Trend analysis and factors associated with biological injuries among health care workers in Southern Italy

Vincenza Cofini[1], Alberto Capodacqua[1], Santina Calisse[2], Italia Galassi[2], Lora Cipollone[2], Stefano Necozione[1]

[1] Department of Life, Health and Environmental Science, University of L'Aquila, Italy
[2] Hospital Management of SS. Filippo e Nicola Hospital, Avezzano (AQ), Italy

SUMMARY

Background: *Biological injuries are the most common and serious among health care workers.* **Objectives:** *This study aims to estimate the injuries' incidence, job distribution and temporal trend in a hospital in Southern Italy.* **Methods:** *Data on accidents, collected from January 2010 to December 2016, were analyzed. Poisson distribution was used to calculate incidence rates and respective 95% confidence intervals. Trends were analyzed using the Joinpoint regression model. A multiple logistic regression model was used to identify factors associated with injuries.* **Results:** *Three hundred and thirty-five injuries were reported from 2010 to 2016, occurring mainly in the morning (54%) and frequently caused by needlestick (70%). We observed a significant decline in the incidence rates of the total amount of injuries (ACP=-11.3; 95% CI: -16.3 – -5.9), for nurses (ACP=-15.7; 95% CI: -24.3 – -6.2) and for health and social care assistants (ACP=-13.2; 95% CI: -23.1 – -2.0). Among male physicians the risk of biological accident was higher than female physicians (OR=3.67; 95% CI:1.9-7.1), while among male nurses the risk was lower than among female nurses (OR=0.31; 95% CI: 0.17-0.59). For the nursing category, "afternoon" and "night" represented risk factors with OR=2.19 (95% CI: 1.2-3.7) and OR=8.8 (95% CI: 3.4-22.8) respectively. For physicians, surgical intervention was a risk factor (OR=7.71; 95% CI: 3.2-18.4).* **Conclusions:** *Our findings confirm the need for continuous monitoring and improved control of work-related exposures, both for health and the associated costs.*

RIASSUNTO

***«Analisi temporale e fattori associati a infortuni biologici tra gli operatori sanitari del Sud Italia».* Introduzione:** *Gli incidenti a rischio biologico sono i più comuni ed i più gravi tra gli operatori sanitari, con un'incidenza in Italia di 100.000 infortuni l'anno.* **Obiettivi:** *Investigare gli infortuni con rischio biologico in un ospedale del Sud Italia.* **Metodi:** *I tassi di incidenza e gli intervalli di confidenza al 95%, sono stati da calcolati con distribuzione di Poisson, da gennaio 2010 a dicembre 2016. La regressione Joinpoint è stata utilizzata per l'analisi dei trend, la regressione logistica multipla per identificare i fattori associati agli infortuni.* **Risultati:** *Nel periodo considerato sono stati segnalati 335 infortuni, verificatisi principalmente durante la degenza, al mattino (54%) e causati da aghi (70%). Abbiamo osservato un calo significativo dei tassi di incidenza totali (ACP=-11,3; IC 95%: -16,3 – -5,9), tra gli infermieri (ACP=-15,7; IC 95%: -24.3 – -6.2) e tra gli assistenti socio-sanitari (ACP=-13,2; IC 95%: -23,1 – -2,0). Tra i medici il rischio di incidente è più alto tra gli uomini (OR=3,67; IC 95%: 1,9-7,1), tra gli infermieri il*

rischio è più basso di quello delle infermiere (OR=0,31; IC 95%: 0,17-0,59). Per gli infermieri, "pomeriggio" e "notte" rappresentano i fattori di rischio (rispettivamente OR=2,19; IC 95%: 1,2-3,7; e OR=8,8; IC 95%: 3,4-22,8). Per i medici, l'intervento chirurgico rappresenta un fattore di rischio (OR=7,71; IC 95%: 3,2-18,4). **Conclusioni:** *Il monitoraggio continuo ed un migliore controllo delle esposizioni appare necessario, sia per la prevenzione della salute sia per i costi degli infortuni.*

INTRODUCTION

Among occupational accidents of health care workers (HCWs), injuries with biological risk are frequent and they are the most dangerous ones, presenting an incidence of about 1,200,000 injuries/year in Europe and 100,000 injuries/year in Italy (10, 24). Health care workers from clinical units are considered more exposed to biological risk injuries compared to workers from service and administrative units, because of the high exposure to blood and biological liquids (5,6,27).

