

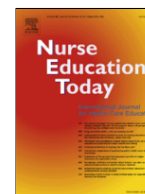


ELSEVIER

Contents lists available at ScienceDirect

Nurse Education Today

journal homepage: www.elsevier.com



Adverse events encountered during clinical placements by undergraduate nursing students in Spain

Marina García-Gámez^a, José Miguel Morales-Asencio^{a, b, *}, Silvia García-Mayor^{a, b}, Shakira Kaknani-Uttumchandani^{a, b}, Celia Martí-García^a, Inmaculada Lopez-Leiva^{a, b}, Álvaro León-Campos^{a, b}, Eloisa Fernandez-Ordoñez^c, Alfonso García-Guerrero^{a, d}, Rosa Iglesias-Parra^a

^a Faculty of Health Sciences, Department of Nursing, Universidad de Málaga, Spain

^b Instituto de Investigación Biomédica de Málaga (IBIMA), Spain

^c Área de Gestión Sanitaria Serranía, Spain

^d Distrito Sanitario Málaga-Valle del Guadalhorce, Spain

ARTICLE INFO

Keywords:

Patient safety
Safety management
Education, nursing, graduate
Medication errors

ABSTRACT

Background: During clinical placements, nursing students are exposed to adverse events generated by the clinical tasks they must perform.

Objectives: To describe the profile of adverse events encountered and the risks facing nursing students in clinical practice, as well as the severity and incidence of these events.

Design: Observational retrospective longitudinal study.

Setting: Clinical placements of undergraduate nursing students from the University of Málaga, in hospitals and primary health care.

Participants: A total of 4284 undergraduate nursing students, enrolled during seven consecutive years (2011–2018).

Methods: Study data were obtained from students' notifications of adverse events during their clinical placements. The form for making this notification is available online, in the virtual campus for the practicum and notification is mandatory.

Results: A total of 1638 reports of adverse events were made during the study period. The adverse events most commonly reported were clinical accidents, followed by sharp and needle-stick injuries, and medication errors. By clinical settings, adverse events occurring in critical care were most frequently reported (35.9%). By the severity of the event, the largest proportion (32.4%) were classified as serious. By the risk of recurrence, 49.8% of the events reported were classified as accidents that "could happen again at some time". In this respect, there were significant differences among the respondents, with fourth-year students reporting up to four times more events of this type than second and third-year students ($p < 0.001$).

Conclusions: Nursing students are subject to clinical safety-related events during their practices, mostly concerning medication errors and sharps and needlestick injuries. The pattern of these events changes over time, as students evolve in their competences. To improve clinical safety competencies among student nurses, priority attention should be paid to medication management, dose calculations and reactions to situations of aggression and violence in healthcare settings.

1. Introduction

The question of clinical safety is of acute importance in all health systems. In the USA, for example, over 400,000 clinical deaths

are recorded each year, and research evidence suggests that adverse events contributed to the death of 1.5% (15,000 over one million patients discharged from hospitals). The same study suggests that 44% (368 of a random sample of 838 patients) of serious medical events could be pre-

* Corresponding author at: c/Arquitecto Francisco Peñalosa, 3, 29071 Málaga, Spain.

Email address: jmmasen@uma.es (J.M. Morales-Asencio)

@jmmasencio (J.M. Morales-Asencio)

vented (James, 2013). In 2016, medical error was reported to be the third major cause of death in the USA, after cardiovascular problems and cancer (Makary and Daniel, 2016). Globally, some 42.7 million adverse events occur each year (Jha et al., 2013).

The main adverse events (AEs) that have been identified are adverse drug reactions, thromboembolism, vascular and urinary catheter infections, decubitus ulcers, nosocomial pneumonia and falls (Jha et al., 2013).

Systems for reporting incidents and AEs have been developed to address this challenge, and important efforts are being made to promote a safety-oriented culture within health organisations, with interventions such as hand-washing programmes, the safe identification of patients and the use of checklists (Graj et al., 2019; Rocco and Garrido, 2017). Moreover, care providers play an essential role in clinical safety, so that, aspects such as the nurse-patient ratio and the nurses' skill mix have been identified as essential elements in preventing AEs (Aiken et al., 2014; Ball et al., 2018).

Another strategic element in ensuring optimum levels of clinical safety in healthcare organisations is the skills training provided for future professionals. Thus, the WHO, with its Patient Safety Curriculum Guide (World Health Organization, 2011), and the Quality and Safety Education for Nurses project, among other initiatives, foster the continuous improvement of quality and safety in health systems via undergraduate education (Altmiller and Armstrong, 2017).

