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Incidence and type of health care associated injuries among nursing students: an experience in northern Italy

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Abstract. *Background and aim of the study:* Nursing students are at high risk of injury while on clinical placement. The incidence of injury is three times higher in comparison to other healthcare workers, with a prevalence ranging from 25% up to 33,2%. Lack of knowledge and of experience in delivering nursing care, anxiety and unfamiliarity with the clinical environment all represent risk factors for injury. This study describes the number and type of injuries occurring in an organizational setting where nursing students are trained in simulation laboratories before being exposed to a real clinical environment. *Methods:* An eight year retrospective observational study (2009 to 2017) was conducted on a non-probabilistic population of 1,403 nursing students from a university in the north of Italy. Incident reports were anonymised and entered in a database. *Results:* Overall the percentage of students who reported an injury (6,2%) was much lower than the one reported in the literature. *Conclusions:* The nursing programme curriculum of the above mentioned university consists of frontal lectures, group works, simulation based sessions and supervised clinical practice designed to equip students with all the necessary knowledge and clinical skills to prevent health care injuries. Despite the encouraging results of this study, further actions in order to protect first year students, who are more subject to risk of injuries, are recommended.

Key words: nursing students, incidents, biological risk, occupational injuries, simulation, nursing tutoring

Introduction

The safety of health workers is paramount. Nursing students, while on placement, are considered to be at high risk of Healthcare Associated Injury (HAI) during clinical placement. In an Australian study, 13,9% out of 319 students reported a needle or sharp injury during the first two semesters of their nursing course (1). On the contrary, another study performed on 2047 students reported only 135 injuries (6,6%) (2). An Italian study compared the incidence of students' injuries within the nursing population over a period of 11 years and found 171 out of 909 biological HAI in nursing students (18,82%) (3). It is interesting to notice that whenever anonymous questionnaires were used to collect the HAI data, the results showed higher percentages than the retrospective studies in which written reports were used, with incidence rates of 25,2% (4) and 32% (5).

The level of knowledge of the procedures, the lack of experience in delivering them, and the first impact with the professional environment are factors that are directly associated with HAI during the period of clinical training (1). Therefore, the acquisition of pre-

ventive strategies including the proper use of safety devices is essential in order to minimize the incidence of HAI in the clinical setting (6).

The greatest risk factors for student injuries are stress, haste, inadequacy, inexperience and a low level of training. The risk of injury is higher in the initial semesters and lower in the last university year. In fact before completing their studies, undergraduate nursing students may benefit of a comprehensive theoretical and clinical learning experience and therefore they will be able to participate more actively and consciously in delivering patients' care. Furthermore they will learn how to properly use safety devices which are also considered as an effective measure of prevention to lower the number of injuries (3, 7). Furthermore, simulation and hospital based clinical training, which promote the proper use of safety devices, is proven to reduce the risk of injury in nursing students and to provide a better patients' care (8). In addition to the proper use of safety devices, first aid recommendations should be provided in case of an incident, according to the different types of injury and all incidents must be systematically reported (1) Furthermore, it is well known that in different clinical settings, where clinical training is carried out, safety devices are randomly used due to lack of time or to the unavailability of the devices. This scenario is further worsened by the frequent inattention of students in using security devices and the lack of reporting of any incident occurred (1).

Needle and cutting injuries are a significant risk for the transmission of infectious diseases, including Hepatitis C Virus (HCV), Hepatitis B Virus (HBV), and Human Immunodeficiency Virus (HIV). The World Health Organization (WHO) has estimated 16,000 cases of hepatitis C, 66,000 cases of hepatitis B and 1,000 cases of HIV as a consequence of needle injury (9). Moreover, percutaneous exposures account for 75% of all biohazard exposures reported by nurses (10).

Needlestick injury appears to be the most frequent incident, and usually occurs during the clinical procedure or immediately after while discharging the needle. In 19,9% of cases the injury occurs when using butterfly needles, in 18,6% when using standard needles, in 15,2% when using insulin needles and in 3.4 % when using blood lancets. The syringe needle determines 37% of injuries (4).

