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Research article

Accidental removal of devices in intensive care unit: An eight-year observational study

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ABSTRACT

Background: In the intensive care unit, invasive devices can be accidentally removed by the patient or by the operators, increasing workload, staff stress level and hospitalisation costs. Objective: to know the incidence of accidental removal of devices in critical patients, to identify their cause, when they occur and if they are repositioned.
Methods: Retrospective observational study carried out in an academic, tertiary-level critical care department composed of three intensive care units. All adult patients recovered between 2011 and 2018 were enrolled. We calculated rates per 1000 device-years.
Results: In the study period 10514 patients (194372 device-days) were admitted to the intensive care units and the number of reported accidental removal of devices was 451, corresponding to a rate of 2.3 episodes per 1000 device-days (95% confidence interval: 2.1–2-5). The overall rates of accidental removals were as follows: gastric tubes 10.2 (n = 270), intracranial devices 3.9 (n = 9), endotracheal tubes 2.4 (n = 27), central venous catheters and arterial catheters 1.5 (n = 92), peripheral intravenous catheters 1.2 (n = 25), surgical drains 0.5 (n = 15), urinary catheters 0.4 (n = 11), Extra Corporeal Membrane Oxygenation cannulas 0.4 (n = 1), tracheostomy cannulas 0.1 (n = 1).
Conclusion: Compared to the literature, this study shows fewer incidents of accidental removal of devices. The number of accidental removals could be an indicator of the quality and safety of the care.

Implications for clinical practice

- The accidental removal of devices in intensive care unit is a common phenomenon.
- The most frequently removed devices are the gastric tubes, intracranial devices and endotracheal tubes.
- Understanding the causes of the accidental removal of devices could prevent or reduce the number of displacements in the future.

Introduction

Adverse events and complications frequently occur in the intensive care unit (ICU) (Needham et al., 2005). The incidence may be as high as two errors per patient per day with up to 18% of ICU patients sustaining a serious adverse event (Bracco et al., 2001; Donchin et al., 1995; Osmon et al., 2004).

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One of the most common types of ICU incidents involves invasive line, tube and drain placement, maintenance or removal (Buckley et al., 1997) but there is a lack of monitoring or reporting systems to measure them (Happ, 2000; Lorente et al., 2004).

For the U.S. Institute of Medicine, voluntary reporting systems are important to help reduce adverse events (Institute of Medicine, 1999): these systems can improve our understanding of what factors contribute to errors and how we may prevent their occurrence (Needham et al., 2005).

Protection of therapeutic devices from patient-initiated removal is a major reason for the use of physical restraints in intensive care units (Benbenbishty et al., 2010; Minnick et al., 2007, 1998). Premature discontinuation of technologically complex therapies (e.g. endotracheal tubes for mechanical ventilation or central venous catheters for vasoactive medications) may result in serious harm, injury or death (Minnick et al., 1998; Mion et al., 1996).

Patient removal of devices other than endotracheal tubes may have similar levels of life-threatening harm. On the other hand, devices such as peripheral intravenous catheters may be more likely to cause minor to no harm in patients but can consume significant staff time or costly resources (Fraser et al., 2001).

A major challenge in ICU is balancing the need to prevent patients from removing devices and meeting the Joint Commission of Healthcare Organizations restricting the use of physical restraints (The Joint Commission, 2016). Although maintenance of therapeutic devices is a primary reason for use of physical restraints in ICUs currently in the literature the usefulness of physical restrain systems as preventive measures for the removal of medical devices is still discussed (Ai et al., 2018; Lucchini et al., 2018).

Over the last years, several studies have specifically evaluated the frequency of accidental endotracheal extubation showing that this potentially life-threatening event occurs in 3%–16% of intubated patients (Carrión et al., 2000). However, the information about rates of accidental removal of nasogastric tubes and vascular lines in critically ill patients is rather limited (Carrión et al., 2000; Mion et al., 2007) and even less for urinary catheters, surgical drains, intracranial devices and Extra Corporeal Membrane Oxygenation (ECMO) cannulas.

Objective

The primary objective of this study is to characterise the rates of accidental removals of devices in adult critically ill patients. The secondary objective is to identify the causes of accidental removals of devices, when they occur and if they are repositioned.

Methods

Study design, hospital and participants

Observational retrospective study. This study was performed in a critical care department which included the general ICU (6 beds), the post-surgery ICU (6 beds) and the neurosurgery ICU (5 beds), located at the Foundation IRCCS Ca' Granda Ospedale Maggiore Policlinico of Milan, an Italian university-tertiary level hospital.

