



## Adverse events associated to the use of equipment and materials in nursing care of hospitalized patients\*

Eventos adversos relacionados ao uso de equipamentos e materiais na assistência de enfermagem a pacientes hospitalizados

Eventos adversos relacionados con el uso de equipos y materiales en la asistencia de enfermería a pacientes hospitalizados

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-  Rosicler Xelegati<sup>1</sup>
-  Carmen Silvia Gabriel<sup>1</sup>
-  Carina Aparecida Marosti Dessotte<sup>1</sup>
-  Yara Pedroso Zen<sup>2</sup>
-  Yolanda Dora Martinez Évora<sup>1</sup>

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<sup>1</sup> Universidade de São Paulo, Escola de Enfermagem de Ribeirão Preto, Departamento de Enfermagem Geral e Especializada, Ribeirão Preto, São Paulo, Brazil.

<sup>2</sup> Hospital Ribeirânia, Grupo São Lucas, Departamento de Qualidade, Ribeirão Preto, São Paulo, Brazil.

### ABSTRACT

**Objective:** To analyze the occurrence of adverse events associated to the use of equipment and materials in nursing care. **Method:** Quantitative, descriptive study, using the electronic records of adverse events notifications in an accredited hospital. **Results:** A total of 1,065 adverse events were reported, of which 180 (16.9%) were related to the use of equipment and materials. The most frequent events were: loss of feeding tube (45.0%), loss of central venous catheter (15.5%), skin injury (10.5%) and accidental extubation (10.0%). The main causes and immediate actions recorded were: loss of feeding tube – removal of the tube by the patient (53.1%) and reinsertion of the device (83.9%); loss of central venous catheter – agitated or disoriented patient (32.1%) and insertion of peripheral venous catheter (46.2%); skin injury – agitated or disoriented patient (26.3%) and application of occlusive dressing (73.7%); and accidental extubation – weaning from sedation, disconnected sedation or inadequate doses of sedation (50.0%) and reintubation (50.0%). The degrees of harm were: mild (23.3%), severe (62.2%), very severe (13.9%) and extremely severe (0.6%). **Conclusion:** The investigation of the occurrence of adverse events related to the use of equipment and materials in care can prevent and minimize harm to the patient.

### DESCRIPTORS

Patient Harm; Hospitalization; Equipment and Supplies; Nursing Care; Patient Safety.

### Corresponding author:

Rosicler Xelegati  
Av. dos Bandeirantes, n. 3900, Campus  
Universitário, Bairro Monte Alegre  
CEP 14040-902 – Ribeirão Preto, SP, Brazil  
[rxelegati@eerp.usp.br](mailto:rxelegati@eerp.usp.br)

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## INTRODUCTION

An adverse event (AE) is defined as “an unintentional injury resulting in temporary or permanent disability, prolongation of hospital stay or death, as a consequence of the care provided”<sup>(1-2)</sup>.

The National Patient Safety Program (PNSP) implemented by the Ministry of Health in 2013, highlights relevant themes for the investigation of AEs, including the safe use of equipment and material<sup>(3)</sup>.

Incidents related to the use of health equipment and devices represent a risk of errors. The variety of devices, manufacturers and technical specifications of each equipment makes the health care environment complex and can also cause AEs<sup>(4)</sup>.

There are many equipment used in health care, such as infusion pumps, respiratory ventilators, cardioverter/defibrillator, multiparameter monitor, capnograph, hemodialysis device, among others. A mis-programmed infusion pump may cause a delayed response to therapy or an unexpected or toxic drug reaction; an imprecise respiratory ventilator can cause respiratory instability; a broken defibrillator will prevent the electrical impulse and will not reverse a cardiac arrest; a multi-parameter monitor that is improperly set-up can keep alarms inoperative and generate monitoring errors; overheating can cause burns in patients<sup>(4-5)</sup>.

The materials or devices widely used in the health services are cannulas, catheters, drains, tubes, surgical instruments, among others. The use of these materials is related to a high risk of occurrence of AEs, exemplified by incidents such as: accidental extubation of an endotracheal tube; unplanned removal of orogastric or nasogastric tube; loss of central, arterial and peripheral venous catheter; loss of drains; surgical instruments who remain dirty after sterilization process, among others.