The areas most affected by the injuries are the hands (83,4%), specifically the fingers of the hand opposite to the dominant one (11). The mucocutaneous contacts with biological fluids are prevalent with 62,2% of exposures, with a 66,6% localization in the face and 91% in the ocular area (12).

During clinical training, nursing students perform a set of procedures at high risk of percutaneous and mucocutaneous exposure to blood potentially infected with pathogens. This risk decreases as students' clinical skills improve, as students' awareness of the biological risk is developed and as preventive measures are correctly applied. This suggests that the development of simulation laboratories for nursing practice, the presence of tutors during clinical placement, the elimination of unnecessary punctures and the implementation of industrial research for the development of safe technologies can improve working conditions while reducing the risk of occupational diseases in healthcare (7).

Students claim that "doing" rather than "reading and writing" aids learning in preparation for clinical training and practice. Studies show that those students who attend simulation laboratories acquire safe and controlled knowledge and skills. Moreover, tutors' clinical experience during laboratory activities is a vital as this contributes in making students' placement safer (8).

However, several studies show a lack of awareness of HAI risks and how these are underestimated by clinical tutors (registered nurses working in the clinical setting) and lecturers in clinical placement and simulation laboratories (13). This sparks a careful consideration of the organizational model of nursing degree courses, where university tutors are directly responsible for the management of simulation laboratories and clinical placement (8, 14).

The Italian Study on HIV Risk Occupational (SIROH) reported changes in knowledge among nursing students, before and after the first year of their degree course. Students in the first two years of nursing courses use gloves when handling needles, mainly as a self-protection procedure, especially during blood collection and intramuscular injections. However, this concept of self-protection has practical inconsistencies. In fact, it has been reported that a large percent-

age of students have maintained the habit of recapping the needle after use. This practice is considered one of the main causes of incidents (13). Since students underestimated the HAI risk a consistent training during all the university course is necessary together with and a tight cooperation between the university and the health agency staff (14).

Aim

The objective of this study is to describe the number and type of injuries occurred to students attending the nursing degree in a university in Northern Italy that has activated simulation laboratories and professional activities preparatory to the clinical placement.

Materials and methods

A retrospective observational study was conducted in which clinical placement injuries occurring to a cohort of nursing students were recorded and investigated.

The students enrolled in the present study received a modular and consecutive learning experience consisting of a mandatory attendance in the simulation laboratory, in-depth seminar activities, nursing science classes, safety courses and specific activities carried out with tutors.

The professional activities were delivered by university nursing lecturers, by clinical skills tutors, by members of the prevention and safety service of the health authority and by university tutors. The apprenticeships involved were the medical areas for the first year, the surgical areas, paediatric and operating room for the second year, critical area, psychiatry and home / family care for the third year.

The sample, of a non-probabilistic type, consists of students from all three years attending the nursing degree program who carried out the clinical placement from 2009 / 2010 to 2016 /2017. The study was carried out for a period of 8 academic years.

Data were collected in a database. Any personally identifiable information was removed from data sets and a numerical code was used for each subject. The following data were recorded: academic year, genre, training period, vaccine coverage for HBV and tuberculosis (TB), unit or ward, the day and time of the incident, training time preceding the incident, dynamic and prognosis. Data collection was authorized by the local Bioethical Committee.

The analysis was conducted with SPSS Version 24. For cardinal variables, univariate (ANOVA) and descriptive analyses were performed, calculating mean (M) and standard deviation (SD), with a confidence interval (CI) of 95%.

The categorical variables were evaluated through the non-parametric chi-square test. A value of $p < 0,05$ was considered statistically significant.

Results

1403 students took part in the present study; 481 (34,28%) were enrolled in the first year, 451 (32,14%) in the second year and 471 (33,57%) in the third year.

The planning of the internship activities is described in the materials and methods section. Daytime presence was 7 a.m. to 9.30 p.m. with a 7-hr and 15-min daily duty. Overall 87 (6,2%) clinical placement injuries were recorded; 41 (41,1%) occurred in the first year, 13 (14,9%) in the second year and 33 (37,9%) in the third year.