The most important consequence of biological injury is the exposure to illnesses' etiological agents and blood transmission, in particular to the hepatitis B virus (HBV), the hepatitis C virus HCV), and the human immunodeficiency virus (HIV) (22).

The accidents at risk of emo-transmitted illnesses represent about 40% of all injuries in the hospital setting (13).

Various measures have been implemented in Italy and Europe to minimize the risk of sustaining needlestick and sharps injuries (NSIs) (5,14,16). To our knowledge, few Italian studies have been focused on the incidence rate of injuries with biological risk in HCWs. The studies we are familiar with have examined rates in individual Italian hospitals over short time spans or for specific health worker categories (2,7,11,26).

Understanding the rate variation of the injury and the associated factors is useful to interpret results from performed prevention strategy and to compare rates among hospitals. This was a pilot study to contribute to planning a specific hospital surveillance system on occupational accidents with biological risk, among all the hospital workers. The principal aim of this study was to investigate the incidence trend rate of injuries at biological risk among the HCWs; the secondary objective was to investigate the factors associated with injuries among physicians and nurses.

METHODS

This observational study used administrative data on injuries with biological risk among 5.671 HCWs employed in "SS. Filippo e Nicola" Hospital in Southern Italy.

The study was authorized by the Hospital Management of SS. Filippo e Nicola Hospital, and the data were treated anonymously.

Measurements

Administrative data on biological accidents, defined as blood or body fluids splash, needlestick injury, or a cut made by a contaminated instrument, collected by the Hospital Management, from January 2010 to December 2016, were analyzed.

The data set include information on:
- characteristics of injured health workers (sex, age, job category, years of practice, vaccination and serological status);
- work injuries (event description, Department, type of exposure, type of used devices, type of involved procedures, use of individual protection devices).

Statistical analysis

We calculated incidence rates with 95% CIs for each year with Poisson distribution. The numerator was the number of injuries in each professional group on focus, while the denominator was the number of person-years in the equivalent group of the workforce. Person-years were calculated separately in all strata, meaning that a person could contribute in different groups for each year.

We further analyzed the data with Joinpoint regression model to investigate the pattern of the incidence rates. Joinpoint regression model analyses rates, proportions, and any other measure that can

be considered (e.g., counts) over time, in order to identify the possible time points at which any given trend changes (these are the joinpoints) and to estimate the regression function with the previously identified joinpoints (23).

We used the log transformation of half-yearly data from 2010 to 2016 and we fixed to 1 the maximum number of joinpoints. We selected the final model using the method of Permutation Test (PT) with alpha 0.05.

Among injuries, we performed a categorization of nurses' injuries (yes/no) and physicians' injuries (yes/no) and we performed a separate logistic model to investigate the factors associated with injuries. The variables sex, age (20-40; 41-60), years of practice (continuous), area of practice (medicine/surgery), needlestick injuries (yes/no), timing of injury (morning, afternoon, night), type of involved procedures (needle use, surgery, other) were entered as covariates in a multiple logistic regression model to identify factors associated with injuries among physicians and nurses separately, with the backward stepwise procedures (pe=0.15, pr=0.20). The odds ratios (OR) and the 95% confidence intervals (95% CI) were calculated. The Joinpoint Regression Program, Version 4.5.0.1 - June 2017; Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute was used for the Jointpoint regression analysis (http://www.srab.cancer.gov/joinpoint/), while Stata 14 was used for all other analysis; alpha error was set at 0.05.

Results

Three hundred and thirty-five injuries were collected from 2010 to 2016, related to 5,671 HCWs. The analyses were based on high quality records. The fraction of missing information (FMI) was 0.3% for seven variables (one missing) and 1.8% for one variable (six missing).

The overall incidence rate of work injuries per 100 person-years was 5.9 (95% CI: 5.3 to 6.6).

Table 1 describes the injured HCWs, reporting demographic and professional characteristics during the study period.

Table 2 reports the characteristics of the injuries. The majority of the injuries were registered in the

hospital stay, during the needle disposal procedure, in the antemeridian shift and in 70% of cases they were represented by needlestick injuries.