When equipment and materials are of recognized quality, are used correctly and undergo systematic maintenance, they contribute to patient safety and to the good performance of health professionals. However, the potential risks that the use of health care equipment can bring to the patient, professional and environment cannot be disregarded<sup>(6)</sup>.

Considering the above and the worldwide concern with patient safety, the objective of this study was to analyze the occurrence of AEs related to the use of equipment and materials in nursing care, considering the characteristics of the patient/service, type of event, work shift and sector of occurrence of the event, as well as the immediate causes and actions adopted and the degree of harm to the patient.

## METHOD

### TYPE OF STUDY

This is a quantitative, descriptive study, with a non-experimental research design.

### SETTING

The electronic records of the Occurrence Notification System (SNO) of a medium-sized private general hospital in the city of Ribeirão Preto – SP, with Level III accreditation (Excellence in Management) by the National Accreditation Organization (ONA) were consulted. The SNO is designed to record notifications of unexpected events/incidents which can cause or have caused harm to patients. With these notifications, it is possible to assess the causes and implement actions, barriers or improvements to minimize or eliminate these causes. This system was implemented in this health center to correct internal processes; it is not about pointing out personal mistakes, but about correcting processes to prevent serious harm to users.

### DATA COLLECTION

All SNO notifications recorded at the hospital under study from January 1<sup>st</sup>, 2011 (when the institution initiated the electronic notification of records) to June 30<sup>th</sup>, 2015 (final date for data collection in the institution) were consulted. The events caused by the use of equipment and materials were selected. It is worth mentioning that events which could also be related to the use of materials and equipment, but that were associated with infection, such as Phlebitis, Primary Bloodstream Infection and Pneumonia were excluded from the sample of this AE study.

The data collection instrument was based on the Conceptual Framework of the International Classification for Patient Safety of the World Health Organization (WHO)<sup>(7)</sup>. It was validated by five judges, of which three were teachers from a public university with expertise in the areas of Patient Safety, Nursing Care of Critical Patients and/or Nursing Management, and two were nurses from the Quality Sector of the institution where data was collected. This instrument was divided into four parts: Characteristics of the Patient (age, gender, date of admission, date of discharge and medical diagnosis); Characteristics of the AE (date, time and sector of the occurrence, equipment or material causing it, professional category that notified it, type and description of the event, main causes and degree of harm caused); Immediate/Corrective Actions; and Preventive Actions.

### DATA MANAGEMENT AND ANALYSIS

The data collected were typed twice in a spreadsheet in Microsoft Excel 2010 and later transferred to the IBM SPSS version 16.0 for Windows (SPSS, Inc., Chicago, IL, USA) for the descriptive analysis of the study variables. Descriptive analyzes of simple frequency were performed for nominal or categorical variables.

### ETHICAL ASPECTS

The research project was elaborated according to the ethical precepts of Resolution no.466/12 of the National Health Council and approved by the Research Ethics Committee (CEP) of the Universidade de São Paulo at the

Ribeirão Preto Nursing School, under protocol No 69/2015. A request for waiver of the Informed Consent Form was prepared and approved, considering the high number of reports of the patients to be evaluated for the development of this study.

## RESULTS

A total of 3,552 SNO records notified in the period from January 1<sup>st</sup>, 2011 to June 30<sup>th</sup>, 2015 were consulted and read in full through the intranet of the institution under study.

Among these records, 1,065 (30%) reported an AE. Considering the total of 26,330 hospitalizations in the period, the occurrence of AEs in this study was 4.05 cases per 100 hospitalized patients.

A total of 180 (16.9%) AEs related to the use of equipment and materials in nursing care were identified. These AEs occurred mainly in older adults (n=91, 50.5%), aged between 60 and 89 years (n=75, 41.7%), hospitalized for 8 to 30 days (n=47, 26.1%), and for 31 to 180 days (n=54,

30.0%), for pulmonology treatment (n=40, 22.2%) and who received hospital discharge (93, 51.7%).

Regarding the number of days between the admission of the patient and the occurrence of the AE related to the use of equipment and materials, 54 cases (30.0%) occurred in the period between 31 and 180 days. As for the work shift in which the event occurred, there was a predominance of morning (n=75, 41.7%), followed by night (n=51, 28.3%). Regarding the sector, the AEs occurred in the Infirmaries (n=95, 52.8%), followed by Intensive Care Units (ICU) (General/Adult, Pediatric, Neonatal) and the Coronary Care Unit (CCU) (n = 62; 34.4%).