All patients were cared for by attending physicians certified in anesthesiology-intensive care and registered nurses who were experienced in critical care. The nurse/patient ratio was 1:2 or 1:3 in the post-surgery ICU. All the ICUs considered were open space, every bed was separated from the others by curtains.

We enrolled all adult patients (age $\geq$18 years old) admitted to our ICUs from the 1st January 2011 to the 31st December 2018.

Accidental removal was defined as the displacement of a medical device, deliberately removed by the patient (either by taking hold of it with his/her hands or by making voluntary movements) or as a consequence of inadequate handling by medical personnel.

The devices considered were: endotracheal tubes, tracheostomy cannula, intravascular catheters (peripheral intravenous catheters, central venous catheters, pulmonary artery catheters, renal replacement therapy catheters, peripherally inserted central catheter (PICC), midline catheter, internal jugular vein retrograde catheters and arterial catheters), gastric tubes, urinary catheters, all kinds of surgical drains, intracranial devices and ECMO cannulas. The fixing method for intravascular catheters (peripheral intravenous catheters excluded), thoracic drains and ECMO cannulas was silk suture, for endotracheal tubes and gastric tubes was taping with thin idrocolloid (1 mm) and plaster (Lucchini et al., 2018). For gastric tubes we considered both orogastric and nasogastric tubes. For intracranial devices we considered both intraparenchymal and intraventricular catheters. For endotracheal tubes we considered both nasotracheal and orotracheal tubes.

The time at risk for each device type (device-days) was recorded from positioning to accidental removal using a standardised form. Since the exact time of removal was not known, to estimate time at risk among shifts we assumed time fractions of 7/24 for the morning and afternoon shift, and 10/24 for the night shift.

The analysis of patients' level of consciousness and sedation was performed using the Richmond Agitation Sedation Scale (RASS) (Sessler et al., 2002), as routinely done in the studied ICUs.

A physical restraint was defined any device placed on the patient to limit the patients movements. These restraints (including wrist, chest and ankles) were used as deemed necessary (during awakening from sedation and during agitation moments) by the nursing staff always according to the physician staff and reported in the medical record.

If a new device was placed after an accidental removal it was included as a new catheter or tube in the study. The decision to replace the accidental removed devices was based entirely on the judgment of the attending physician or by the nurse in charge based on competence.

According to the literature, the rates of accidental removal of tubes and catheters were calculated as follows: accidental removal according to the time at risk number of tubes or catheters accidentally removed per 1000/sum of the time that each tube or catheter remained placed (Carrión et al., 2000; Mion et al., 2007).

A standardised data collection instrument was devised and tested for three months in 2010: all the staff nurses were instructed to fill in a schedule for any patient with an accidental removal of devices. At the same time the schedule with every patient's device details was improved in the medical record.

Statistical analysis

We calculated overall rates of removal (per 1000 device-days) and rates specific for year, device, and shift. To evaluate the trend over the years and simultaneously evaluate the potential effect of shift on removal rate, we fitted two multivariable Poisson regression models which included the covariates type of device (categorical), year (categorical in one model and quantitative in the other model to evaluate time trend) and shift to calculate rate ratios (RR) and 95% confidence intervals (CI). Analyses were performed with Stata 15 (StataCorp, USA).

Results

In the study period 10,514 patients were admitted to the ICUs. They were 64% male, with an average age of 59.2 (±12.1) years and

an ICU stay of 4.4 (±10.2) days. The admission diagnosis was surgical in 56% and medical in 44% with an average Simplified Acute Physiology Score II (SAPS II) of 34 (±9.1). The number of accidental removal of devices was 451 that is 2.3 episodes/1000 device-days. As it is shown in Table 1, the most frequently removed devices were the gastric tube with 10.2 removals for 1000 device days (271 removals, $p < 0.001$) followed by the intracranial devices with 3.9 removals for 1000 device days (9 removals, $p < 0.001$) and the endotracheal tubes with 2.4 removals for 1000 device days (27 removals, $p < 0.001$). The gastric tubes days are composed of the 0.8% of gastric tubes days and of the 99.2% of nasogastric tubes. The intracranial devices days are composed of the 20% of intraparenchymal catheters and of the 80% of intraventricular devices. All unplanned extubations were in patients with orotracheal intubation (94.8% of intubation days). During the eight-year study no accidental removals occurred for renal replacement therapy catheters, PICC, midline catheter and internal jugular vein retrograde catheters. The overall rate of accidental removal (adjusted for device type and shift) did not vary over the years considered ($p = 0.29$). Compared to the morning shift, we found lower rates (adjusted for device type and year) of removal for both the afternoon shift (RR = 0.92, 95% CI: 0.65–1.04) and the night shift (RR = 79, 95% CI: 0.63–0.98).