The non-parametric calculation shows no statistically significant differences ($X^2 = 12,309$, $P = ,581$) on the total number of incidents occurred for each Academic Year (AY). However, as shown in Table 1, the first-year and third-year students have a higher number of incidents than the second-year, especially in the Academic Year 2009/10 and 2015/16.

Gender does not show substantial differences (P=, 393). However, as expected by the predominant representation in course degree, the female population was the most affected (n = 28, 68,29%).

There are no differences regarding the times in which the incidents occurred ($P = ,957$); however, the most sensitive segment would seem to be from 10:00 to 14:00 with an average percentage of incidents > to 9,5% (figure 1).

On the dynamic characteristics and the anatomical sites affected by injury, there are no differences re-

Table 1. Overall distribution of injuries occurring to nursing students during clinical practice

Number of injured students	Year 1 n=41		Year 2 n=13		Year 3 n=33		Total N=87		
	n	%	n	%	n	%	N (%)	X^2	P
Academic year								12,309	,581
2009-10	8	19,51	2	15,38	5	15,15	15 (17,24)		
2010-11	5	12,20	3	23,08	2	6,06	10 (11,49)		
2011-12	6	14,63	2	15,38	4	12,12	12 (13,79)		
2012-13	3	7,32	1	7,69	6	18,18	10 (11,49)		
2013-14	2	4,88	3	23,08	4	12,12	9 (10,34)		
2014-15	3	7,32	1	7,69	4	12,12	8 (9,20)		
2015-16	8	19,51	1	7,69	6	18,18	15 (17,24)		
2016-17	6	14,63	-	--	2	6,06	8 (9,20)		

lated to the years of the course. Needle-stick injury shows a higher percentage (n = 45, 51,72%); injury mostly occurred (n = 57, 65,52%) during medication administration, mostly affecting the hand / finger area (n = 62, 72,09%) (Table 2).

Table 3 describes the trend of incidents during the eight academic years considered and demonstrates that needle injury significantly occurs during the procedure (P = <,0001).

It is interesting to note that the percentage of injury occurring during needle disposal (n = 9, 60%) in the 2009-10 AY almost halved in the following years. However, needle injury remains steadily high during the administration technique.

ANOVA analysis on the days and hours of clinical placement were injuries did not occur (Table 4) demonstrates that the incident-free interval is inversely proportional to student's year of study; in fact, this interval is shorter in first-year students than in students' enrolled in other years of their course: 211,20 ± 130,38 hours, followed by second-year students with 311,71 ± 209,39 and from third-year students with 391,45 ± 230,82, P = <,0001. Similar values are obtained when the number of days spent on clinical placement before