Table 1 lists the types of AEs related to equipment and materials most frequently encountered in this study, namely: Loss of Feeding Tube (n=81; 45.0%), Loss of Central Venous Catheter (n=28; 15.5%), Skin Injury (n=19, 10.5%), Accidental Extubation (n=18, 10.0%), Loss of Long-term Urinary Catheter (n=8, 4.4%) and Medication Administration Errors (due to mis-programmed infusion pump) (n=7, 3.9%).

**Table 1** – Type of adverse events related to equipment and materials in nursing care, registered in the Occurrence Notification System – Ribeirão Preto, SP, Brazil, 2015.

Types of adverse events related to equipment and materials	n	%
Loss of feeding tube (nasogastric, nasogastric, orogastric and gastrostomy)	81	45.0
Loss of Central Venous Catheter	28	15.5
Skin Injury	19	10.5
Accidental Extubation	18	10.0
Loss of Long-term Urinary Catheter	8	4.4
Medication Administration Errors (infusion pump)	7	3.9
Loss of Drain	5	2.8
Postmarketing Surveillance	5	2.8
Obstruction of Tracheostomy Tube	3	1.7
Loss of Invasive Blood Pressure Catheter	3	1.7
Falls	2	1.1
Loss of Epidural Analgesia Catheter	1	0.6
<b>Total</b>	<b>180</b>	<b>100</b>

The causes and immediate actions adopted in the four most frequent AEs related to equipment and materials, registered by the nurses in the SNO records, are presented below.

Regarding loss of feeding tube, the main causes of unplanned removal were: removal of the tube by the patient (n=43; 53.1%); agitated and disoriented patient (n=29, 35.8%); and obstruction of the device (administration of tablets not fully macerated/diluted; lack of lavage of the tube after the diet or medication administration) (n=20, 24.7%). The most frequent immediate actions adopted and registered by nurses in this type of AE were: reinserting the device (n=68, 83.9%); removing

the tube (when it was externalized, taut, obstructed and/or damaged) (n=19; 23.4%); and suspending enteral nutrition (n=16; 19.7%).

The most frequent causes of loss of central venous catheter were: agitated and disorientated patient (n=9, 32.1%); removal of the catheter by the patient (n=7; 25.0%); and obstruction of the device (due to improper manipulation or heparinization or due to blood return) (n=7; 25.0%). The most frequent immediate actions adopted and registered by nurses: insertion of peripheral venous catheter (n=13, 46.4%); communicating the medical team (n=10; 35.7%); removing the device (when it was externalized, taut, obstructed and/or damaged) (n=10; 35.7%);

and applying occlusive and/or compressive dressing at the site (n=7; 25.0%).

The main causes of skin injuries were: agitated and disorientated patient (n=5; 26.3%); inadequate physical restraint of patient (n=4; 21.0%); lack of skin protection when placing the device (n=3; 15.8%); not alternating fingers for pulse oximetry (n=3; 15.8%). The most frequent immediate actions adopted and registered by nurses: applying occlusive dressing at the site (n=14; 73.7%); evaluating the lesion and communicating to the medical team (n=5; 26.3%); and guiding the nursing team regarding the rotation of sites and fixation of the device (n=3; 15.8%).

Accidental extubations were mainly caused by weaning from sedation, disconnected sedation or inadequate doses of sedation (n=9; 50.0%); followed by agitated or confused patient (n=7; 38.9%); companion who removed or "loosened" physical restraint (n=3; 16.6%); and weaning from ventilation (n=3; 16.6%). The most frequent immediate actions adopted and registered by nurses: reintubation (n=9; 50.0%); communication of the event to the physician (n=9; 50.0%); and use of oxygen catheter or Venturi mask (n=6; 33.3%).