The joint regression analysis didn't report jointpoint for risk injuries during the 6 years study period (p=0.25), but indicated a significant negative trend (β=-0.12, p<0.001) with a significant annual change percent ACP=-11.3 (CI95%: -16.3 - -5.9, p<0.001) (figure 1).

The trend of injuries that occurred in the afternoon was significantly decreased ACP=-17.2; [95% CI: -24.7 - -12.9, p<0.001]. There was a significant negative trend for needlestick injuries with ACP=

Table 1 - Characteristics of the HCWs with injuries (n=335)

Age (mean±sd)	41.3±12.0
Gender	
Female	243 (73%)
Male	92 (27%)
Job category	
Physician	64 (19%)
Nurse	144 (43%)
Nursing student	65 (20%)
Healthcare assistants (HCAs)	38 (11%)
Other professions	24 (7%)
Years of practice (mean±sd)	11.19±9.7
Department	
Surgery	106 (32%)
Medicine	87 (26%)
Emergency	90 (27%)
Operating room	9 (3%)
Others	41 (12%)
Aspartate Aminotransferase (AST)*	21.9±6.8
Normal §	323 (96%)
Abnormal	11 (4%)
Alanine aminotransferase (ALT)*	25,2±11,3
Normal §§	326 (97%)
Abnormal	8 (3%)
Vaccination for HBV	316 (94%)
Protective title use for HBV (yes)	290 (87%)
Anti HBs positive (>10 UI/L)	288 (86%)
Seroconversion	
HCV	0%
HIV	0%

* Totals differ from 335 due to missing data
§ Normal range: 15-46 U/L ; §§ Normal range: 7-56 U/L
HBV: Hepatitis C Virus; Anti HBs: anti-Hepatitis B surface; HCV: Hepatitis C Virus; HIV: Human Immunodeficiency Virus

-5.1 [95% CI: -8.8 - -1.3 p<0.00]. In general, there were negative trends for females and males with ACP (females)=-4.6; [95% CI: -8.1 - -0.9, p<0.001], and ACP (males) -5.8; [95% CI: -10.3 - -1.1, p<0.001].

Table 2 - Characteristics of injuries collected in SS. Filippo e Nicola Hospital from 2010 to 2016 (n=335)

	n (%)
Place of injury *	
Hospital stay	141 (42.09%)
Operating room	58 (17.31%)
Emergency room	31 (9.25%)
Medical center	19 (5.67%)
Intensive care/Resuscitation	19 (5.67%)
Laboratory	15 (4.48%)
Medical clinic	11 (3.28%)
Sector room/Engraver	9 (2.69%)
Diagnostic Room	5 (1.49%)
Angiographic room	3 (0.90%)
Home care activities	3 (0.90%)
Ambulance	2 (0.60%)
Hemodynamic room	2 (0.60%)
Sterilization center	1 (0.30%)
Timing of injury*	
Morning (07:00 – 14:00)	180 (53.8%)
Afternoon (14:00 – 21:00)	112 (33.4%)
Night (21:00 – 07:00)	39 (11.6%)
Type of exposition*	
Needlestick injuries	229 (69.55%)
Mucosal exposure	47 (14.03%)
Sharp wound	35 (10.45%)
Damaged skin exposure	19 (5.67%)
Not known	1 (0.30%)
Individual protection devices use	
Yes	300 (89.55%)
No	35 (10.45%)
Procedure being performed at the time of exposure	
Needle disposal	50 (14.93%)
Withdrawal	33 (9.85%)
Surgery	33 (9.85%)
Waste/linen disposal	15 (4.48%)
Drip removal	21 (6.27%)
Intramuscular injection	9 (2.69%)
Laboratory activity	8 (2.39%)
Surgical instruments washing	6 (1.79%)
Dialysis switch-off	1 (0.30%)
Recapping	1 (0.30%)
Other practices	158 (47.16%)

*Totals differ from 335 due to missing data

Trend analysis indicated a significant decline for injuries among nurses and health and social care assistants with ACP=-15.7; [95% CI: -24.3 - -6.2, p<0.001] and ACP=-13.2; [95% CI: -23.1 - -2.0, p<0.001], respectively. Negative trends were also estimated for other professional categories but the reduction was not significant.

