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User-friendly system (a smartphone app) for reporting violent incidents towards emergency nurses in the Emergency Department: an Italian multicenter study

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Summary

Background: *Nurses, particularly emergency nurses, are among the health workers most exposed to workplace violence. Although reporting systems are increasingly used, under-reporting remains high. Recent studies suggest that the use of easy registration systems could facilitate violence reporting.* **Objectives:** *To verify if a friendly reporting system based on a Mobile-app can facilitate the reporting of violent episodes and reduce under-reporting.* **Methods:** *Twenty emergency departments of five North and Central Italian regions participated in an interventional, multicentric, pre-post study to verify if a user-friendly reporting system based on a mobile app can facilitate the reporting of violent episodes and reduce under-reporting.* **Results:** *Three hundred and eighty-four out of 754 potentially eligible nurses answered the short questionnaire at time T_0, and 318 registered for the use of the app. One hundred and eighty-nine answered the questionnaire at time T_1. The t–Test for Paired Samples, although with a low mean difference, shows a significant difference in the change in the frequency of the reporting of violent episodes. The correlational tests showed no significant differences in the subgroups divided by demographic and professional characteristics. The usability of the app was considered very high.* **Conclusions:** *The simplification of the reporting system and the preliminary acquisition of data on the characteristics of the ED and each nurse, can save time and facilitate the reporting, but technology alone is not enough to solve the under-reporting.*

BACKGROUND

The problem of violence in the health environment is a recognised (31) and increasingly studied phenomenon (15, 17). Nurses, especially emergency nurses engaged in triage activities (36), are the most exposed workers (26, 55). Despite reporting systems (1, 16, 24) and monitoring of workplace violence (WPV) increasingly used (18, 49), the under-reporting phenomenon widely described in the international literature (19, 23, 30, 33, 47) remains a severe obstacle to the knowledge of the problem (2, 3, 17). Moreover, the under-reporting represents a limit to effectiveness evaluation of the counteracting interventions (50, 53). Scholars have identified several causes underlying the under-reporting phenomenon. Healthcare personnel consider WPV as part of their 'daily' job (35, 51) developing a sort of 'normalization' of violence in the workplace (14). They believe that their assailants are not responsible for their actions (27) and fear the disapproval of administrators (12, 43). They also complain about the lack of management accountability toward such reporting (7), believing it is useless to report the event because no institutional intervention will be implemented (54). Furthermore, international literature highlights that many nurses consider the reporting mechanism time-consuming (21), complicated (49), unpractical (23), and onerous (22). Recent studies suggest that the use of user-friendly and time-saving registration systems could facilitate the reporting of violent events (9, 21). Starting from the results by Hogarth, Beattie & Morphet (21), we conducted a pilot study on the implementation of an app for smartphones and tablets. The preliminary results of this study were presented at the 5th International Conference on Violence in the Health Sector (Dublin, 2016) (45) (34) and the 35th Aniarti - Italian National Association of Critical Care Nurses - National Congress (Bologna, 2016) (38). Encouraged by the results of this pilot study, we developed a registered app to report violence against emergency nurses. The whole developed system, named *PSAggress* (in Italian PS means Emergency Department), is composed of a back-end server, a web application for data storage and a smartphone app (for both iOS and Android). The smartphone app is straightforward and usable. It has been developed in React Native technology.

The system was developed following the Ramacciati, Ceccagnoli and Addey conceptual model of the "Global Approach to Violence towards Emergency Nurses - GAVEN" which includes four domains (nurse, patient/family member, context/situation, and organisation/structure) (32). The information regarding each emergency nurse, as well as the structural, regulatory, safety and comfort measures of each Emergency Department, are collected at the time of registration. The event information (situation and characteristics inherent to the violent person) are instead collected through a few quick records entered with a touch on the phone screen. Preliminary data on the use of the "PSaggress" app have been presented in Toronto at 6th International Conference on Violence in the Health Sector (39) and was received with great interest among the delegates. Because one of the most critical problems often encountered in research on intervention measures in the field of occupational health violence is linked to the small size of the sample groups in which the interventions are studied (10, 40, 49, 50), we designed a multisite study. Because there are several definitions of WPV, in this study we referred to violence towards emergency nurses by patients, family members and visitors. This violence is classified according to the University of Iowa Injury Prevention Research Center (52), as Type II Violence (client/customer violence on worker). Furthermore, our research group adopted the definition of the National Institute for Occupational Safety and Health (NIOSH):"*[...] violent acts (including physical assaults and threats of aggression) directed towards people at work or in service*" (34).