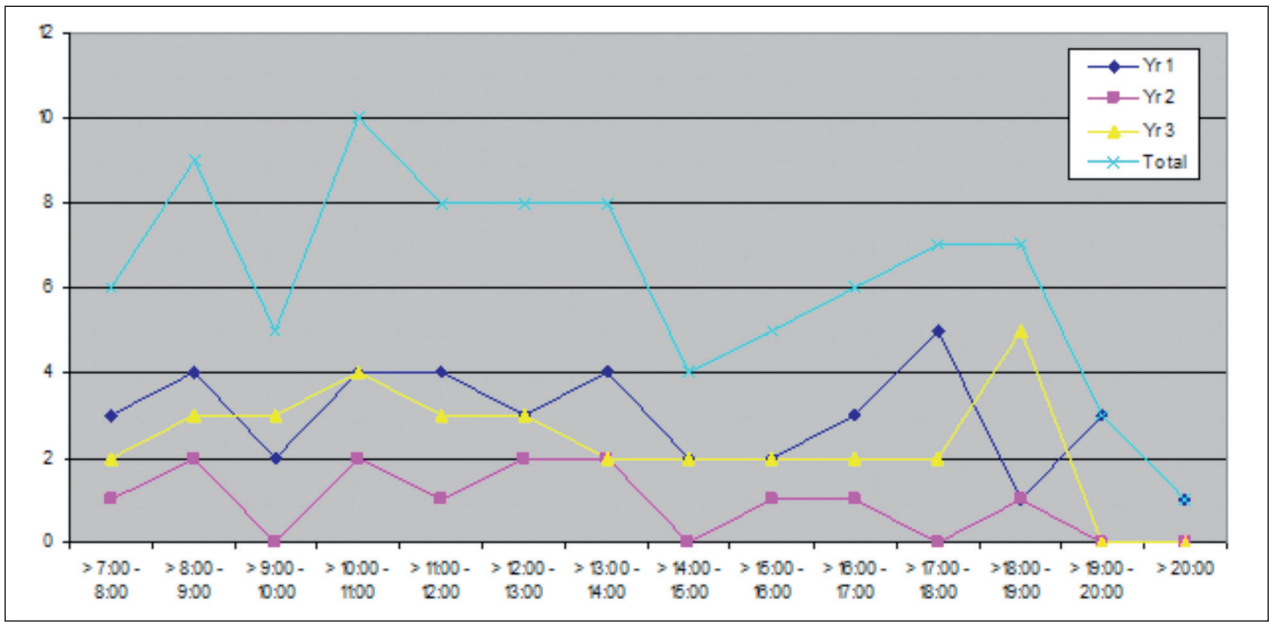

Figure 1. Distribution of injuries according to working hours

Table 2. Time and type of HAI

	Yr 1 n=41		Yr 2 n=13		Yr 3 n=33		Total n=87			
	n	%	n	%	n	%	n	%	X^2	*P*
Time									15,033	,957
>7:00-8:00	3	7,32	1	7,69	2	6,06	6	6,9		
>8:00-9:00	4	9,76	2	15,38	3	9,09	9	10,34		
>9:00-10:00	2	4,88	--	--	3	9,09	5	5,75		
>10:00-11:00	4	9,76	2	15,38	4	12,12	10	11,49		
>11:00-12:00	4	9,76	1	7,69	3	9,09	8	9,2		
>12:00-13:00	3	7,32	2	15,38	3	9,09	8	9,2		
>13:00-14:00	4	9,76	2	15,38	2	6,06	8	9,2		
>14:00-15:00	2	4,88	--	--	2	6,06	4	4,6		
>15:00-16:00	2	4,88	1	7,69	2	6,06	5	5,75		
>16:00-17:00	3	7,32	1	7,69	2	6,06	6	6,9		
>17:00-18:00	5	12,2	--	--	2	6,06	7	8,05		
>18:00-19:00	1	2,44	1	7,69	5	15,15	7	8,05		
>19:00-20:00	3	7,32	--	--	--	--	3	3,45		
>20:00	1	2,44	--	--	--	--	1	1,15		
Type of injury									9,181	,515
Needlestick injury	22	53,66	6	46,15	17	51,52	45	51,72		
Blood exposure	6	14,63	1	7,69	5	15,15	12	13,79		
Exposure to other body fluids	7	17,07	3	23,08	6	18,18	16	18,39		
Muscle skeletal injuries	--	--	2	15,38	2	6,06	4	4,6		
Sharps injury	5	12,2	1	7,69	1	3,03	7	8,05		
Other	1	2,44	--	--	2	6,06	3	3,45		
Type of dynamic									3,766	,439
Needlestick injury while preforming the procedure	29	70,73	7	53,85	21	63,64	57	65,52		
Needlestick injury at needle disposal	11	26,83	4	30,77	8	24,24	23	26,44		
Not specified	1	2,44	2	15,38	4	12,12	7	8,05		
Anatomic site of injury									7,386	,287
Head/face	11	26,83	3	23,08	8	25	22	25,58		
Hand/fingers	30	73,17	9	69,23	23	71,88	62	72,09		
Trunk	--	--	--	--	1	3,13	1	1,16		
Foot	--	--	1	7,69	--	--	1	1,16		

Table 3. Mode in which injuries in the academic years studied occurred

	2009-10 n=15		2010-11 n=10		2011-12 n=12		2012-13 n=10		2013-14 n=9		2014-15 n=8		2015-16 n=15		2016-17 n=8		Total		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	N (%)	X^2	*P*
																		30,4	,007
Needlestick injury while preforming the procedure	6	40	8	80	10	83	8	80	2	22,22	6	75	12	80	5	62,5	57 (65,52)		
Needlestick injury at needle disposal	9	60	2	20	--	--	1	10	4	44,44	2	25	3	20	2	25	23 (26,44)		
Not specified	--		--		2	17	1	10	3	33,33	--	--	--	--	1	12,5	7 (8,04)		