As reported in figure 2, among nurses, the incidence rate estimated in 2010 (11.8*100 person-years) was significantly higher than the rate calculated in 2015 (3.3*100 person-years) and the rate calculated in 2016 (4.2*100 person-years).

The multivariate logistic model indicated that for physicians, male gender and surgical intervention were risk factors for injuries, while for nurses, male gender and working in the surgical area, rather than the medical area, were protective factors (table 3).

Discussion

Injuries with biological risk among HCWs represent the main professional risk in the hospital setting (40-50% total) with the hazard of significant costs, increasing over time (16, 26).

We evaluated annual injuries with biological risk incidence rates among HCWs in an Italian hospital from 2010 to 2016. The overall incidence rate of work injuries per 100 person-years was 5.9 (95% CI: 5.3 to 6.6), and as expected, because of the introduction of new legislation, the trend was significantly negative with ACP=-11.3; [CI95%: -16.3 - -5.9; p<0.001].

The reduction was expected as a consequence of the introduction of the Law "Testo unico sulla salute e sicurezza sul lavoro (2008)" and the following European directive of 2010. This reduction was probably correlated to the fact that in the examined Hospital, since 2013/2014 specific programs of prevention for HCWs safety at work were promoted.

According to Macias et al., injuries mainly occur during the morning, likely because in this time period there is more personnel at work and the activity in Italian hospital units is more intense, compared to afternoon and evening shifts (15).

Injury time trends based on time slots showed a significant decrease only in the afternoon shift with ACP=-17.2; [CI 95%: -24,7 - -12,9, p<0,001]. Our analysis highlighted that the nursing category is
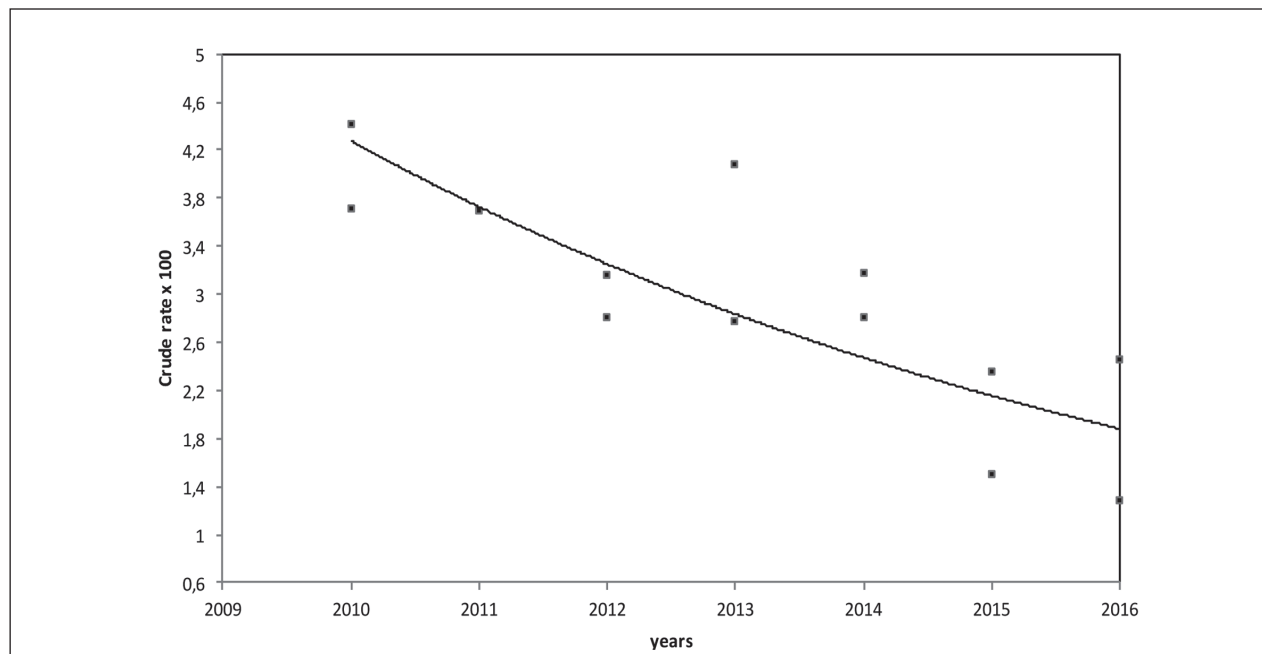
Figure 1 - Injuries trend during the study period 2010-2016 (crude rate*100 person-years): ACP 11.27 (p<0.01)

mainly affected, in line with the evidence provided by previous studies (10, 19, 25, 26). The incidents reported by nurses or health and social assistants significantly diminished with time and in particular the incidence rates amongst nurses were reduced from 2015.

