36.1% of the total. After reaching our result, 22 improvement actions have been recommended (Table 3).

## Discussion

The results of this study cannot be related to other similar studies. Although FMEA has been applied to other fields of medicine, it had never been applied to the process studied by our group, and therefore, it is a pioneer in the field of critical patient safety.

We found a range of indices from 24 to 648. The highest RPN in our study was "648," a very surprising figure. That number corresponds to "improper evaluation prior to performing the technique." In our working environment, ETT suctioning is frequently performed without proper prior evaluation. The cause usually lies in that it is performed

**Table 2. Failure Mode and Effect Analysis**

| Process | Suctioning by Endotracheal Tube | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Score | | | | | | | | |
| Team | Severity (G) | | Frequency (F) | | Likelihood of Detection (D) | | | | |
| | Catastrophic | 9–10 | Very frequent | 9–10 | Little or none | 9–10 | | | |
| | High | 5–8 | Occasional | 5–8 | Moderate | 7–8 | | | |
| | Moderate | 3–4 | Not very frequent | 3–4 | Occasional | 5–6 | | | |
| | Low | 1–2 | Very low | 1–2 | High | 1–4 | | | |
| **Steps in Process** | **Possible Failures** | | **Possible Causes** | | **Possible Consequences** | **G** | **F** | **D** | **RPN** |
| Evaluating need for suctioning. | Not evaluating. | | Rushing; lack of experience; lack of care; excess work load; not enough personnel. | | ETT obstruction; excessive secretions. PAMV; risk to life; excessive/too few suctionings; atelectasis. | 9 | 6 | 8 | **432** |
| | Inaccurate evaluation. | | Rushing; lack of experience; lack of care; excess work load; lack of knowledge; nonauscultation. | | ETT obstruction. VAP; risk to life; atelectasis; excessive/too few suctionings. | 9 | 9 | 8 | **648** |
| HD evaluation. | Not evaluating. | | Lack of knowledge; rushing; excess work load; not enough personnel; lack of care; oversight; habit; monitor turned off. | | HD alterations; risk to life. | 9 | 8 | 6 | **432** |
| | Inadequate evaluation. | | Lack of knowledge; lack of experience; lack of care; monitor not configured, broken, with no alarms or inadequate alarms. | | HD alterations; risk to life. | 9 | 6 | 6 | **324** |
| Informing the patient. | Inadequate information. | | Rushing; lack of care; lack of knowledge; Patient's cognitive alteration. | | Pain; HD alterations; pulmonary injuries. | 8 | 6 | 6 | 288 |
| | Not informing. | | Patient sedated; lack of knowledge; lack of care; oversight; habit. | | Pain; HD alterations; pulmonary injuries. | 8 | 8 | 8 | **512** |
| Checking ETT and ventilation systems. | Not checking. | | Rushing; lack of knowledge; lack of experience; not following protocol; lack of care. | | Extubation; risk to life; hypoxia; hypoxemia; atelectasis. | 9 | 6 | 6 | **324** |
| | Erroneous check. | | Rushing; lack of care; lack of experience; not following protocol; lack of knowledge. | | extubation; risk to life; hypoxia; hypoxemia; atelectasis. | 9 | 6 | 6 | **324** |
| Hyperoxygenating the patient. | Not doing this. | | Rushing; lack of care; lack of knowledge; failure in respirator or BVM; lack of experience. | | Hypoxia; HD alterations. | 8 | 8 | 4 | 256 |
| | Doing so excessively. | | Lack of knowledge; forgot to do so; lack of care; urgency; ventilator failure; lack of experience. | | HD alterations and/or of acid-base equilibrium. | 4 | 7 | 8 | 224 |