Almost all nursing students, at some point in their training and clinical placements, experience situations in which adverse scenarios or events compromise patient safety or that of the student. Studies carried out in various contexts have documented the existence of such AEs, although the reported incidence varies greatly, highlighting the magnitude of the problem and, in addition, revealing the frequently deficient notification of such problems (Christensen, 2018).

2. Background

Diverse approaches have been taken to the question of patient safety from the standpoint of nursing students, and research findings vary widely in this regard.

According to the review conducted by García-Gómez et al. (2019), up to 18% of the AEs related to the presence of students in clinical settings involve sharps and needlestick injuries. In another review, around it was stated that 28–30% of students experience medication errors in their clinical practice (Asensi-Vicente et al., 2018). To our knowledge, very few studies have investigated other types of AEs, such as falls, aggressions, or errors with medical devices in nursing students.

Furthermore, some studies have shown that although students are aware of safety standards, the necessary precautions are not systematically taken. For example, nursing students' adherence to handwashing recommendations is usually low (Labrague et al., 2018), with figures that range from 15.9% (Geller et al., 2009), to 25% (Gould and Ma, 2013), although some recent studies using objective measures have reported that the percentage of skin surface covered by alcohol-based hand rub was 82.0% on both hands (Öncü et al., 2018).

Other essential aspects of patient safety, such as the notification of incidents, are not always addressed in nursing skills training (Espin and Meikle, 2014).

Notification systems may be highly useful in enabling healthcare staff to learn from the experience of AEs, and promoting a culture in which changes can be made to ensure such problems do not repeat. However, most of the research in this area has mainly focused on the notification of medication errors by established health professionals (Vrbnjak et al., 2016), while few studies have analysed the question of students' notification of AEs, apart from those involving medication errors.

The aim of this paper is to analyse the characteristics of AE notifications by undergraduate nursing students during their clinical placements (in primary care, hospital care and nursing homes) and to evalu-

ate the association between these notifications and factors related to the students and their environment.

3. Methods

3.1. Design

Retrospective observational longitudinal study.

3.2. Sample and setting

The study population was composed of 4284 students enrolled in the undergraduate nursing degree offered by the University of Malaga (Spain) during seven consecutive years (2011–2018). This course has a duration of four years and requires 240 ECTS credits. Of these, 60 credits correspond to basic training, 84 are compulsory subjects, six are optional subjects, six are the final degree project and 84 are mandatory clinical placements in the health care system. The practicum experience is divided into seven internships to be performed during the last three years of the course, with rotations among different hospitals and health centres and among various healthcare services. This procedure is common to all nursing students. Students have a compulsory 150-hour subject on Patient Safety during their second year, prior to their first immersion in the clinical setting. First-year students did not participate in clinical placements and so were excluded from this study.

3.3. Study variables

The following study variables were considered: the semester in which the event was declared, setting (primary care, hospital, nursing home), type of unit (medical-surgical, critical care, health centre, obstetrical care, paediatric care, or mental health), the person affected by the event (patient, family caregiver or student) and the type of event, according to the classification proposed by the Andalusian Observatory for Patient Safety (AOPS) (Andalusian Observatory of Patient Safety, 2018): (a) structural: arising from environmental conditions, such as fire, catastrophe, flood, generating material loss and/or risk to the health and safety of patients, caregivers or staff; b) personal: producing risk to the student's health and safety, such as accidents during clinical practice, sharp and needlestick injuries, aggressions by a patient or family member, or any occupational disease; c) clinical: likely to harm the patient's health and safety (patient falls in the presence of the student, events related to invasive interventions -such as infiltrations, wound care, infections derived from procedures, etc.-, patient self-injuries, self-extubations, self-withdrawn catheters, anaphylaxis, adverse reaction to medications, non-detected allergies, error in medication administration, error in monitoring signs or symptoms). Finally, the severity of the event as classified by the student (catastrophic, severe, moderate, slight or none) was evaluated, together with a consideration of the risk of recurrence, according to the four-level criteria set by the AOPS ("It is very unlikely to ever happen again", "It is unlikely to happen again, but it is possible", "It could happen again, at some time", and "It will happen again and frequently").

3.4. Data collection

The study data were obtained from students' notifications of AEs during their practicum. The form for making this notification is available online, in the virtual campus (available upon request).

3.5. Analysis

Statistical analysis was carried out using frequency distributions, percentages and measures of central tendency and dispersion. The normality of the distributions was determined by asymmetry and kurtosis and the Kolmogorov-Smirnov test.

The frequency of notification of AEs was calculated by dividing the number of students reporting an AE, by the total number of students enrolled in the practicum during the study period.

The incidence of AEs notified was estimated from the total number of notifications recorded during the study period divided by the total number of students enrolled in the practicum during the same period.