Table 2 displays the degree of harm to patients caused by the AEs related to the use of equipment and materials. The degree of harm was classified by the nurses as: mild (n=42, 23.3%), severe (n=112; 62.2%), very severe (n=25, 13.9%) and extremely severe (n=1, 0.6%). The hospital under study uses the following classification for the degree of harm to patients: Mild – can cause minor injuries (temporary irritation or discomfort); Severe – can cause temporary disability (burn, minor skin injuries, minor fractures); Very Severe – can cause very severe injuries, with sequelae or need for chronic treatments; Extremely Severe – may have contributed to impending death. This classification was maintained in the present study, since it was engrained in the organizational culture of AE notification and the institution used it prior to the publication of the International Classification for Patient Safety<sup>(7)</sup>.

**Table 2** – Degree of harm generated by adverse events related to equipment and materials recorded in the Notification Occurrence System – Ribeirão Preto, SP, Brazil, 2015.

Degree of harm generated by adverse events related to equipment and materials	N	%
Mild	42	23.3
Severe	112	62.2
Very Severe	25	13.9
Extremely Severe	1	0.6
<b>Total</b>	<b>180</b>	<b>100</b>

## DISCUSSION

A systematic review on the assessment of AEs in hospitals identified, in nine studies published in the United States,

Australia, New Zealand, France, England, Denmark and Canada, that the incidence of AEs varied from 2.9 to 16.6 per 100 patients<sup>(2)</sup>. The present study found the occurrence of 4.05 AEs per 100 patients. Regarding age, gender and reason for hospitalization, the data found are similar to those from other studies<sup>(8-10)</sup>.

A study conducted at a public cardiology hospital in the city of Rio de Janeiro, Brazil, analyzed the occurrence of medication AEs and found that the probability of a patient surviving without an AE varies according to the length of hospital stay (at 30, 60 and 100 days the probability was 96%, 93% and 73% respectively). Therefore, the longer the time in the hospital, the higher the chances of having an AE<sup>(11)</sup>. These data corroborate those found in this study, since 47 (26.1%) and 54 (30.0%) of the patients who experienced an AE were hospitalized for 8 to 30 days and for 31 to 180 days, respectively.

However, regarding the work shift of occurrence of AEs, a study performed in the surgical clinic of a university hospital in Goiânia found that the events occurred mostly at the night shift (10.61%), followed by the morning shift (4.92%)<sup>(12)</sup>. This goes against the findings of this research, which showed that 75 (41.7%) of the events occurred in the morning shift.

Regarding the sector in which the events occurred, a study that analyzed the AEs in a private tertiary hospital in the city of São Paulo found results that disagree with those from the present study, since most of the AEs occurred in patients admitted to the ICU (44.9%) followed by Infirmaries/hospitalization units (33.2%)<sup>(9)</sup>. The present study found that 95 (52.8%) of the events occurred in Infirmaries and 62 (34.4%) in the ICUs and CCU.

A study performed in a university hospital in the Central-South region of the state of São Paulo analyzed 750 AEs in Notification Reports from a 2.5-year period and found that 73 events (9.7%) were related to the loss of tubes and catheters. Among the 73 AEs, 27.4% were related to loss of nasogastric tube and 27.4% to loss of central venous catheter<sup>(13)</sup>.

A study conducted in a surgical unit of a university hospital in Goiânia observed the occurrence of 264 AEs from 2005 to 2009 and concluded that the most prevalent AE was removal of tubes, drains and catheters (61.36%). Among these events, 64.82% involved nasogastric, nasogastric, orotracheal, urinary, cystostomy and gastrostomy tubes, while 17.28% occurred with peripheral venous catheters, 14.20% with central venous catheters and 3.70% with tubular drains<sup>(12)</sup>.

The present study also found a prevalence of AEs related removal/loss of tubes, catheters and drains, with 81 (45.0%) losses of feeding tube, 28 (15.5%) of central venous catheter, 18 (10.0%) of orotracheal tubes (accidental extubation), eight (4.4%) of long-term urinary catheters, five (2.8%) of drains, and four (2.2%) of other types of catheters.

A cross-sectional, retrospective study that analyzed patients' records in the surgical unit of a hospital belonging to the Network of Sentinel Hospitals found, among

the AEs related to equipment and materials, events related to clinical procedures/processes (53.26%) and inadequate maintenance of medical equipment (1.38%). Among the AEs related to the clinical process were unplanned removal of catheters, tubes and drains (10.6%), obstruction of catheter/drains/tracheal tube (5.96%) inadequate catheter fixation (0.46%) and others<sup>(14)</sup>.