OBJECTIVES

The present study aims to verify if a user-friendly and straightforward reporting system using a mobile app can facilitate the reporting of violent episodes and help reduce the under-reporting phenomenon in a majority of emergency nurses.

METHODS

Study design

The study design is descriptive. The methodology is observational, prospective, and multisite. A cross-sectional approach was used to measure nurses' perceptions at one point in time. The study duration was 6 months. The nurses participating in the study could use a free mobile app to report any episode of violence occurred in the testing period (6 months).

The primary endpoint was to verify: 1. the degree to which emergency nurses found the app easy to use, and 2. whether using the app changed their attitude towards reporting. Secondly, we have collected data concerning the violent events reported with our app during the 6-month observation period. Study participants completed a short questionnaire at the beginning of the study (Time T_0) and after 180 days (Time T_1). The questionnaire (see Figure 3. in appendix section) investigated the exposure of nurses to acts of violence in the last six months of work, the type of abuse (verbal, physical or both) experienced, the frequency of reporting (always, sometimes, only informally, never), and the reasons for missing reports. Finally, the respondents indicated the trend of violent episodes in their Emergency Department (ED) in the last 6 months (increasing, stable, or decreasing).

At time T_1, the questionnaire was re-administered. At the end of the study, participants were asked to evaluate the usability of the tested app. They were also asked if during the study period, they had participated in communication or violence management courses.

Study procedures

Preliminarily, for each participating center a local referent was identified (usually the ED head nurse). Each local referent (contact person) had the task of delivering the informed consent and data collection form and the short questionnaire to each nurse of their ED, to collect and transmit the completed forms to the principal investigator (NR) by fax, e-mail or Whatsapp. To facilitate the task of the head nurses as local referent and emergency nurses as participants, all forms could be completed also in online forms. In the study information form, there were all the contact details (via QR code, SMS message, WhatsApp, email linkage) for direct submission to the principal investigator and the link for compilation via the Internet. In addition, a section with FAQ and a step-by-step presentation of the study phases was included in the information.

- Phase 1: Emergency nurses, contacted by local referent according to the inclusion criteria, are requested to complete the informed consent form, the registration form and the Short Questionnaire as described above. Nurses who voluntarily join the study can download the free *PSaggress* app from the Apple Store or Google Play Store. They can use it with login credentials provided by e-mail to the address indicated at the time of registration.

- Phase 2: in case of reporting via the app, the nurse receives a receipt on the smartphone and a confirming e-mail. The report is promptly communicated to the head nurse of the respective ED to provide immediate institutional feedback.

- Phase 3: At the end of the study period (6 months), the participating nurses are invited to complete the final short questionnaire. The procedures for verifying the correspondence between respondents at T_0 and T_1 was based on the surname and first name of the participants. As specified in the consent form, all the data acquired was subsequently processed by coding and anonymisation.

Enrollment procedure

The enrollment procedure was proactive. The recruitment of the participating centres began in September 2017. The experimental phase began on 5 February 2018 and ended on 17 March 2019. In any case, the trial period of each participating nurse started at the time of registration and ended with the completion of the 180th day from that date. Figure 1 shows the recruitment flow of emergency nurses for the study.