For the categories of physicians, nursing students and other operators, the trend was negative but it was not significant. This result appears to be in line with what was reported by the 2012 Italian study, in which it was emphasized that nurses were more cautious in prevention than physicians (8).

The study points out that in the examined hospital, the majority of injuries were linked to needlestick injuries with a total value of 70% in line with what was reported by Di Bari et al. (75%) and Davanzo et al. (76%) but in contrast with the data reported in other studies (4, 19, 21). The differences highlighted should probably be considered in relation to the conclusions drawn by other studies, as well as the different logistical characteristics of the hospitals investigated and the various relevant health authorities.

The study has noted that needlestick injury trends have significantly decreased with ACP=-5.1 [CI 95%: -8.8 - -1.3; p<0.001], underlining a meaningful decrease from 2014, likely correlated to the implementation of security procedures in the hospital over the years.

The risk of needlestick injuries and infection through contaminated blood is usually a consequence of inadequate use of personal protection devices; in this case it is stressed that the primary method to avoid these injuries is represented by the correct and scrupulous application of the standard precautions (12, 18, 28).

From our analysis, thirty-one injuries (9%) occurred to HCWs without the appropriate protection, lower than the 31% reported by a German study (3).

In our study, a statistically significant relationship was found between the occurrence of injuries and gender, in line with the study of Pili et al (20).

Males were at risk less than females among nurses (OR=0.31; 95% CI: 0.17-0.59), but more than females among physicians (OR=3.32; 95% CI:1.8-6.2). This result could be related to the unbalance gender data between physicians and non-physicians health workers.

Our results are consistent with the findings from different studies about the fact that female nurses
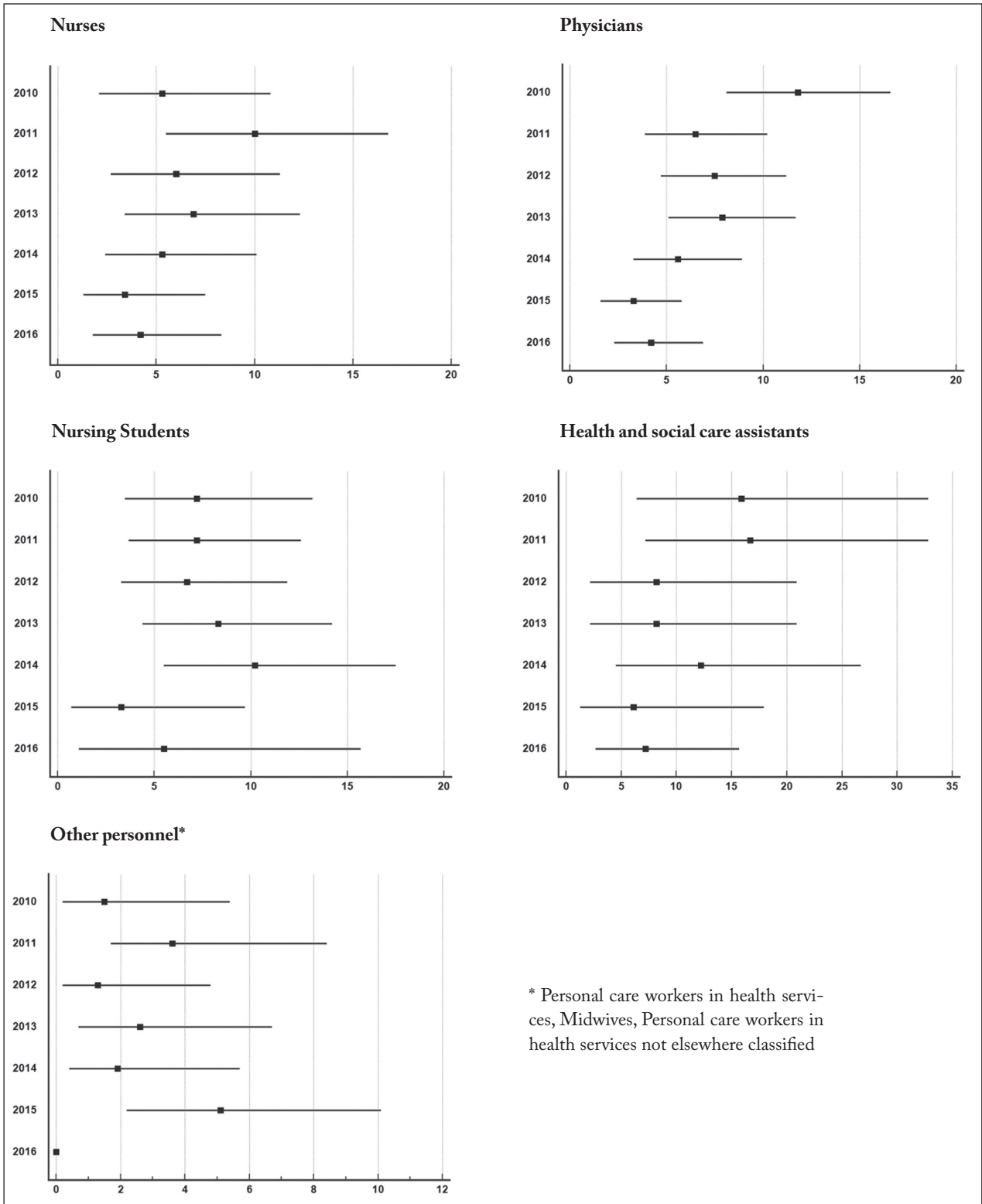
Figure 2 - Incidence rate (x100 person-years) for personnel employed in SS Filippo e Nicola Hospital (2010-2016)