Bivariate analyses were carried out using Student's *t*-test for independent samples, and the chi-square test, according to the characteristics of the variables analysed. ANOVA was used to examine the characteristics of the quantitative (number of notifications) and qualitative variables (clinical setting, course), with measures of central robustness (the Welch and Brown-Forsythe test) when non-homoscedasticity (according to the Levene's test) was observed. Finally, a multivariable analysis based on linear regression models was performed to identify risk profiles for the appearance of AEs, based on predictors related to the characteristics of the students, the clinical context and/or the patient. The level of statistical confidence assumed was 95% and all analyses were conducted using SPSS 25 software.

3.6. Ethical considerations

This study complies with the fundamental ethical principles expressed in the Declaration of Helsinki. The protection and confidentiality of the study data were ensured by the use of alphanumeric identification coding. No personal identification data were used in the data manipulation and analysis phases of the study. Permission for this study was obtained from both the Ethical Committee of Experimentation, and from the Research Commission of the Department of Nursing (within the Faculty of Health Sciences) at the University of Malaga.

4. Results

The study population was composed of 4284 students enrolled in the seven practicums performed during the study period (2011 to 2018). This population was divided in 1103 (25.74%) male students and 3161 (73.78%) female students. These students made 1638 notifications, accounting for 38.2% of all the students in this period. Of their notifications, 10.5% ($n = 172$) were made by second-year students, 7.5% ($n = 123$) by third-year students and 82.0% ($n = 1343$) by fourth-year students.

From the total number of notifications, 27.5% ($n = 450$) of the students who reported an event were men and 72.5% ($n = 1188$) were women.

Significantly fewer notifications were made in the earliest year of the degree course. On average, each second-year student made 4.1 notifications (SD: 5.0), while the third year students made 8.10 (SD: 10.9) and the fourth-year students 8.2 (SD: 6.9) ($F(2;1635) = 24.9$, $p < 0.001$). Male students provided more notifications than female students (9.13; SD: 9.70 vs 7.22; SD: 6.02; $t = -3.89$; $p < 0.001$).

The frequency of students' notifications was significantly higher during their clinical placements in hospitals, with regards to primary health care (mean: 7.98; SD: 7.48 vs mean: 6.01 SD: 5.1; $t: 4.60$; $p < 0.001$). Regarding the clinical settings in which AEs were reported, the most common location was that of critical care, where 588 (35.9%) AEs were declared. This was followed in frequency by paediatric care ($n = 378$, 23.1%), medical care ($n = 287$, 17.5%), primary health care centres ($n = 172$, 10.5%), mental health ($n = 124$, 7.6%), surgical care ($n = 59$, 3.6%), and obstetric care ($n = 30$, 1.8%). The mean of notifications ranged from 4.59 (SD: 5.47) in surgical care, to 15.33 (SD: 12.09) in obstetric care, ($F(6; 1631) = 11.54$; $p < 0.001$).

By event types, clinical AEs were most commonly reported (see Table 1), with errors in the administration of medication being most frequent ($n = 212$, 18.2%), followed by events related to errors in follow-up and/or monitoring ($n = 191$, 16.4%) and those related to invasive interventions ($n = 186$, 16%). Regarding to errors in the administration of medication, there were significant differences by course,

Table 1
Frequency of events, by type.

Event	n (%) ^a
Structural ($n = 605$; 36.9%)	
Equipment/device failure	124 (20.5)
Accident due to poor condition of building or infrastructure	71 (11.7)
Accident related to dangerous waste	121 (20.0)
Other	289 (47.8)
Total	605 (100.0)
Clinical ($n = 1164$; 71.0%)	
Fall by the patient in the presence of the student	148 (12.7)
Event related to invasive intervention	186 (16.0)
Self-harm by the patient	37 (3.2)
Anaphylaxis	19 (1.6)
Adverse reaction to medication	34 (2.9)
Undetected allergy	165 (14.2)
Error in the administration of medication	212 (18.2)
Error in follow up or monitoring	191 (16.4)
Other	172 (14.8)
Total	1164 (100.0)
Personal ($n = 626$; 38.3%)	
Biological accident	158 (25.2)
Aggression by the patient or a family member	101 (16.1)
Accident during clinical practice	264 (42.2)
Other	103 (16.5)
Total	626 (100.0)

^a Some events could be classified as more than one type.

with the second-year students reporting higher levels of clinical AEs than the third and fourth-year students ($n = 23$; 10.8%; $n = 12$; 5.7%, and $n = 177$; 83.5%, respectively) ($\chi^2 = 88.8$, $p < 0.001$).

Significant differences were also found in the types of clinical events according to the units in which the students were working. Thus, notifications of patients' falls and self-inflicted injuries were most frequent in the critical care area, while adverse drug reactions were most commonly reported in medical care, medication errors in paediatric care and mental health and, finally, errors in follow-up in obstetric care (see Table 2).