Therefore, the results regarding the types of AEs related to equipment and materials are similar to several studies published in scientific journals<sup>(9,12-14)</sup>.

Regarding the causes of loss of feeding tube and the corrective/immediate actions found in the literature, a retrospective cross-sectional study carried out in 2010 in the ICU of a private hospital in the city of Rio de Janeiro found 141 unplanned removals of feeding tubes, of which 67% were enteral tubes and 33% were feeding tubes (gastrostomy and jejunostomy). The causes of these events included removal by the patient (50%), followed by obstruction (36%) and by other factors, such as: "unknown causes, vomiting, buried bumper syndrome, cough, tube wrapped in mouth, rupture of connection of the enteral tube during upper gastrointestinal endoscopy, knotting of enteral tube, body hygiene, enteral migration of jejunostomy tube" (14%)<sup>(15)</sup>. The present study also found as main causes of unplanned removal of feeding tube the removal of the tube by the patient (n=43, 53.1%) and obstruction of the device (n=20; 24.7%).

Some preventive nursing interventions indicated to avoid unplanned loss/removal of feeding tube are fixing the device properly, periodically observing the patient, measuring the external length of the tube at regular intervals, and restraining the patient if necessary (as prescribed). The recommendations to minimize the obstruction of these tubes are to wash them with water before and after the administration of diets and medications, every 4 hours during continuous feeding and after removal of the aspirated liquid; and completely dissolve macerated medications in liquid (if the medication is not available in liquid form)<sup>(16)</sup>.

Regarding the loss of central venous catheter, studies emphasize that patients and families should be instructed not to manipulate venous devices, nor to make connections or disconnections, and that care should be performed by the nursing professional<sup>(6,17)</sup>. In addition, to avoid obstruction of central venous catheters, it is recommended to flush the tubes using saline or heparin (according to the institution's protocol)<sup>(18)</sup> or to maintain continuous infusion of intravenous solution<sup>(19)</sup>. Data found in the present study reinforce the importance of the guidelines and interventions suggested in literature, since among the most frequent causes of loss of central venous catheter are removal by the patient (n=7, 25.0%) and obstruction of the device (n=7; 25.0%).

Regarding skin injuries, some recommendations should be considered to maintain the integrity of the skin when selecting and fitting a medical device: review and select medical devices in the institution based on the devices' ability to induce the least degree of damage from the

forces of pressure and/or shear; selection of more flexible and softer devices to minimize damage to skin; apply all medical devices following manufacturer's specifications; reposition the device whenever necessary and possible to prevent injuries<sup>(20)</sup>.

To avoid skin lesions caused by physical/mechanical restraints, it is necessary to monitor the level of consciousness, the vital signs and the skin conditions and circulation in and limbs restrained, which should be checked regularly (at least every hour) to prevent adverse events<sup>(21)</sup>. These measures should be emphasized, since this research presented five (26.3%) AEs related to skin injuries that occurred due to agitation and disorientation of the patient and four (21.0%) due to inadequate physical restraint.

Accidental extubation may occur due to psychomotor agitation, lack of adequate sedation, inadequate fixation or inadvertent movement of orotracheal tube, endotracheal cuff leakage, pull due to the weight of the extensions of the mechanical ventilator and during procedures performed by the nursing team, such as bed baths, position changes, moving the patient and in-hospital transfer<sup>(22-24)</sup>. Confirming these data, the present study showed that the two major causes of accidental extubation were weaning from sedation, disconnected sedation or inadequate doses of sedation (n=9; 50.0%), followed by agitated and/or confused patient (n=7; 38.9%).

A descriptive study carried out with nursing professionals from a General ICU of a university hospital in João Pessoa suggests that actions such as checking the patient's sedation, positioning the patient in a Fowler's position, evaluating the insufflation of the cuff, fixing change of the tube with a shoelace maintaining one hand in the endotracheal tube, positioning the orotracheal tube in a central position and maintaining its numbering at the corners of the mouth of the patient are preventive measures for accidental extubation<sup>(24)</sup>.

Regarding the degree of harm generated by AEs, a study that investigated 264 events found that 52.27% of them contributed to temporary damage, which required intervention or prolonged hospitalization, 1.14% caused damage and required intervention for maintenance of life and 0.38% contributed to or resulted in patient death<sup>(12)</sup>. The results of the present study indicated that 137 (76.1%) patients who had an AE related to the use of equipment and materials in nursing care required intervention or prolongation of hospital stay (112 (62.2%) cases considered severe and 25 (13.9%) very severe). There was one (0.6%) extremely severe event, which may have contributed to the imminent death of the patient.