Table 3. Associations between factors and injuries among Physicians and Nurses (Multivariate Logistic regression analysis)

Job category	Variables	OR	p	95% CI
Physicians				
	Gender			
	Female	1		
	Male	3.67	0.00	1.9-7.1
	Timing of injury			
	Morning (7am-2pm)	1		
	Afternoon (2pm-9pm)	2.0	0.04	1.0-3.9
	Type of procedures involved			
	Needle use	1		
	Surgical intervention	7.71	0.00	3.2-18.4
Nurses				
	Gender			
	Female	1		
	Male	0.31	0.00	0.2-0.6
	Age (range)			
	20-40			
	41-60	1.62	0.11	0.9-2.9
	Years of practice	1.04	0.02	1.0-1.1
	Timing of injury			
	Morning (7am-2pm)	1		
	Afternoon (2pm-9pm)	2.1	0.01	1.2-3.7
	Night (9pm-7am)	8.8	0.00	3.4-22.8
	Area of practice			
	Medicine	1		
	Surgery	0.36	0.00	0.2-0.6

were at higher risk of injuries than other HCWs, particularly for needlestick injuries, in developed as well as developing countries (1, 29).

Some studies report that work experience is associated with injuries: in our study, years of practice is not a factor associated with injuries neither among doctors nor nurses (3,18).

There are some limitations in this study that should be taken into consideration when interpreting the results.

A limit of the study is that the collected data don't allow us to correlate the injuries with the typology of treated patients, neither with the hours worked by the employees at the moment of the injury, that could represent an important risk factor (9).

However, the study could be useful for a first level analysis - at low cost- to identify the personnel categories or the areas that need to be studied further.

Another limit of the study is the lack of information about the subsequent work absence caused by the injury, that would allow an investigation of the knock-on costs resulting from the injury.

Nevertheless, the study could represent a valuable resource both for the sensitization of the biological risk theme and for the protection of workers' health. The research confirms the importance of a surveillance system and prevention strategies, in the business and the social perspective to control the costs associated with the work accident. While the costs for their prevention may seem high at the beginning, ultimately they prove to be the opposite because of resulting cost savings (16).

CONCLUSIONS

The call to prevention and security management among health care workers has certainly contributed to the better administration of the injury risk and the biological risk amongst the hospital employees in the case study. The hope is to implement a surveillance system that could promptly allow to intervene in a specific and effective manner for the control of injuries, mainly in the categories in which a significant reduction wasn't registered.

No potential conflict of interest relevant to this article was reported by the authors

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