We calculated the rate of arterial catheter displacement only for the year 2018 and it was 0.5 episodes/1000 device-days while for the others intravascular catheters (peripheral intravenous catheters excluded) it was 1.5 episodes/1000 device-days ($p = 0.30$).

Considering the cause of the removals, in 368 (81.6%) cases the patient removed the devices by him/her self, during the mobilization in 43 (9.5%) cases and for ineffective fixing in 24 (5.3%) cases. We considered the patient's active and passive mobilisation, with and without the physiotherapist presence. Table 2 shows the causes of the removal of devices. All causes of displacement are significant ($p < 0.001$). Comparing the state of consciousness with the RASS, we observed that the accidental removal of devices happened with: 4 (0.9%) RASS + 4, 61 (13.5%) RASS + 3, 119 (26.4%) RASS + 2, 158 (35%) RASS + 1, 58 (12.9%) RASS 0, 26 (5.8%) RASS −1, 3 (0.7%) RASS −2, 7 (1.5%) RASS −3, 13 (2.9%) RASS −4 and 2 (0.4%) RASS −5. So the accidental removal of devices depends on the patient's RASS for all types of devices ($p < 0.001$) and independently of the type of device the major number of displacement occurs with a patient's RASS from 1 to 3 ($p < 0.001$).

The work shift with the high number of accidental removals was the morning shift (6 hrs) with 2.7 episodes/1000 device-days, followed by the afternoon shift (6 hrs) 2.2 and the night shift (12 hrs) 2.1 ($p = 0.041$). The trend of accidental removal of devices during the three work shifts didn't change in the years considered.

Analysing the physical restraint used to prevent the patient's removal of devices, in 277 (61.4%) cases the patients were restrained while in the other 174 (38.6%) cases they were not. This is not statistically significant ($p = 0.082$) but the restrained patients removed more devices. The 44% of patients were physically restrained at least once during the ICU stay.

The accidentally removed devices were repositioned 289 (64%) times while the device was not considered necessary again in 162 (36%) cases ($p = 0.144$). During this study no deaths occurred as a direct result of the accidental removal of a device, not even with the partial removal of a venous ECMO cannula. In the study period 180 patients underwent ECMO and in 2011 a better cannula fixing was performed after the partial venous cannula removal. As it is shown in Table 3, the most repositioned devices were the gastric tubes (67%) while the less were the surgical drains (66.7%).

Table 1
Number of accidental removals of devices in the years considered.

Devices		2011	2012	2013	2014	2015	2016	2017	2018	Total
Gastric tubes	N	44	37	23	33	26	39	34	35	271
	Device-days	4159	3812	3277	3114	3484	3200	2453	2992	26,491
	Rate	10.6	9.7	7	10.6	7.5	12.2	13.9	11.7	10.2
Intracranial devices	N	1	2	0	0	0	1	4	1	9
	Device-days	320	266	230	428	298	229	320	236	2327
	Rate	3.1	7.5	0	0	0	4.4	12.5	4.2	3.9
Endotracheal tubes	N	1	5	3	5	2	4	2	5	27
	Device-days	1425	1363	1390	1177	1300	1572	1371	1561	11,159
	Rate	0.7	3.7	2.2	4.2	1.5	2.5	1.5	3.2	2.4
Intravascular catheters	N	14	14	11	9	9	16	10	9	92
	Device-days	8564	8267	8076	7551	7590	7861	7366	7140	62,415
	Rate	1.6	1.7	1.4	1.2	1.2	2	1.4	1.3	1.5
Peripheral intravenous catheters	N	0	5	4	2	6	6	0	1	24
	Device-days	2737	2919	2614	2905	2452	2773	2799	2430	21,629
	Rate	0	1.7	1.5	0.7	2.4	2.2	0	0.4	1.1
Surgical drains	N	3	3	1	4	1	0	3	0	15
	Device-days	4676	5132	4297	4569	2881	2417	2841	2636	29,449
	Rate	0.6	0.6	0.2	0.9	0.3	0	1.1	0	0.5
Urinary catheters	N	1	1	0	4	0	2	1	2	11
	Device-days	3480	3867	3690	3622	3670	3500	3296	3268	28,393
	Rate	0.3	0.3	0	1.1	0	0.6	0.3	0.6	0.4
ECMO cannulas (venous)	N	1	0	0	0	0	0	0	0	1
	Device-days	240	144	200	88	348	597	409	807	2833
	Rate	4.2	0	0	0	0	0	0	0	0.4
Tracheostomy cannulas	N	0	0	0	1	0	0	0	0	1
	Device-days	1752	1255	1112	1152	1468	1233	744	960	9676
	Rate	0	0	0	0.9	0	0	0	0	0.1
Total	N	65	67	42	58	44	68	54	53	451
	Device-days	27,353	27,025	24,886	24,606	23,491	23,382	21,599	22,030	194,372
	Rate	2.4	2.5	1.7	2.4	1.9	2.9	2.5	2.4	2.3