The factors generating the notifications were mainly patient-related ($n = 1143$, 69.8%), followed by those concerning the student ($n = 243$, 14.8%), structural causes ($n = 225$, 13.7%) and finally, those concerning the family caregivers ($n = 27$, 1.6%) ($\chi^2 = 158.6$, $p < 0.001$). A similar pattern was observed for students at all stages of their degree course.

The AE most commonly notified event among those of a personal type was that of an accident during clinical practice ($n = 264$, 42.2%), followed by needlestick and sharps injuries ($n = 158$, 25.2%) and presence during aggression by the patient or a family member ($n = 101$, 16.1%). There were important differences between students in different years of their course; thus, the second-year students reported 32 percentage points more biological accidents than those in the fourth year, while the latter reported 22.7 percentage points more episodes of aggression than the second-year students ($\chi^2 = 96.3$, $p < 0.001$).

With respect to the severity of the event, 32.4% of the events ($n = 530$) were classified as very serious, followed by 32.2% ($n = 528$) considered to be moderately serious, 23.7% ($n = 389$) as slight and 8.2% ($n = 139$) as trivial. Finally, 3.2% ($n = 52$) were termed catastrophic. The distribution of this severity varied among the students, with the fourth-year nurses being more likely to report the most serious events (Table 3).

Significant differences were observed between the severity of the event and the location in which the students' practice took place (Table 4). Thus, the events declared "serious" occurred mostly in the critical care areas, while those with only "slight" impact were more commonly reported in health centres and medical care units.

The students estimated the following likelihoods of recurrence of the events that they detected. In 49.8% ($n = 815$) of cases, it was considered that the event "could happen again, at some time", while

Table 2
Relation between area of clinical practice and type of adverse event.

Site	Fall by the patient in the presence of the student	Event related to invasive intervention	Self-harm by the patient	Anaphylaxis	Adverse reaction to medication	Undetected allergy	Error in the administration of medication	Error in follow up or monitoring	Other	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Health centre	7(4.7)	22(11.8)	2(5.4)	3(15.8)	3(8.8)	11(6.7)	13(6.1)	16(8.4)	26(15.1)	103(8.8)
Critical care	79(53.4)	64(34.4)	22(59.5)	9(47.4)	14(41.2)	61(37)	48(22.6)	72(37.7)	59(34.3)	428(36.8)
Medical care	20(13.5)	38(20.4)	4(10.8)	6(31.6)	12(35.3)	28(17)	34(16)	21(11)	25(14.5)	188(16.2)
Obstetrics	2(1.4)	2(1.1)	1(2.7)	0(0)	0(0)	3(1.8)	4(1.9)	8(4.6)	5(2.9)	25(2.1)
Paediatrics	30(20.3)	49(26.3)	6(16.2)	0(0)	3(8.8)	45(27.3)	78(36.8)	53(27.7)	37(21.5)	301(25.9)
Surgery	6(4.1)	6(3.2)	0(0)	1(5.3)	1(2.9)	1(0.6)	10(4.7)	6(3.1)	9(5.2)	40(3.4)
Mental health	4(2.7)	5(2.7)	2(5.4)	0(0)	1(2.9)	16(9.7)	25(11.8)	15(7.9)	11(6.4)	79(6.8)
Total	148(100)	186(100)	37(100)	19(100)	34(100)	165(100)	212(100)	191(100)	172(100)	1164(100)

χ^2 :122.21; $P < 0.001$.

Table 3
Distribution of severity of event, by study year.

Severity	2nd-year	3rd-year	4th-year	Total n(%)
	n (%)	n(%)	n(%)	
Catastrophic	0 (0)	2 (1.6)	50 (3.7)	52 (3.2)
Severe	18 (10.5)	34 (27.6)	478 (35.6)	530 (32.4)
Moderate	44 (25.6)	28 (22.8)	456 (34.0)	528 (32.2)
Slight	84 (48.8)	38 (30.9)	267 (19.9)	389 (23.7)
None	26 (15.1)	21 (17.1)	92 (6.9)	139 (8.5)
Total	172 (100)	123 (100)	1343 (100)	1638 (100)

χ^2 ; 125.87; $p < 0.001$.

in 26.1% of cases ($n = 427$), the opinion was “It is unlikely to happen again, but it is possible” and in another 20.8% ($n = 340$) that “It will happen again and frequently”. Only 3.4% of the students believed “It is very unlikely to ever happen again”. Those events classified by the students as “moderate” (39.1%) or “severe” (37.9%) (χ^2 : 76.6; $p < 0.001$) obtained the highest probability of recurrence, according with the students' perception. In this respect, too, significant differences were found among the students; thus, the fourth-year students reported a greater probability of recurrence ($n = 318$; 23.7% of these students, vs. $n = 12$; 9.8% of the third-year students and $n = 10$; 5.8% of those in their second year) ($\chi^2 = 77.9$; $p < 0.001$).