Table 1 show the participating centres by ED level, total annual ED visits, geographical area, total number of eligible nurses, number and percentage of respondents to the questionnaire at time T0, registered for use of the app and respondents to the final questionnaire at the time T1.
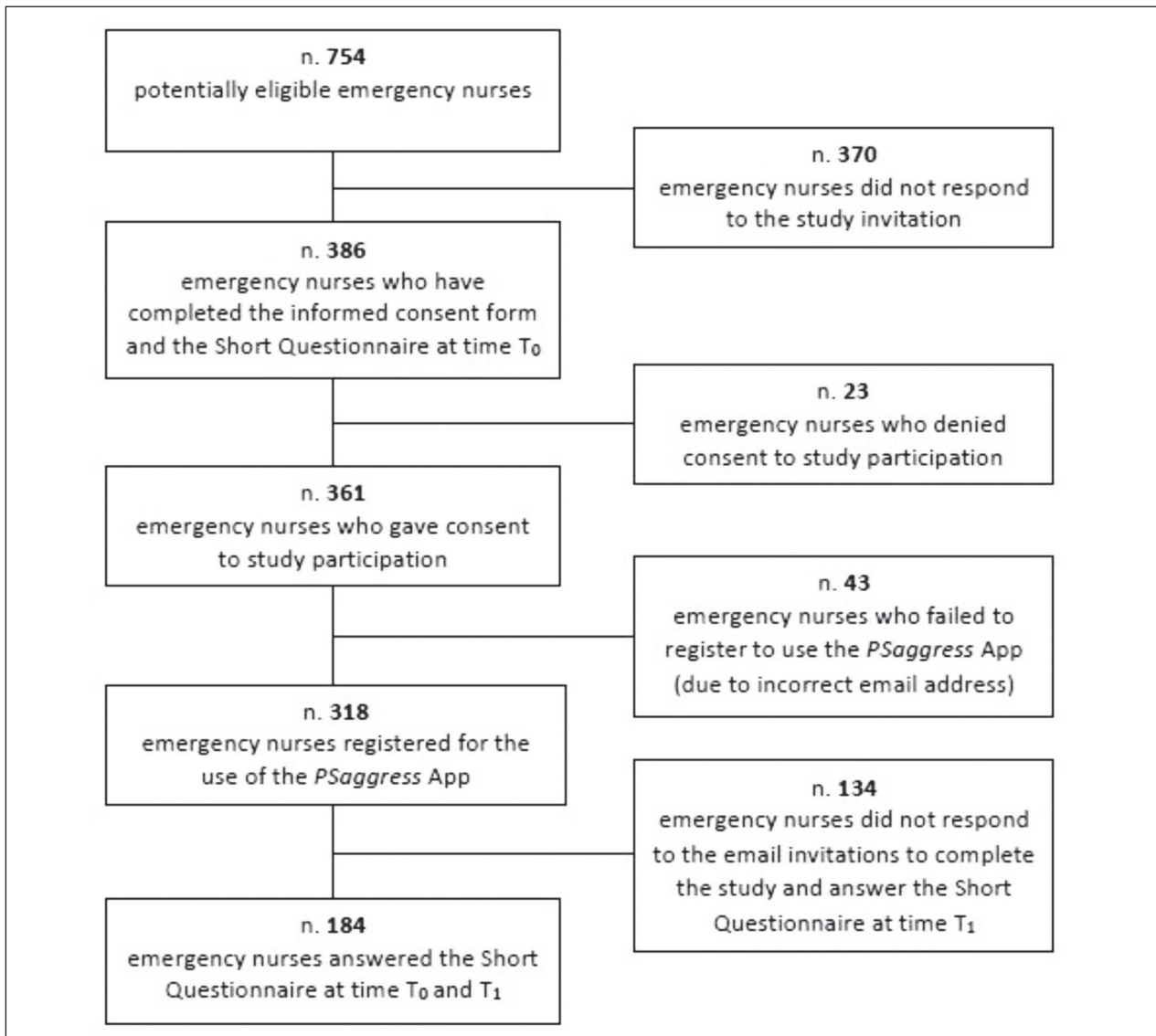
Figure 1 - The flow of the recruited Emergency nurses

Ethical considerations

The study protocol and any other related document provided to the participants, such as the Information Note and the Informed Consent Form were submitted for approval to the Tuscany Ethics Committee (Comitato Etico Toscano di Area Vasta Centro). Moreover, we have received the approval and authorisation of the Institutional Board of each healthcare institution of each participating ED.

Study population

Twenty emergency departments of five North and Central Italian regions joined the study. Participation in the experiment was voluntary, free, with informed consent and the possibility of leaving the study at any time. All participants were registered nurses on duty in the ED according to the following enrollment criteria:

Inclusion criterion

- Being a nurse assigned to the ED for at least 6 months.