Table 4. Days and hours free of injury

	Yr 1 n = 41	Yr 2 n = 13	Yr 3 N = 33	Total n = 87		
	M±SD				F	*P*
Days of traineeship	30,76±18,5	45±29,97	56,28±32,89	42,41±28,66	8,448	,000
Hours of traineeship	211,2±130,38	311,71±209,39	391,45±230,82	293,46±201,27	8,554	,000

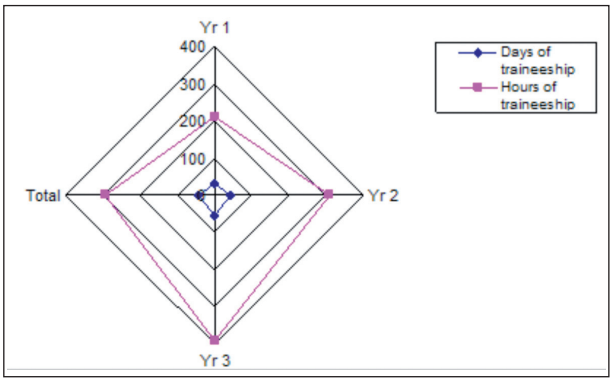

Figure 2. ANOVA analysis on the days and hours of traineeship spent free of injury

an incident are considered; 30,76 ± 18,50 for first-year students, 45 ± 29,97 for second-year students, 56,28 ± 32,89 for the third-year students, P = <,0001.

In figure 2, it is evident that the time spent in training before the incident report for second-year students, overlaps the total average of the days and hours of all three years of the nursing course.

Discussion

Overall the percentages of Healthcare Associated Injury (HAI) occurred to students in the eight academic years taken into consideration, were lower than reported in the literature (6,20%). (1, 3) However, these results could underestimate this phenomenon. In fact, it has been reported that half of the injured students tend not to report the incident (1, 15) and this explains the higher rate of injuries detected through an anonymous questionnaire administered to students (2, 4, 5).

The results of the study could be influenced by educational and organizational factors. Before going on clinical placement, students attended and passed the exams in the simulation laboratories where they applied the procedures and techniques learned during nursing classes. This allowed a possible knowledge consolidation related to the correct use of Personal Protective Equipment (PPE). The first-year laboratory activities have been supplemented by 16 hours of frontal teaching compliant with the 81/2008 Legislative Decree, dealing with health workers safety. Furthermore, in-depth seminars delivered during the nursing degree program also supported skills laboratory and clinical placement activities.

The need to evaluate the relationship between the number of skills laboratory hours and the number of exposures is already considered an important element that needs to be further explored in literature (2). The percentage of HAI detected, albeit low, does not prove that the adopted educational approach is better than other approaches currently in place in other universities. In fact, it is not possible to compare the number of students injured during the course of study with the number of HIA occurred in a previous teaching model, in which laboratory activities were not delivered. For this reason, it was not possible to evaluate the direct relationship between simulation and accident reduction during clinical placement.

The nursing degree program has developed specific teaching material preparatory to the clinical placement, which consist of topics integrated by theoretical and practical activities. Tutors' supervision of practical activities have fostered student critical thinking in care planning in pre, intra and post-training phases The organizational model, in accordance with the literature (2, 3, 5, 13), has allowed to reduce the risks of exposure, making students more aware and proactive during their time in the clinical setting.

The laboratory activities were carried out by ex-

pert clinical tutors, which actively collaborated with the university nursing lecturers, responsible for the teaching processes, in order to reduce the gap between theory and practice, favouring access to clinical placement. Most of the laboratory tutors supervised students during their clinical placement. This favoured a strong integration of clinical tutors in the university setting. According to Smith et al. (2), this dual function of laboratory tutors allowed students to prevent injuries and at the same time to have a solid and consolidated clinical training. In this regard, Stefanati et al. (3) support the important role of the clinical tutor integrated with the university system. Nursing professionals who supervise students must foster and increase trainees' awareness towards the biohazardous incidents and the correct and responsible use of the PPE.