Table 2
Causes of accidental removal of devices.

Devices	CAUSES											
	Hygienic care		Mobilisation		Transport		The patient		Ineffective fixing		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Gastric tubes	0	0	15	3.32	1	0.22	249	55.21	5	1.12	270	59.87
Intracranial devices	1	0.22	3	0.67	0	0	4	0.89	1	0.22	9	2.00
Endotracheal tubes	0	0	1	0.22	0	0	26	5.76	0	0	27	5.99
Intravascular catheters	6	1.33	20	4.43	6	1.33	47	10.42	13	2.88	92	20.40
Peripheral intravenous catheters	0	0	1	0.22	0	0	21	4.66	3	0.67	25	5.54
Surgical drains	1	0.22	3	0.67	1	0.22	9	2.00	1	0.22	15	3.32
Urinary catheters	0	0	0	0	0	0	11	2.44	0	0	11	2.44
ECMO cannulas (venous)	0	0	0	0	0	0	0	0	1	0.22	1	0.22
Tracheostomy cannulas	0	0	0	0	0	0	1	0.22	0	0	1	0.22
Total	8	1.77	43	9.53	8	1.77	368	81.60	24	5.32	451	100

Table 3
Devices repositioned and not repositioned after the accidental removal.

Devices	Repositioned		Not Repositioned		Total
	N	%	N	%	N
Gastric tubes	181	67	89	33	270
Intracranial devices	5	55.6	4	44.4	9
Endotracheal tubes	13	48.1	14	51.9	27
Intravascular catheters	60	65.2	32	34.8	92
Peripheral intravenous catheters	15	60	10	40	25
Surgical drains	5	33.3	10	66.7	15
Urinary catheters	8	72.7	3	27.3	11
ECMO cannulas (venous)	1	100	0	0	1
Tracheostomy cannulas	1	100	0	0	1
Total	289	64	162	36	451

Discussion

Considering the global number of accidental removal of devices, this phenomenon involved approximately 4% of ICU patients. The purpose of this study was not only to characterise the rates of accidental removal of devices in the ICU, but also to know the causes of removal to prevent or reduce the number of removals in the future. The number of accidental removals could be an indicator of quality and safety of care.

There is little literature about this topic and the rates of accidental extubations have been calculated in most studies by taking the number of intubated patients as denominator but not the days at risk (days with a tube in place), so it is difficult to compare populations in which the duration of intubation is unavoidably different (Carrión et al., 2000; Peñuelas et al., 2011), this consideration could be extended for all devices.

The incidence of accidental removal of devices is high for the gastric tubes when compared to the other devices, but we obtain a lower rate (10.2 removals for 1000 device days) compared to a Brazillian study (Pereira et al., 2013) (16.8 removals for 1000 device days) and to a Spanish (Carrión et al., 2000) study (48.3 removals for 1000 device days).

The incidence of unplanned extubation in the studied setting (2.4 removals for 1000 device days) showed rates according to the minimal values reported in scientific literature (from 2 to 8.7%)(Ai et al., 2018).

The incidence of accidental vascular catheters removal (1.5 removals for 1000 device days) is also less than previously reported in the literature (18.8 (Carrión et al., 2000) and 5.6 (Lorente et al., 2004) removals for 1000 device days). For the year 2018, the accidental removal of arterial catheters (0.5 removals for 1000 device days) was less than what reported in other studies (29.7 (Carrión et al., 2000), 11.3 (Lorente et al., 2004) and 9.7 (Lorente et al., 2013) removals for 1000 device days).