Table 1 - Participating centres by ED level, total annual ED visits, geographical area, total number of nurses eligible by inclusion criteria, number and percentage of respondents to the questionnaire at time T_0, registered for use of the app and respondents to the questionnaire at the time T_1

Participating Centre (ED level) Total annual ED visits	Italian Region (geographical area)	ENs total No.	ENs responders T_0 No. (%)	ENs study participants No. (%)	ENs registered to app No. (%)	ENs responders T_1 No. (%)
#1(DEA1 livello) 25-50,000	Lazio (Central Italy)	38	26(68.4)	22(84.6)	20(90.9)	6(30.0)
#2(DEA2 livello) 50-75,000	Lombardy (Northern Italy)	40	33(82.5)	33(100)	33(100)	31(93.9)
#3(DEA1 livello)75-100,000	Lombardy (Northern Italy)	39	27(69.2)	26(96.3)	24(92.3)	15(65.2)
#4(DEA1 livello) 25-50,000	Piedmont (Northern Italy)	40	15(37.5)	14(93.3)	11(78.6)	6(54.5)
#5(PS) <25,000	Tuscany (Central Italy)	12	4(33.3)	4(100)	4(100)	2(50.0)
#6(PS) <25,000	Tuscany (Central Italy)	25	18(72.0)	17(94.4)	13(76.5)	7(53.8)
#7(DEA1 livello) <25,000	Tuscany (Central Italy)	20	4(20.0)	4(100)	4(100)	1(25.5)
#8(DEA2 livello) >100,000	Tuscany (Central Italy)	95	51(47.2)	39(76.5)	35(89.7)	17(48.6)
#9(DEA1 livello) 25-50,000	Tuscany (Central Italy)	53	45(84.9)	45(100)	32(71.1)	25(78.1)
#10(DEA1 livello) 25-50,000	Tuscany (Central Italy)	57	2(3.5)	2(100)	2(100)	1(50)
#11(DEA1 livello) 25-50,000	Tuscany (Central Italy)	35	19(54.3)	19(100)	18(94.7)	7(38.8)
#12(DEA2 livello) 50-75,000	Tuscany (Central Italy)	60	13(21.7)	13(100)	13(100)	8(61.5)
#13(DEA1 livello) 25-50,000	Tuscany (Central Italy)	34	26(76.5)	26(100)	25(96.1)	18(72.0)
#14(DEA2livello)75-100,000	Tuscany (Central Italy)	26	22(84.6)	20(90.9)	18(90.0)	9(50.0)
#15(DEA1 livello) 25-50,000	Tuscany (Central Italy)	15	2(13.3)	2(100)	2(100)	0(0.0)
#16(DEA2 livello) 50-75,000	Tuscany (Central Italy)	48	7(14.6)	7(100)	6(85.7)	4(66.7)
#17(PS) <25,000	Tuscany (Central Italy)	11	3(27.3)	3(100)	3(100)	0(0.0)
#18(DEA1 livello) 25-50,000	Tuscany (Central Italy)	24	4(16.7)	4(100)	4(100)	2(50.0)
#19(DEA2 livello) 50-75,000	Tuscany (Central Italy)	38	38(100)	36(94.7)	29(80.1)	7(24.1)
#20(DEA2 livello) 50-75,000	Umbria (Central Italy)	35	25(71.4)	25(100)	23(92.0)	23(100)
Total		**745**	**384(51.5)**	**361(94.0)**	**318(88.0)**	**189(59.4)**

Note: ENs = Emergency nurses

- Signing the paper informed consent or express consent in the online form.
   Exclusion criteria
- Being an unstructured staff member: students, volunteers, interns, etc.

The mobile app and the system procedure

All study participants were registered to the system after their consensus. They received a registration e-mail containing the link to Play Store and Apple store (as more appropriate) to download the mobile app and credentials to log in for reporting episodes of violence. In this stage, all emergency nurse and ED characteristics data were preliminarily registered in the database. After the log in phase (username and password are required only the first time and stored within the app), the user can access to the reporting form and is then asked to select some primary and pre-defined required fields such

as date, hour, kind of aggression, kind of aggressor (e.g. the patient, a relative, etc.), and other optional fields such as aggression motivation and specific notes. Then the nurse clicks on the "submit" button to send the form; the data are received by the web server which registers them and consequently sends an e-mail to the nurse him/herself (as a receipt) and to all the interested persons/offices (administrators) that have to be informed of the event and eventually are in charge of intervening. In this stage, the event data can be associated with the characteristics of the nurse and the ED for the case analysis.

Statistical analysis

After performing the data pre-processing, the t-test for paired samples was used to compare the emergency nurses participating at time T_0 and T_1. The analysis of correlations between the variables was based on Chi-square and Fisher' exact test. All results with $p < 0.05$ were considered statistically significant. The data were analysed using IBM SPSS Statistics Version 20.0 (IBM Corp, 1 New Orchard Rd, Armonk, New York).