The analysis of severity and likelihood of recurrence across different settings yielded no significant differences, although less severe events were reported in primary care. Thus, severe or catastrophic events with a high likelihood of occurrence were 32.2% in hospital settings, while in primary health care was 31.1%. In the case of AEs with a low likelihood of occurrence and low or moderate severity, stu-

Table 4
Severity of events, by hospital area.

	Hospital area							
	Health centre	Critical care	Medical care	Obstetrics	Paediatrics	Surgery	Mental health	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Catastrophic	1(0.6)	25(4.3)	6(2.1)	2(6.7)	9(2.4)	2(3.4)	7(5.6)	52(3.2)
Serious	36(20.9)	222(37.8)	75(26.1)	5(16.7)	127(33.6)	16(27.1)	49(39.5)	530(32.4)
Slight	66(38.4)	105(17.9)	92(32.1)	6(20.0)	80(21.2)	19(32.2)	21(16.9)	389(23.7)
Moderate	52(30.2)	209(35.5)	82(28.6)	9(30.0)	124(32.8)	16(27.1)	36(29.0)	528(32.2)
None	17(9.9)	27(4.6)	32(11.1)	8(26.7)	38(10.1)	6(10.2)	11(8.9)	139(8.5)
Total	172(100)	588(100)	287(100)	30(100)	378(100)	59(100)	124(100)	1638(100)

$\chi^2 = 100.3$; $p < 0.001$

dents reported up to 65.5% in the hospital setting and 76.2% in primary health care (χ^2 : 1.73; $p = 0.193$).

A multivariable linear regression model was used to identify possible predictors of AE notification. With an acceptable degree of fit ($VIF < 1.2$ and tolerance > 0.8 for all the predictors) but with limited predictive capacity ($R^2 = 0.12$), the model showed that the students in the later years of the degree course, those who were male, those in the second semester of the year and those in study years when fewer students were enrolled, were more likely to report an adverse event (Table 5).

5. Discussion

The aim of this study was to analyse the characteristics of the notification of AEs by nursing students during their clinical placements in different healthcare contexts, and then to evaluate the association between these characteristics and certain factors relating to the students and their environment.

The main study findings were that the notification of AEs by nursing students varies according to the circumstances of the placement and to the year of the degree course. These notifications tend to concern more serious events, and to be made by third or fourth-year students, in settings traditionally associated with a high incidence of AEs, such as critical care, and paediatric units. These results corroborate those of previous studies in this regard, which have reported a greater presence of AEs in these contexts (Lin et al., 2014; Ministerio de Sanidad, 2009; Zárate-Grajales et al., 2015).

The number of AE notifications increases as students advance in their degree courses. This could be due to their progressive discriminating competence and increased sensitivity towards the culture of clinical safety. Previous research has reported that third-year students reported more events than those in their first or second year (Stevanin et

Table 5
Multivariate model to estimate the probability of notification.

	β	p	95% CI		Tolerance	VIF
			Inf	Sup		
Study years	0.25	<0.001	2.20	3.32	0.84	1.19
Male gender	0.07	0.002	0.44	1.95	0.97	1.03
Number of students	-0.24	<0.001	-0.09	-0.06	0.96	1.04
Semester0	0.16	<0.001	1.53	2.99	0.85	1.18

al., 2015). Petrucci and Small recorded a higher incidence of needlestick and sharps injuries among first-year students, suggesting this might be due to their inexperience and lack of skill (Petrucci et al., 2009).

Various studies concur in assigning an incidence of 17–18% to sharps and needlestick injuries, mostly caused during sample collection or catheter extraction (Orozco, 2013; Stefanati et al., 2015). It is important to analyse such AEs because of the feelings of fear, anger, insecurity and anxiety they may generate, together with the risk of infection or further injury (Lin et al., 2014; Hambridge et al., 2016).

AEs are most commonly notified for reasons concerning the patient, although in the early years of the degree course student-related factors may also be involved (this effect is absent among the fourth-year students). This pattern of event notification might be attributed to a greater awareness among students of more advanced courses of safety considerations, together with greater confidence in self-protection against adverse biological events, as their clinical experience increases.

Most previous studies in this field have examined AEs affecting students in the form of needlestick and sharps injuries and accidents in clinical practice, focusing on students rather than on patient-related factors (Geller et al., 2009; Gould and Ma, 2013; Canli & Aydin, 2013). However, we believe that this approach should be broadened to include events affecting patients, as well as those impacting on the student's own safety.