*(Continued)*

**Table 2. Continued**

| Process | Suctioning by Endotracheal Tube | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Score | | | | | | | | |
| Team | Severity (G) | | Frequency (F) | | Likelihood of Detection (D) | | | | |
| | Catastrophic | 9–10 | Very frequent | 9–10 | Little or none | 9–10 | | | |
| | High | 5–8 | Occasional | 5–8 | Moderate | 7–8 | | | |
| | Moderate | 3–4 | Not very frequent | 3–4 | Occasional | 5–6 | | | |
| | Low | 1–2 | Very low | 1–2 | High | 1–4 | | | |
| **Steps in Process** | **Possible Failures** | | **Possible Causes** | | **Possible Consequences** | **G** | **F** | **D** | **RPN** |
| Preparing materials. | Not prepared. | | Rushing; lack of experience; lack of care; forgot to do so; broken materials; out of stock. | | Poor technique; ineffective technique; desaturation; VAP; HD alterations. | 8 | 6 | 4 | 192 |
| | Materials lacking. | | Rushing; not replaced; lack of experience; lack of care; carelessness. | | Poor technique; HD alterations; VAP | 8 | 6 | 4 | 192 |
| | Inadequate materials. | | Probes missing; not replaced; out of stock; lack of care; lack of knowledge; carelessness. | | Poor technique; HD alterations; VAP; atelectasis; infections. | 8 | 6 | 4 | 192 |
| Aseptic technique with sterile gloves. | Without sterile gloves. | | Lack of knowledge; habit; not following protocol; rushing; urgent suctioning; gloves missing. | | VAP; HD alterations. | 8 | 8 | 8 | **512** |
| | Improper technique. | | Putting gloves on wrong; not washing hands; inadequate hand washing; urgency; not following the protocol. | | VAP; HD alterations. | 8 | 9 | 8 | **576** |
| Disconnecting MV. | Too much time. | | Lack of knowledge; lack of experience; alarms turned off; mechanical error; lack of care; urgency. | | Hypoxia/hypoxemia; desaturation; HD alterations; risk to life. | 9 | 5 | 1 | 45 |
| Introducing the probe. | Excessive time. | | Lack of knowledge; lack of care; excessive secretions; lack of experience; clogged probe. | | Atelectasis; VAP; HD alterations; bronchial spasm; hypoxia; risk to life. | 9 | 8 | 6 | **432** |
| | Ineffective technique. | | Suctioning with low pressure; problems with the system; lack of care; lack of experience; lack of knowledge; inadequate probe. | | Accumulation of secretions; VAP; HD alterations; increase of pressures in air passage. | 8 | 8 | 4 | 256 |
| | Improper probe caliber. | | Lack of knowledge; lack of proper probes; lack of care; rushing; out of stock. | | Ineffective aspiration; atelectasis; hypoxia; HD alterations; risk to life. | 9 | 6 | 4 | 216 |
| | Introducing probe while performing suctioning. | | Lack of knowledge; rushing; lack of experience; oversight. | | Atelectasis; hypoxia; HD alterations. | 8 | 8 | 6 | **384** |
| | Excessive suctioning. | | Lack of knowledge; lack of experience; bad habits. | | VAP; HD alterations. | 8 | 8 | 8 | **512** |
| | Extubation. | | Malpractice; not verifying TOT attachment; probe clogging. | | Risk to life. | 9 | 6 | 4 | 216 |

*(Continued)*

**Table 2. Continued**

| Process | Suctioning by Endotracheal Tube | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Score | | | | | | | | |
| Team | Severity (G) | | Frequency (F) | | Likelihood of Detection (D) | | | | |
| | Catastrophic | 9–10 | Very frequent | 9–10 | Little or none | 9–10 | | | |
| | High | 5–8 | Occasional | 5–8 | Moderate | 7–8 | | | |
| | Moderate | 3–4 | Not very frequent | 3–4 | Occasional | 5–6 | | | |
| | Low | 1–2 | Very low | 1–2 | High | 1–4 | | | |
| **Steps in Process** | **Possible Failures** | | **Possible Causes** | | **Possible Consequences** | | **G** | **F** | **D** | **RPN** |
| | Lack of aseptic technique. | | Poor technique; lack of experience; lack of skill; rushing; reused or contaminated probe. | | VAP. | | 8 | 8 | 8 | **512** |
| | Clogged probe. | | Thick secretions; improper or not lubricated probe; excess pressure. | | HD alterations; bronchial spasm; atelectasis; extubation; nonaspiration. | | 8 | 8 | 1 | 64 |
| | ETT mobilization. | | ETT poorly attached; pneumatic tamponade loose; rushing. | | HD alterations; Extubation; Atelectasis. | | 8 | 6 | 6 | 288 |
| Suctioning during removal. | Does not perform suctioning. | | Probe obstructed, pinched or leaking; vacuum cleaner broken; poor technique. | | Nonsuction; accumulation of secretions; VAP. | | 4 | 6 | 1 | 24 |
| | Probe clogged. | | Thick secretions; Improperly lubricated or nonlubricated probe; excess pressure. | | HD alterations; bronchial spasm; atelectasis; nonaspiration; extubation. | | 8 | 8 | 1 | 64 |
| | ETT mobilization. | | ETT poorly attached; pneumatic tamponade loose; clogged probe; poor technique; lack of experience; rushing. | | HD alterations; atelectasis; extubation. | | 8 | 6 | 4 | 192 |
| | Excessive time. | | Lack of care; oversight; lack of knowledge; inactive alarms. | | HD alterations; atelectasis. | | 8 | 6 | 4 | 192 |
| Reconnecting MV. | No reconnection. | | Rushing; inoperative alarm; oversight; urgency of other patient. | | HD alterations; risk to life. | | 9 | 4 | 4 | 144 |
| | Poor reconnection. | | Rushing; oversight; lack of experience; lack of skill; MV broken; no alarms. | | Hypoxia/hypoxemia; HD alteration; risk to life. | | 9 | 4 | 5 | 180 |
| Evaluation of effectiveness. | No evaluation. | | Rushing; lack of care; lack of experience; oversight; excess work load. | | Not knowing of effectiveness; accumulating secretions; excessive suctioning. | | 4 | 6 | 6 | 144 |
| | Inadequate evaluation. | | Lack of experience; poor monitoring; rushing; lack of care; lack of knowledge. | | Excess of/defect in suctions. | | 4 | 6 | 6 | 144 |