RESULTS

Three hundred and eighty-four out of 754 potentially eligible nurses answered the short questionnaire at time T_0, and 318 registered for the use of the app. Finally, 189 answered the questionnaire at time T_0 and T_1. The demographic and professional characteristics of the emergency nurses participating in the study are described in Table 2.

All the emergency nurses participating in the study at the time of registration (Time T_0) answered three questions in the Short Questionnaire regarding the exposure to violent episodes in the last 6 months (Item #1), about their reporting (Item #2), the reasons for the non-reporting (Item #2.1) and the perception on the trend of the phenomenon of violence towards healthcare workers in their ED (Item #3). At time T_1, the questionnaire was re-administered, with a further three questions. Table 3 shows the results.

The underlying assumption of our study is that an easy and time-saving reporting system can fa-

cilitate the notification of violent episodes and reduce the phenomenon of under-reporting. Figure 2 graphically shows the answers at the time T_0 and T_1 of each nurse experimenter of the app regarding her/his attitude towards the reporting of episodes of violence in the respective two previous periods of 6 working months.

We assigned a score to the answers attributable to the item #2 about the frequency of reporting of violent events by emergency nurses in the last 6 months: 1 for "Yes, all", 2 for "Yes, some", 3 for "No, only informally", and 4 for "No, not at all". We have obtained the following arithmetic mean values (M), standard deviation (SD) and standard error (Err) at time T_0 and T_1, respectively M = 2.65, SD = 0.972, Err = 0.098 and M = 2.26, SD = 0.864, Err 0.087. The result of the Paired Samples t-Test returned a t=3.614, df= 99 and p-value <0.001. This result indicates a statistically significant difference in the change in the propensity to report, even if for small values. Therefore, we conducted a comparative analysis of the subgroups to verify whether the demographic and professional characteristics (such as gender, marital status, age, ED experience, work seniority, professional role, type of shift, and educational qualifications) had any correlation to the change towards the reporting. Fisher's exact test and Chi-square test showed no significant differences in the subgroups. We repeated the same tests also taking into consideration the group of nurses who had declared an increase in the propensity to report. We broke out the demographic data between those two groups (increased and unchanged reporting propensity) to see if they are different in some way. Here too, no significant differences were found for demographic and professional variables. Of course, a confounding factor that could interfere was the influence that training courses on the topic of violence could have in terms of awareness and encouraging violence reporting. This aspect was considered through the answers given to item #5. We repeated the test for paired samples on the 65 participants who during the study period declared that they had been exposed to violence and had no WPV training. In this subgroup we have obtained the following arithmetic mean values (M), standard deviation (SD) and standard error (Err) at time T_0

Table 2 - Characteristics of the Emergency Nurses participants to the study

Characteristics	Respondents at Time T_1 (No.=189)			
Age		M	SD	min-max
(years old)		39	± 9	23 - 62
Working seniority				
Overall (years)		14	± 10	1 - 38
In ED (years)		9	± 8	0.5 - 38
Gender	No. (%)			
Female	117 (61.9)			
Male	72 (38.1)			
Marital status				
Single	98 (51.6)			
Married (including living common law)	86 (45.3)			
Separated	1 (0.5)			
Widowed	0 (0.0)			
Not declared	5 (2.6)			
Professional degree				
Bachelor (or 6 level ISCED)[a]	189 (100)			
Master (or 7 level ISCED)[a]	66 (34.9)			
Masters				
Master Degree in Nursing Sciences	10 (5.3)			
Emergency or Critical Care Nursing	29 (15.3)			
Nurse Coordinator	32 (16.9)			
Shift type				
Only day shifts	39 (20.6)			
All shifts	151 (79.9)			
Role in Emergency department				
Staff nurse	179 (94.7)			
Specialist nurse	2 (1.1)			
Head nurse	8 (4.2)			

Note: M = Mean, min = minimum, max = maximum, No. = number, SD = Standard Deviation
[a] = International standard classification of education ISCED 2011.

and T_1, respectively M = 2.77, SD = 1.042, Err = 0.129 and M = 2.23, SD = 0.880, Err 0.109. The result of the Paired Samples t-Test returned a t=3.309, df= 64 and p-value <0.002. Unfortunately, the influence of other confounding factors cannot be excluded. However, during the study, local managers were asked not to change in any way the usual behaviours and procedures used in their ED. The incidence of episodes of violence towards emergency nurses de-

clared as answer to the Item #1 was substantially similar in the two observation periods, namely 113 and 102 verbal violence episodes, 2 and 0 physical aggressions, 17 and 14 cases for both types (see Table 3).