In our study, the patient-related clinical event that was most commonly reported was that of an error in the administration of medication, although the incidence was lower than in previous studies. Thus, Stevanin et al. reported a figure of 52.9% (Stevanin et al., 2015) and Westphal et al., 23% (Westphal et al., 2014). These differences could be due to the effect of educational strategies, and/or variations in the notification culture. Nevertheless, further comparative studies, both national and international, are needed to determine the cause and extent of this variability.

Other studies have suggested that the most common reasons for AE notification are medication errors, failure in mathematical competence and the incorrect use of formulas (Coyne et al., 2013; Bagnasco et al., 2016).

In our study, the greater number of reports made by fourth-year students concerning aggressions by patients or their family members is a noteworthy finding, which might be explained by the fact that it is at this stage of their studies that nursing students are assigned to work in areas such as mental health or critical care, where situations of conflict are more likely to arise (Spector et al., 2014). Other studies have found that 43% of students receive verbal and/or physical threats from a patient or family member (ANA, 2015).

Regarding the distribution of AE notifications according to the hospital area in which the clinical practice is performed, our results show that most events occur in the critical care and paediatric care environments. In the Spanish health care system, the critical care context is the area in which the most serious AEs are recorded (Ministerio de Sanidad, 2009; Zárate-Grajales et al., 2015).

The least serious events are usually declared in primary care, while those of moderate and greater severity are more often reported in hospital care. This finding was to be expected, due to the greater aggressiveness and invasiveness of procedures and techniques performed in the hospital context, such as vascular or urinary catheterization, man-

agement of artificial airways, insertion of feeding tubes, etc. To our knowledge, this differentiation by areas of health care has not been evaluated previously.

With regard to the probability of AE recurrence, very few students believe "It is very unlikely to ever happen again", and most are of the opinion that "It could happen again at some time". No previous studies have been undertaken to determine the risk of recurrence of an AE declared by nursing students, and so at present no comparison can be made in this respect. It is surprising that the second-year students believe the event is unlikely to happen again, while those in the fourth year of their course assign a higher probability to recurrence. The difference may be associated with the greater competence and awareness of clinical safety considerations among the older students, as well as their greater reflective and metacognitive capacity concerning the risk factors for AEs. However, it might also be attributed to the fact that in the initial stages of clinical practice, rotations take place in environments where AEs are more stabilised and where the safety culture is more solidly established. Nevertheless, more research is needed in this issue.

This study has some limitations. Firstly, our findings cannot readily be extrapolated to the case of other students if their degree course does not address clinical safety or if, during clinical placements, no emphasis is carried out on this issue as a key element.

Secondly, as the notifications considered in this study are self-reported, our analysis may be subject to under-report bias, although this issue has been confirmed in multiple studies. In addition, as the students are instructed to report AEs using the virtual campus, there could be a recall bias, since the notification must be made after the event has occurred.

With regards to the predictors identified in the multivariable analysis, the model has obtained a limited predictive capacity, and additional variables should be considered in future studies.

Finally, the results obtained may be influenced by differences in the safety cultures existing within each of the health organisations in which the clinical practice is performed. This is an aspect that should be considered in future research.

6. Conclusions

The findings obtained reflect a concentration of notifications regarding medication errors and sharps/needlestick injuries, together with a significant increase in the rate of notifications as students gain clinical experience. Over time, changes also take place in the focus of notifications, and in the students' estimation of the probability of recurrence of clinical safety incidents.

These results have significant implications for the educational strategies adopted in nurses' undergraduate training, providing detailed information about the magnitude of AEs and about the factors associated with their occurrence, thus allowing administrators to prioritise actions to improve competencies in clinical safety, in areas such as medication management and dose calculation, and to take appropriate action in response to aggression and violence in clinical contexts.

Multicentre studies are needed to facilitate comparisons between different universities and faculties, to identify and interpret heterogeneity in the results obtained and to determine whether the associations found are reproduced in different contexts. Finally, long-term longitudinal studies should be conducted to assess the long-term (i.e., post-graduation) impact produced on clinical safety by these training activities.

Funding source

None.

CRedit authorship contribution statement

Marina García-Gómez: Investigation, Validation, Data curation, Visualization, Writing - review & editing. **José Miguel Morales-**

Asencio: Conceptualization, Methodology, Software, Resources, Formal analysis, Data curation, Writing - review & editing. **Silvia García-Mayor:** Investigation, Validation, Writing - review & editing. **Shakira Kaknani-Uttumchandani:** Investigation, Validation, Writing - review & editing. **Celia Martí-García:** Investigation, Validation, Writing - review & editing. **Inmaculada Lopez-Leiva:** Investigation, Validation, Writing - review & editing. **Álvaro León-Campos:** Investigation, Writing - review & editing. **Eloisa Fernandez-Ordoñez:** Investigation, Writing - review & editing. **Alfonso García-Guerrero:** Investigation, Writing - review & editing. **Rosa Iglesias-Parra:** Investigation, Validation, Supervision, Writing - review & editing.