Bold indicates values that are above 300 indicating higher risk due to complexity of the critical patient.

RPN, risk prioritization number; ETT, endotracheal tube; VAP, ventilator-associated pneumonia; HD, hemodynamic; BVM, bag, valve, mask ("Ambu"); MV, mechanical ventilation; PAMV, pneumonia associated with the mechanical ventilation.

**Table 3. Improvement Action**

| Failure/RPN | Cause | Improvement | Responsible | Implementation |
|---|---|---|---|---|
| Step 1. Not evaluating; 432 | Rushing; lack of experience; lack of care; excess work load; not enough personnel. | Training. Raising awareness. | FMEA team | 3 mo |
| Step 1. Inadequate evaluation; 648 | Rushing; lack of experience; lack of care; excess work load; lack of knowledge; nonauscultation. | Training. | Further training | 12 mo |
| Step 2. Not evaluating; 432 | Lack of knowledge; rushing; excess work load; not enough personnel; lack of care; oversight; habit; monitor turned off. | Training. Monitors in perfect condition. | Further training Device manager | 12 mo 1 mo |
| Step 2. Inadequate evaluation; 324 | Lack of knowledge; lack of experience; lack of care; monitor not configured, broken, with no alarms or inadequate alarms. | Training. Monitors in perfect condition. | Further training Further training | 12 mo 1 mo |
| Step 3. Not informing; 512 | Patient sedated; lack of knowledge; lack of care; oversight; habit. | Training. Raising awareness. | FMEA team | 3 mo |
| Step 4. Not checking; 324 | Rushing; lack of knowledge; lack of experience; not following protocol; lack of care. | Training. Raising awareness. | FMEA team | 3 mo |
| Step 4. Erroneous check; 324 | Rushing; lack of care; lack of experience; not following protocol; lack of knowledge. | Training. Reminders. | FMEA team | 6 mo |
| Step 8. Without sterile gloves; 512 | Lack of knowledge; habit; not following protocol; rushing; urgent suction; gloves missing. | Training. Raising awareness. | FMEA team FMEA team | 1 mo 3 mo |
| Step 8. Improper technique; 576 | Putting gloves on poorly; not washing hands; improper hand washing; urgency; not following the protocol. | Training. | Further training | 12 mo |
| Step 10. Excessive time; 432 | Lack of knowledge; lack of care; excessive secretions; lack of experience; clogged probe. | Training. Lubricate probe. | FMEA team | 6 mo |
| Step 10. Introducing it while performing suctioning; 384 | Lack of knowledge; rushing; lack of experience; oversight. | Training. | FMEA team | 6 mo |
| Step 10. Suctioning excessively; 512 | Lack of knowledge; lack of experience; poor habits. | Training. | FMEA team | 6 mo |
| Step 10. Not aseptic; 512 | Poor technique; lack of experience; lack of skill; rushing; probe reused or contaminated. | Training. Raising awareness. | FMEA team | 6 mo |

FMEA, Failure Mode and Effect Analysis.

by habit or routine, as found in our brainstorming stage, which leads to an increase in its frequency in manipulation and, therefore, in risk. Performing suctioning without prior proper evaluation may increase the risk of developing pneumonia, as well as putting the patient at risk of extubation or bronchial suctioning. A need to increase staff awareness of this was identified.

The lowest RPN in our study was equal to 24. It corresponded to "nonsuctioning while we remove the suction tube" because the tube is obstructed, pinched or leaking suction, poor technique realized, and the container of suction is broken or full. Little danger, therefore, seems to arise when aspiration cannot be performed, when the probe fails to do so. The cause of this RPN lies in the

fact that its consequences may be reversible, and therefore, the failure adequately activates the process barriers which minimize the possibility of an adverse event.