Although the study does not highlight statistically significant differences between the number of injuries in the academic years taken into consideration, first-year students were more subject to incidents despite laboratory tests, safety courses, and tutoring. The number of injuries, although very small, depends on the student's individual difficulty in perceiving risk (17) within an organizational context in which the student has no previous experience (7). Another factor that can affect this result is the area in which the injuries occurred. In fact, first-year students spent 420 hours of training in the medical areas. This supports previous findings by Giuliani et al. (17) who showed that 63,7% of incidents occur in medical departments.

Another relevant figure is the percentage of incidents in third-year students (37,9%) that differ from percentages reported in the literature (7, 13). Possible explanations could include the clinical complexity encountered in the clinical area and the use of advanced techniques and complex devices, despite the fact that available studies suggest the adoption of less complex procedures, which might expose students to a higher risk of injury (7, 18).

The time slots in which there is a rate of incidents > 10% are 8 to 9 a.m. and 10 to 11 a.m. From this time onwards there is a progressive reduction interrupted by an afternoon peak > 8% in the slot from 5p.m. to 7 p.m. In this survey the students were exposed in time slots not confirmed by the literature (11); however, the current dynamism of the organizational and welfare models has affected the workplans of the operative units with consequent shifting of risk into different time slots.

Regarding the dynamics and the characteristics of the injury, the needle injury is the most frequent injury (51,72%). This occurs during the administration phase (65,52%); with 26,44% of injury occurring in the disposal phase. The most affected anatomical site is the hand / fingers with a 72,09%. The results are in accordance with those provided by previous studies (4, 11, 16).

This study also tried to map the average time spent by the student in training before the incident report. The results are in line with research carried out in this field (7) and provide valuable indications for establishing appropriate and effective teaching planning for tutors. Considering that the incidence of injury is higher in first-year students when compared to their second and third year colleagues, specific sessions were designed and carried out by the university tutors to tackle this phenomenon. These sessions could promote and strengthen the safety culture, in which students, clinical and / or university tutors, would no longer underestimate the risks of HAI, as highlighted by Bergamini et al. (13).

Students following injuries report negative feelings such as anxiety, fear, anger, worry, low self-esteem, insecurity, frustration and perception of insecurity (15). These feelings could lead students to drop out of their course, especially in the first year (19). From the analysed data none of the injured students dropped out. All students exposed to biological fluid risk followed the occupational medicine recommendations. This result contrasts with results reported by Almeida et al. (16), which recorded a drop-out rate of 32,8%. This discrepancy could reflect the activity of university tutors that met the injured students in one-on-one meetings or in small groups in which the internship experiences are re-elaborated together. This practice is essential and it will have to be implemented in the future. It is also very important to collect data on how incidents occurred in order to develop strategies to be shared in safety courses and simulation laboratories before the beginning of clinical placement.

Conclusions

The percentages of Healthcare Associated Injury (HAI) occurred to students in the eight academic years taken into consideration were lower than reported in the literature (6,20%).

The university has favored a model in which the training is planned and valued with preparatory and introductory professional activities. Students were engaged in a learning process consisting of simulation laboratory classes, in-depth seminar activities, nursing science classes, safety courses and dedicated tutoring activities. Professional activities were delivered by university nursing lecturers, clinical laboratory tutors, members of the prevention and safety service of the health authority and university tutors.

This model requires a close collaboration between the university and the healthcare regional system institutions. The activities described above were managed by clinical staff who were supported and supervised by university tutors, responsible for the teaching and learning process. The clinical placement was monitored by university tutors through meetings with small groups of students. These meetings took place throughout the academic year with the purpose of promoting students' self-reflection on care planning, sharing good practice and enhancing critical reasoning.

Limitations of the study

Students recruitment limited to a single campus in a university with multiple campus and the small sample size represent the limitations of this study.

Given the importance of the topic, it is advisable to conduct a cross-sectional study involving students from different nursing degree programs throughout the national territory. This would allow to compare different teaching and organizational models and to indicate what could further limit the incidence of HAI.

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