Finally, the Short Questionnaire also explored the "perception" of the participants on the trend of the phenomenon in their service. The results show a substantial balance between emergency nurses who

Table 3 - Response to Short Questionnaire at Time T_0 and T_1

Short Questionnaire Items	Time T_0 No. (%)	Time T_1 No. (%)
Type of violence in the last six months	**No.=189**	**No.=189**
verbal abuse	113 (59.8)	102 (54.0)
physical aggression	2 (1.0)	0 (0.0)
both verbal abuse and physical aggression	17 (9.0)	14 (7.4)
None	57 (30.2)	73 (38.6)
Propension to reporting	**No.=132**	**No.=116**
All episodes	19 (14.4)	25 (21.5)
Some episodes	37 (28.0)	38 (32.8)
No one, only informally	47 (35.6)	47 (40.5)
No one, never	29 (22.0)	6 (5.2)
(I have not suffered them)	*(57)*	*(73)*
If no, why?	**No.=76**	**No.=53**
Justification for the patient pathological conditions or the situation	17 (22.4)	4 (7.5)
Did not have time	9 (11.8)	5 (9.4)
Violence as Part of job	5 (6.6)	6 (11.3)
Reporting never leads to changes	5 (6.6)	5 (9.4)
Not aware of the reporting system	4 (5.3)	3 (5.7)
Fear of reporting	1 (1.3)	1 (1.9)
Lack of support from management	1 (1.3)	3 (5.7)
Forgot to do it	0 (0.0)	4 (7.5)
Not declared	34 (44.7)	22 (41.5)
Violence trend in your ED in the last 6 months	**No.=189**	**No.=189**
Increased	92 (53.5)	70 (40.7)
Unchanged	94 (54.7)	113 (65.8)
Decreased	3 (1.7)	6 (3.5)
Usability of the "PSaggress" app		**No.=189**
Very easy	--(---)	50 (26.5)
Easy	--(---)	41 (21.7)
Quite easy	--(---)	34 (18.0)
Difficult	--(---)	2 (1.0)
Very difficult	--(---)	0 (0.0)
Not declared	--(---)	62 (32.8)
Training in the last 6 months		**No.=189**
Communications	--(---)	22
Workplace Violence	--(---)	18
both Communication and Workplace Violence	--(---)	7
None	--(---)	142

Table 3 *(continued)*- Response to Short Questionnaire at Time T_0 and T_1

Short Questionnaire Items	Time T_0 No. (%)	Time T_1 No. (%)
Propensity to reporting violent acts		**No.=189**
Increased	--(---)	83
Unchanged	--(---)	104
Decreased	--(---)	2
If increased, why?		**No.=85**
Because reporting is easier with the app	--(---)	6 (7.0)
Because reporting can improve knowledge of the problem	--(---)	16 (18.9)
To be protected	--(---)	9 (10.6)
Because it's right	--(---)	14 (16.5)
Because I don't feel alone anymore	--(---)	3 (3.5)
Not declared	--(---)	37 (43.5)
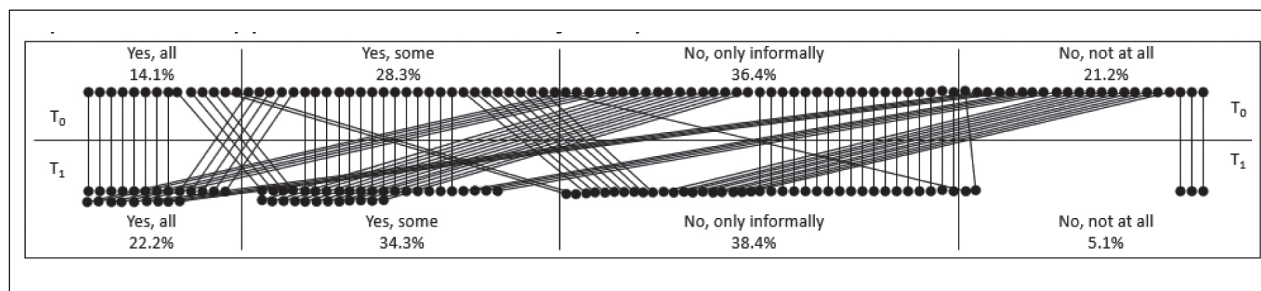
Figure 2 - Responses concerning the violence reporting attitude of the nurse users of experimental app at time T_0 and T_1 by coupled data

perceived the phenomenon unchanged over the last six months (51%) and those who considered it to be increasing (47%). The problem was considered as decreasing only by 2% of the participants.