Other failure modes, such as "not reconnecting the patient to the ventilator," impress with a greater level of danger. It is logical to think about the danger caused to a patient dependent on a ventilator if that patient is not reconnected. However, our analysis shows that the level of danger in this is low because of the very safety mechanism of the ventilator-audible alarms. On occasion, routine causes us to become less alert when an alarm is sounded. There may even be cases in which an alarm is disconnected because it becomes a nuisance. Both actions increase the danger level and render the device's safety system inoperative. This demonstrates the effectiveness of the barriers in place to decrease the consequences of errors and their occurrence, such as the barrier consisting of use of the FMEA tool. We can say that the more FMEA is used, the less the risk there will be. To use a simile, one could state that FMEA is like a ventilator alarm: it could protect us from any dangerous occurrence.

Of the improvement actions which are proposed in this research project, a large number are based on health care professionals' training and awareness. Creation of a training plan that standardizes the work performed by the staff is important and such a training plan must be rolled out across the medical center. It is never excessive to reexamine previously known techniques and even contribute new knowledge that has been published. Reeducation based on proper training will lead to greater awareness among more veteran professionals whose routines are more difficult to change.

The brainstorming stage is decisive in the FMEA model because it puts on the table a large number of potential failures in our processes and subprocesses. These are situations which many times nobody on the team providing care had stopped to think about in the past. The multidisciplinary points of view, also influenced by the professional category in which each individual does his or her work, can open up the others' eyes.

It is therefore worthwhile to receive training on the FMEA tool and deal little by little with the analysis of all the most habitual processes in everyday practice. By doing so, we achieve the creation of a "risk map" that will allow us to work with lower risk and in a more efficient manner. The costs associated with a lack of safety cannot be afforded by organizations at times when the system's equity does not allow for any nonadherence to budgets.

## Conclusions

The FMEA tool has demonstrated effectiveness at detecting failure modes in the selected process. FMEA has made it possible to identify errors in the selected process, with the identification of 32 failure modes, 13 of which surpassed an RPN of 300, with 22 improvement actions proposed. Many of the failures are consequences of practices deeply rooted in custom, which one must attempt to change through training and increased awareness. The use of FMEA creates the possibility of working in a safer environment. Putting the improvement actions into practice is an attempt to decrease such major consequences such as ventilator-associated pneumonia or unintentional extubation. We recommend including the FMEA tool in training plans as well as use in the most common processes of health care practice.

## References

1. Institute of Medicine. *To Err is Human: Building a Safer Health System*. 1999.

2. Spanish Ministry of Health and Consumer Affairs. *Estudio Nacional sobre los Efectos Adversos Ligados a la Hospitalización (ENEAS)*. 2005.

3. Spanish Ministry of Health Care, Social Policy and Equality. *Incidentes y Eventos Adverso en Medicina Intensiva. SYREC*. 2007.

4. De Rosier J, Stalhandske E, Bagian JP, Nudell T. Using health care Failure Mode and Effect Analysis™: The VA National Center for Patient Safety's prospective risk analysis system. *Jt Comm J Qual Improv*. 2002;28:248-267.

5. Duwe B, Fuchs BD, Hansen-Flaschen J. Failure mode and effects analysis application to critical care medicine. *Crit Care Clin*. 2005;21:21-30.

6. Chico Fernández M, García Fuentes C, Alonso Fernández MA, et al. Desarrollo de una herramienta de comunicación para la seguridad del paciente (Briefing). Experiencia en una una unidad de cuidados intensivos de trauma y urgencias. *Med Intensiva*. 2012;36:481-487.

7. National Patient Safety Foundation. Patient Safety Dictionary. Available at http://www.npsf.org/?page=dictionaryae. Accessed April 20, 2016.

8. Ruíz López P. Las Herramientas Básicas para la Gestión de Riesgos. Análisis Modal de Fallos y Efectos. Quality Coordinator at Hospital Universitario 12 de Octubre. 2007.

9. Ruíz López P. and González Rodríguez Salinas C. El Análisis Modal de Fallos y Efectos (AMFE). Una herramienta muy útil para la seguridad del paciente. Quality Unit. Hospital Universitario 12 de Octubre. 2008.JANO Julio 2.008. n° 1702. Available at www.jano.es. Accessed May 5, 2016.

10. Grima Cintas P, Trot-Martorell Llabres J. *Técnicas para la gestión de la Calidad*. Madrid, Spain: Editorial Díaz de Santos; 1995:49-62.

11. Salvadores Fuentes P, Sánchez Sanz E, Carmona Monge F. *Enfermería en cuidados críticos*. Madrid, Spain: Editorial Universitaria Ramón Areces; 2011.

12. Urden L. *Cuidados Intensivos En Enfermería*, 3rd ed. Madrid, Spain: Elsevier Health Sciences; 2001.

13. Vázquez A. *Cuidados de Enfermería en Unidades de Pacientes Críticos*. Madrid, Spain: Ongoing Nurse Training Unit. Hospital General Universitario Gregorio Marañón; 2007.