Analysing the causes of removal in 368 (81.6%) cases the patient removed the device by him/herself, while the second cause was during patient's mobilisation, 43 (9.5%) of the removals. This expected result is in line with a recent meta-analysis that shows from 0 to 23% of adverse events during the mobilisation/rehabilitation sessions in ICU (Nydahl et al., 2017). This data does not discourage the importance of mobilisation for critical patients.

The morning is the work shift with the major number of accidental removals of devices (2.7 episodes/1000 device-days), it could be explained because in this shift the major number of the day activities were done.

Physical restraint is a tool with ambiguous effectiveness in preventing accidental removal of devices because the 61.6% succeeded in removing the devices. In the literature the usefulness of physical restraint systems as preventive measures is still discussed and it seems a risk factor for unplanned extubation (Ai et al., 2018; Chang et al., 2008). The prevalence of patients physically restrained even only once was high (44%), but with an average time of 1 (±2) hrs for post-surgery patients; this period of time coincided with the awaking from sedation when the restrain was carried out as a safety measure.

According to a recent meta-analysis (Ai et al., 2018) a patient's higher level of consciousness, in this study positive value of RASS, is associated with a high risk of accidental removal of devices. The accidental removal of a device by the patient with a turbulent state of consciousness could be dangerous for the medical staff, in a study the 10% of the episodes resulted in some degree of harm to the nursing staff (Mion et al., 2007). In addition to reinsertion of devices, more than half of the episodes resulted in further nursing or medical treatments (Mion et al., 2007). A study demonstrated

that the cost of a single ICU due to these episodes can exceed a quarter million dollars a year (Fraser et al., 2001).

The number of devices requiring reinsertion (64%) varied from one device type to another, but the high percentage (36%) of not replaced devices reflects on the real need to keep the device on the patient again. Some studies have postulated that if these devices are utilised too long this may contribute to physical restraint use, which in turn can lead to delirium, that is a big common problem in ICU (Binda et al., 2017) or to agitation and subsequent patient's removal of devices (Mion et al., 2007).

Limitations

This study has some limitations. First, the number of accidental removal did not change in the years considered, which means that the attention to the phenomenon did not decrease, but the number of reports could be underestimated in all years, in particular during the night shift when the workload is high but the number of medical staff decreases. Second, a separated analysis of the arterial catheter compared to all venous catheters, as it was done for the year 2018, should be done for all the years considered to better address the topic. Third the neurosurgery ICU with its particular type of patient could be analysed separately.

Conclusion

The accidental removal of devices in ICU is not uncommon and it is an important target for quality improvement and patients' safety initiatives. Indeed, rates of removal of devices, either all types or specific types, may serve as a marker for quality of care. One of the strategies to reduce the number of accidental removals, considering the number of non-repositioned devices, is to accurately evaluate the real need for maintaining devices and removing them as soon as possible.

Ethical statement

The study was approved by the Ethical Committee of Milan – Area 2, with the notification number 26_2019bis.

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Declaration of Competing Interest

None of the authors discloses potential conflicts of interest.