Declaration of competing interest

None.

References

- Aiken, L.H., Sloane, D.M., Bruyneel, L., Van Den Heede, K., Griffiths, P., Busse, R., Sermeus, W., 2014. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. *Lancet* 383, 1824–1830. [https://doi.org/10.1016/S0140-6736\(13\)62631-8](https://doi.org/10.1016/S0140-6736(13)62631-8).
- Altmiller, G., Armstrong, G., 2017. 2017 national quality and safety education for nurses faculty survey results. *Nurse Educ.* 42 (5), 3–7. <https://doi.org/10.1097/NNE.0000000000000408>.
- American Nurses Association (ANA), 2015. *Nursing Scope and Standards of Practice*, 3rd Ed, (ANA).
- Andalusian Observatory for Patient Safety, 2018. Available in <https://www.sspa.juntadeandalucia.es/agenciadecalidadsanitaria/observatorioseguridadpaciente/opencms/es/index.html>, Accessed 17 June 2018.
- Asensi-Vicente, J., Jiménez-Ruiz, I., Vizcaya-Moreno, M.F., 2018. Medication errors involving nursing students: a systematic review. *Nurse Educ.* 43, E1–E5. <https://doi.org/10.1097/NNE.0000000000000481>.
- Bagnasco, A., Galaverna, L., Aleo, G., Maria, A., Rosa, F., Sasso, L., 2016. Nurse education in practice. Mathematical calculation skills required for drug administration in undergraduate nursing students to ensure patient safety: a descriptive study. *Drug calculation skills in nursing students. Nurse Educ. Pract.* 16, 33–39. <https://doi.org/10.1016/j.nepr.2015.06.006>.
- Ball, J.E., Bruyneel, L., Aiken, L.H., Sermeus, W., Sloane, D.M., Rafferty, A.M., ... Griffiths, P., 2018. Post-operative mortality, missed care and nurse staffing in nine countries: a cross-sectional study. *Int. J. Nurs. Stud.* 78, 10–15. <https://doi.org/10.1016/j.ijnurstu.2017.08.004>.
- Christensen, L., 2018. Are clinical instructors preventing or provoking adverse events involving students: a contemporary issue. *Nurse Educ. Today* 70, 121–123. <https://doi.org/10.1016/j.nedt.2018.08.024>.
- Coyne, E., Needham, J., Rands, H., 2013. Enhancing student nurses medication calculation knowledge; integrating theoretical knowledge into practice. *Nurse Educ. Today* 33 (9), 1014–1019. <https://doi.org/10.1016/j.nedt.2012.04.006>.
- Espin, S., Meikle, D., 2014. Fourth-year nursing student perceptions of incidents and incident reporting. *J. Nurs. Educ.* 53 (4), 238–243. <https://doi.org/10.3928/01484834-20140217-04>.
- García-Gómez, M., Morales-Asencio, J.M., García-Mayor, S., Kaknani-Uttumchandani, S., Martí-García, C., Lopez-Leiva, I., ... Iglesias-Parra, M.R., 2019. A scoping review of safety management during clinical placements of undergraduate nursing students. *Nurs. Outlook* <https://doi.org/10.1016/j.outlook.2019.06.003>.
- Geller, N.F., Bakken, S., Currie, L.M., Schnall, R., 2009. Infection control hazards and near misses reported by nursing students. *Am. J. Infect. Control* 38 (10), 811–816. <https://doi.org/10.1016/j.ajic.2010.06.001>.
- Gould, D., Ma, N.D., 2013. Student nurses' experiences of infection prevention and control during clinical placements. *Am. J. Infect. Control* 41 (9), 760–763. <https://doi.org/10.1016/j.ajic.2013.01.025>.
- Graj, E., Sheen, J., Dudley, A., Sutherland-Smith, W., 2019. Adverse health events associated with clinical placement: a systematic review. *Nurse Educ. Today* 76, 178–190. <https://doi.org/10.1016/j.nedt.2019.01.024>.
- Hambridge, K., Nichols, A., Endacott, R., 2016. The impact of sharps injuries on student nurses: a systematic review. *Br. J. Nurs.* 25, 1064–1071.
- James, J.T., 2013. A new, evidence-based estimate of patient harms associated with hospital care. *J. Patient Saf.* 9 (3), 122. <https://doi.org/10.1097/PTS.0b013e3182948a69>.
- Jha, A.K., Larizgoitia, I., Audera-Lopez, C., Prasopa-Plaizier, N., Waters, H., Bates, D.W., 2013. The global burden of unsafe medical care: analytic modelling of observational studies. *Br. Med. J. Qual. Saf.* 22, 809–815. <https://doi.org/10.1136/bmjqs-2012-001748>.