The limitations of the present study are related to the fact that data was collected in a single medium-sized hospital and to the occurrence of failures and/or gaps in the completion of the AE notification forms. In order to conduct future research on this subject, the authors suggest a multicenter study and the use of other methods to detect AEs, such as field observation and retrospective audit of medical records.

## CONCLUSION

The use of equipment and materials in health care contributes substantially to the care, treatment and recovery of hospitalized patients, but it also represents risks when equipment is used improperly, disregarding the recommended preventive maintenance and/or specifications.

Identifying which equipment and materials can cause AEs, as well as the causes, actions taken and the degree of harm generated can alert health professionals to the prevention of this type of event and direct continuing education programs in services, minimizing harms to patients and ensuring their safety.

## RESUMO

**Objetivo:** Analisar a ocorrência de eventos adversos relacionados ao uso de equipamentos e materiais na assistência de enfermagem. **Método:** Estudo quantitativo, descritivo, com consulta às fichas informatizadas de notificação de eventos adversos de um hospital acreditado. **Resultados:** Foi constatada a notificação de 1.065 eventos adversos, 180 (16,9%) deles relacionados ao uso de equipamentos e materiais, sendo os mais frequentes: perda de sonda de alimentação (45,0%), perda de catéter venoso central (15,5%), lesão de pele (10,5%) e extubação acidental (10,0%). As principais causas e ações imediatas registradas foram, respectivamente: perda de sonda de alimentação – retirada da sonda pelo paciente (53,1%) e repassado o dispositivo (83,9%); perda de catéter venoso central – paciente agitado ou desorientado (32,1%) e puncionado catéter venoso periférico (46,2%); lesão de pele – paciente agitado ou desorientado (26,3%) e realizado curativo oclusivo (73,7%); e extubação acidental – paciente em desmame da sedação ou com sedação desligada/inadequada (50,0%) e reintubação (50,0%). Os graus de danos encontrados foram: ligeiro (23,3%), grave (62,2%), muito grave (13,9%) e gravíssimo (0,6%). **Conclusão:** A investigação da ocorrência de eventos adversos relacionados ao uso de equipamentos e materiais na assistência pode prevenir e minimizar danos ao paciente.

## DESCRITORES

Dano ao Paciente; Equipamentos e Provisões; Cuidados de Enfermagem; Segurança do Paciente.

## RESUMEN

**Objetivo:** Analizar la ocurrencia de eventos adversos relacionados con el uso de equipos y materiales en la asistencia de enfermería. **Método:** Estudio cuantitativo, descriptivo, con consulta a las fichas informatizadas de notificación de eventos adversos de un hospital acreditado. **Resultados:** Fue constatada la notificación de 1.065 eventos adversos, 180 (16,9%) de ellos relacionados con el empleo de equipos y materiales, siendo los más frecuentes: pérdida de sonda de alimentación (45,0%), pérdida de catéter venoso central (15,5%), lesión de piel (10,5%) y extubación accidental (10,0%). Las principales causas y acciones inmediatas registradas fueron, respectivamente: pérdida de sonda de alimentación – retirada de la sonda por el paciente (53,1%) y reintroducido el dispositivo (83,9%); pérdida de catéter venoso central – paciente agitado o desorientado (32,1%) y puncionado el catéter venoso periférico (46,2); lesión de piel – paciente agitado o desorientado (26,3%) y realizado apósito oclusivo (73,7%); y extubación accidental – paciente en discontinuación de la sedación o bajo sedación desconectada/inadecuada (50,0%) y reintubación (50,0%). Los grados de daños encontrados fueron: ligero (23,3%), severo (62,2%), muy severo (13,9%) y severísimo (0,6%). **Conclusión:** La investigación de la ocurrencia de eventos adversos relacionados con el uso de equipos y materiales en la asistencia puede prevenir y minimizar los daños al paciente.

## DESCRIPTORES

Daño del Paciente; Hospitalización; Equipos y Suministros; Atención de Enfermería; Seguridad del Paciente.

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