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References

Ai, Z.P., Gao, X.L., Zhao, X.L., 2018. Factors associated with unplanned extubation in the Intensive Care Unit for adult patients: a systematic review and meta-analysis. Intensive Crit. Care Nurs. 47, 62–68.
Benbenbishty, J., Adam, S., Endacott, R., 2010. Physical restraint use in intensive care units across Europe: the PRICE study. Intensive Crit. Care Nurs. 26, 241–245.
Binda, F., Galazzi, A., Brambilla, A., Adamini, I., Laquintana, D., 2017. Fattori di rischio per l'insorgenza di delirium in terapia intensiva nei pazienti sottoposti a trapianto di fegato. Assist. Inferm. e Ric. 36, 90–97.
Bracco, D., Favre, J.B., Bissonnette, B., Wasserfallen, J.B., Revelly, J.P., Ravussin, P., et al., 2001. Human errors in a multidisciplinary intensive care unit: a 1-year prospective study. Intensive Care Med. 27, 137–145.
Buckley, T.A., Short, T.G., Rowbottom, Y.M., Oh, T.E., 1997. Critical incident reporting in the intensive care unit. Anaesthesia 52, 403–409.
Carrión, M.I., Ayuso, D., Marcos, M., Paz Robles, M., de la Cal, M.A., Alía, I., et al., 2000. Accidental removal of endotracheal and nasogastric tubes and intravascular catheters. Crit. Care Med. 28, 63–66.
Chang, L.-Y., Wang, K.-W.K., Chao, Y.-F., 2008. Influence of physical restraint on unplanned extubation of adult intensive care patients: a case-control study. Am. J. Crit. Care 17, 408–415.
Donchin, Y., Gopher, D., Olin, M., Badihi, Y., Biesky, M., Sprung, C.L., et al., 1995. A look into the nature and causes of human errors in the intensive care unit. Crit. Care Med. 23, 294–300.
Fraser, G.L., Riker, R.R., Prato, S., Wilkins, M.L., 2001. The frequency and cost of patient-initiated device removal in the ICU. Pharmacotherapy 21, 1–6.
Happ, M.B., 2000. Preventing treatment interference: the nurse's role in maintaining technologic devices. Heart Lung J. Acute Crit. Care 29, 60–69.
Institute of Medicine, 1999. To err is human: building a safer health system (Report Brief). Inst. Med., 1–8
Lorente, L., Brouard, M.T., Roca, I., Jiménez, A., Pastor, E., Lafuente, N., et al., 2013. Lesser incidence of accidental catheter removal with femoral versus radial arterial access. Med. Intensiva 37, 316–319.
Lorente, L., Huidobro, M.S., Martin, M.M., Jimenez, A., Mora, M.L., 2004. Accidental catheter removal in critically ill patients: a prospective and observational study. Crit. Care 8, R229–R233.
Lucchini, A., Bambi, S., Galazzi, A., Elli, S., Negrini, C., Vaccino, S., et al., 2018. Unplanned extubations in general intensive care unit: a nine-year retrospective analysis. Acta Biomed. 89.
Minnick, A.F., Mion, L.C., Johnson, M.E., Catrambone, C., Leipzig, R., 2007. Prevalence and variation of physical restraint use in acute care settings in the US. J. Nurs. Scholarsh. 39, 30–37.
Minnick, A.F., Mion, L.C., Leipzig, R., Lamb, K., Palmer, R.M., 1998. Prevalence and patterns of physical restraint use in the acute care setting. J. Nurs. Adm. 28, 19–24.
Mion, L.C., Minnick, A., Palmer, R., 1996. Physical restraint use in the hospital setting: unresolved issues and directions for research. Milbank Q. 74, 411–433.
Mion, L.C., Minnick, A.F., Leipzig, R.M., Catrambone, C.D., Johnson, M.E., 2007. Patient-initiated device removal in intensive care units: a national prevalence study. Crit. Care Med. 35, 2714–2720.
Needham, D.M., Sinopoli, D.J., Thompson, D.A., Holzmueller, C.G., Dorman, T., Lubomski, L.H., et al., 2005. A system factors analysis of "line, tube, and drain" incidents in the intensive care unit. Crit. Care Med. 33, 1701–1707.
Nydahl, P., Sricharoenchai, T., Chandra, S., Kundt, F.S., Huang, M., Fischill, M., et al., 2017. Safety of patient mobilization and rehabilitation in the intensive care unit: Systematic review with meta-analysis. Ann. Am. Thorac. Soc. 14, 766–777.
Osmon, S., Harris, C.B., Dunagan, W.C., Prentice, D., Fraser, V.J., Kollef, M.H., 2004. Reporting of medical errors: an intensive care unit experience. Crit. Care Med. 32, 727–733.
Peñuelas, Ó., Frutos-Vivar, F., Esteban, A., 2011. Unplanned extubation in the ICU: a marker of quality assurance of mechanical ventilation. Crit. Care 15.
Pereira, S.R.M., Coelho, M.J., De Mesquita, A.M.F., Teixeira, A.O., De Almeida Graciano, S., 2013. Causes for the unplanned removal of the feeding tube in intensive care. Acta Paul. Enferm. 26, 338–344.
Sessler, C.N., Gosnell, M.S., Grap, M.J., Brophy, G.M., O'Neal, P.V., Keane, K.A., et al., 2002. The Richmond agitation-sedation scale: validity and reliability in adult intensive care unit patients. Am. J. Respir. Crit. Care Med. 166, 1338–1344.
The Joint Commission, 2016. Comprehensive Accreditation Manual for Hospitals.