DISCUSSION

The number of emergency nurses potentially enrolled in our study according to the inclusion criteria was 745, but only 384 (51.7% of the total) returned the informed consent form. This first result would require an Intention-to-Treat analysis (20). In fact, the lack of adherence to the study could arise from the widespread problem of the perception of loneliness and the lack of support from institutions and managers experienced by many nurses, well described in international literature (25). However, the lack of participation of authorised centre nurses can be explained not only by the factors mentioned above (to be considered among the determinants of the phenomenon), but also as stated by Bambi et al: *"a sort of"* survey fatigue *"affecting nurses, who usually receive frequent invitations to fill in questionnaires for nursing theses"* (4, p.755). An "effect" that occurred in some participating centres of our study and verified anecdotally by the principal investigator (NR) during the normal preliminary contacts. Therefore, the evidence is offered by the analysis of the received informed consent forms which expressly provided for the possibility of indicating the refusal to participate in the study and the motivation. Twenty-three out of 384 nurses (6.0%), who completed the short

questionnaire at time T_0, did not agree to participate in the study. Only three nurses have motivated the non-participation: because they consider the violence *"normal by doing this job"*, a problem that *"happens often"*, because *"nothing changes"*. These reasons of non-reporting declared by some participants, shown in Table 3, are similar to those highlighted in the literature (50). The WPV "normalization" as part of job or the justification for the patient pathological conditions are common between emergency nurses (6, 31). The perception of loneliness and the lack of support from institutions and managers often experienced by many nurses lead to distrust of reporting systems (30, 34). Similarly, the feeling of the report uselessness is widespread (40, 54). These are all critical factors to consider interventions to support personnel subject to violence and actions to improve the reporting culture (34). However, the "lack of time" is considered by many study participants to be the reason for no report as described in international literature (9, 21). Finally, due to a registration error (wrong e-mail address), 43 participants in the study did not receive the credentials to use the App.

The first relevant aspect of our study is the change in the frequency of the reporting of violent events at the time T_0, and T_1 declared by the study participants. The t-Test for Paired Samples, although with a low mean difference, shows a significant difference between the two moments T_0 and T_1. Figure 2 graphically shows this change.

As a result of these considerations, the assumption that a time-saving system could reduce the under-reporting phenomenon was confirmed in our test, and statistically confirmed by the test for paired samples. Of course, the change, although significant, is minimal.

Observing Table 3, the incidence of episodes of violence towards emergency nurses declared answer to the Item # 1 was substantially identical in the two observation periods, namely 59.8% and 54.0% for verbal violence, 1.0% and 0.0% for physical abuse, 9.0% and 7.4% for both types (verbal and physical). More than a third of the participants stated that they had not suffered violence in the two semesters analysed (respectively 30.2% and 38.6%). This fluctuation of the percentage of the incidence of violence declared by the participants in the two observation times (T_0 and T_1) is attributable, in addition to the sample size, to the coexistence of multiple intrinsic, extrinsic and situational factors, as foreseen by our GAVEN conceptual model (42). Furthermore, the lower incidence values compared to other Italian studies (28, 47) can also be explained by the different extension of the time interval considered (6 months versus 1 or more years).

Anticipating this possible variability in the absence for each ED participant of the objective data of the number of cases of violence in the 6 months preceding the study, we asked each participant to express their perception regarding the trend of violence in their service. Our result is in line with recent Italian studies (13), even if we are aware that the measurement of the magnitude of the phenomenon of violence cannot be based on the perception of health workers, or on memory recall of exposure to violent acts (29). Hence the need to adopt innovative strategies to develop effective reporting systems (9).

The second aim of our study was the evaluation of the app-based reporting system. The usability of the app was considered very high. In fact, the vast majority of participants (67.2%) found the app easy to use, and almost 50% found it easy and very easy. We tried to identify any differences between the participants based on their demographic and professional characteristics, as potential factors influencing the degree of familiarity with the use of the smartphone app (37) but the correlation tests showed no significant differences between the subgroups. Finally, as stated by Stene and colleagues, greater use of a reporting system and the consequent minimization of under-reporting can be favoured by training towards WPV (49). In order to control this variable, we asked the participants if during the experimentation period of our app they had attended training courses on communication in critical situations or on WPV management. The repeated test for paired samples on the 65 participants who during the study period declared that they had been exposed to violence and had no WPV training indicates a statistically significant difference in the change in the propensity to report, with an even greater increase in the propensity level between time T_0 and

T_1. This significant difference, all things being equal, recorded in this subsample argues for a positive effect of the app with regards to reporting violent acts.