- Labrague, L.J., McEnroe-Petite, D.M., van de Mortel, T., Nasirudeen, A.M.A., 2018. A systematic review on hand hygiene knowledge and compliance in student nurses. *Int. Nurs. Rev.* 65, 336–348. <https://doi.org/10.1111/inr.12410>.
- Lin, F., Wu, W., Lin, H., Lee, T., 2014. The learning experiences of student nurses in pediatric medication management: a qualitative study. *Nurse Educ. Today* 34, 744–748. <https://doi.org/10.1016/j.nedt.2013.08.004>.
- Makary, M.A., Daniel, M., 2016. Medical error—the third leading cause of death in the US. *Br. Med. J.* 353, i2139. <https://doi.org/10.1136/bmj.i2139>.
- Ministerio de Sanidad, Política Social e Igualdad, 2009. Incidents and adverse events in intensive medicine. Safety and risk in critically ill patients. Available from <https://www.seguridaddelpaciente.es/recursos/documentos/syrec.pdf>, Accessed 12 April 2019.
- Öncü, E., Vayisöglü, S.K., Lafci, D., Yıldız, E., 2018. An evaluation of the effectiveness of nursing students' hand hygiene compliance: a cross-sectional study. *Nurse Educ. Today* 65, 218–224. <https://doi.org/10.1016/j.nedt.2018.02.027>.
- Orozco, M., 2013. Accidentalidad por riesgo biológico en los estudiantes de enfermería de la Universidad de Ciencias Aplicadas y Ambientales U.D.C.A. Bogotá, Colombia. In: *Revista U.D.C.A Actualidad & Divulgación Científica* 16. ISSN: 0123-4226, pp. 27–33, Available from http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0123-42262013000100004&lng=en.
- Petrucchi, C., Alvaro, R., Cicolini, G., Cerone, M.P., Lancia, L., 2009. Percutaneous and mucocutaneous exposures in nursing students: an Italian observational study. *J. Nurs. Scholarsh.* 41, 337–343. <https://doi.org/10.1111/j.1547-5069.2009.01301.x>.
- Rocco, C., Garrido, A., 2017. Seguridad del paciente y cultura de seguridad. *Rev. Med. Clín. Las Condes* 28, 785–795. <https://doi.org/10.1016/j.rmcl.2017.08.006>.
- Spector, P.E., Zhou, Z.E., Che, X.X., 2014. Nurse exposure to physical and nonphysical violence, bullying, and sexual harassment: a quantitative review. *Int. J. Nurs. Stud.* 51, 72–84. <https://doi.org/10.1016/J.IJNURSTU.2013.01.010>.
- Stefanati, A., Boschetto, P., Previato, S., Kuhdari, P., De Paris, P., Nardini, M., Gabutti, G., 2015. A survey on injuries among nurses and nursing students: a descriptive epidemiologic analysis between 2002 and 2012 at a university hospital. *La Medicina Del Lavoro* 106 (3), 216–229.
- Stevanin, S., Bressan, V., Bulfone, G., Zanini, A., Dante, A., Palese, A., 2015. Knowledge and competence with patient safety as perceived by nursing students: the findings of a cross-sectional study. *Nurse Educ. Today* 35, 926–934. <https://doi.org/10.1016/j.nedt.2015.04.002>.
- Vrbnjak, D., Denieffe, S., O'Gorman, C., Pajnikhar, M., 2016. Barriers to reporting medication errors and near misses among nurses: a systematic review. *Int. J. Nurs. Stud.* 63, 162–178. <https://doi.org/10.1016/j.ijnurstu.2016.08.019>.
- Westphal, J., Lancaster, R., Park, D., 2014. Work-arounds observed by fourth-year nursing students. *Western Journal of Nursing Research* 36, 1002–1018. <https://doi.org/10.1177/0193945913511707>.
- World Health Organization, 2011. Patient safety curriculum guide. Multi-professional edition. In: *Patient Safety*. pp. 1–272. <https://doi.org/10.1097/00001888-200005000-00082>.
- Zárate-Grajales, R., Olvera-Arreola, S., Hernández-Cantoral, A., Hernández Corral, S., Sánchez-Angeles, S., Valdez Labastida, R., ... Zapién-Vázquez, M.A., 2015. Factors related to nursing-reported adverse events in intensive care units: multicenter project. *Enfermería Universitaria* 12, 63–72. <https://doi.org/10.1016/j.reu.2015.03.003>.