Limitations of the study

This study has some limits. First of all, we used a self-built and not validated questionnaire. We considered our app to be inherently easy, preventing us from comparing its usability in the context of software design and implementation enabled by the use of validated scales (5). The sample attrition was an unexpected issue. Due to a registration error (wrong e-mail address), 43 participants in the study did not receive the credentials to use the mobile app, and for this reason, they left the study. Moreover, some nurses left the study due to the high turnover in some ED enrolled in the study. Further limitations are not having collected objective data about the episodes of violence previously reported in the same EDs, the perception of attention for violence by the Hospital Company (a factor widely considered in the literature on violence in healthcare and linked to the propensity or not with which people report), the attitudes of the participants towards the use of technology/smartphone (a bias that may also have auto-selected the respondents). Attitude towards the report of violent episodes measured through the answers to a question in a questionnaire is subject to the risk of recall bias. Finally, it is impossible to exclude the presence of the Hawthorne effect and to have a measure of the size of this effect. In fact, a before-after study include the possibility that people are changing behaviour simply because there is some attention being paid to the issue.

To reduce this effect we have expressly asked the local referents not to modify in any way how reports were usually managed. Indeed, the local referent as head nurses actively participates in the reporting procedures and influences the attitudes of nurses towards reporting.

Conclusions

This is the first study, as far as we know, regarding the use of an app for smartphone to facilitate the reporting of violent episodes. We have not come to a definitive conclusion. Many points remain to be clarified, which we hope to analyze with future research. Without a doubt, violence in the workplace is an extremely complex problem. In fact, there are at least twenty-four theories and conceptual frameworks that explain this phenomenon in ED context (41). The involved factors are multiple and multidimensional. It is crucial to act on all the modifiable factors and not limit ourselves to single interventions (40). This "global approach" is not only valid for risk minimisation and violence management interventions (32), but also for monitoring and improving reporting systems (46). In our study, we tried to verify whether the simplification of the reporting system and the preliminary acquisition of data on the characteristics of the ED and each nurse, can save time and facilitate the reporting. The strength of the app-based system is, in fact, the speed of the reporting time, which takes a few seconds. The positive results that emerged from this study are an incentive to develop and test user-friendly and rapid reporting systems. We intend to develop the next studies for measuring our app usability using the System Usability Scale (SUS), a standard tool to measure software/application usability that assesses several interrelated attributes as user satisfaction, learnability, efficiency, memorability, and frequency of errors (8). It will be necessary to develop new study designs, preferably RCTs (49) overcoming the limitations found in the present study. Of course, we know that technology cannot solve the problem of underreporting alone. And that to solve this problem it is necessary to act on several fronts. Our hope is that all stakeholders (physicians, nurses, administrators, managers, trade unions, scientific societies, police and security forces, citizenship and political decision-makers) will take up this challenge. And that no one is left alone in the face of workplace violence.

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APPENDIX

Short Questionnaire

Item #1. Have you suffered any violence in the last six months?
- ❏ No, none
- ❏ Yes, verbal violence
- ❏ Yes, physical violence
- ❏ Yes, both (verbal and physical violence)

Item #2. If so, did you report them? (any mode, as long as it is formal)
- ❏ Yes, everyone
- ❏ Yes, some
- ❏ No, only informally*
- ❏ No, in no way*
   *Item #2.1. If No, why? _____

Item #3. In your opinion, in the last six months, the acts of violence in your ED are:
- ❏ Increased
- ❏ Decreased
- ❏ Unchanged

Item #4) What is your opinion on the usability of the "PSaggress" App?
- ❏ Very easy
- ❏ Easy
- ❏ Quite easy
- ❏ Difficult
- ❏ Very difficult

Item 5#) In the last 6 months (during the App experimentation) did you carry out training courses?
- ❏ Yes, on communication
- ❏ Yes, on Workplace Violence
- ❏ Yes, both on communication and on Workplace Violence
- ❏ No, no course

Item #6) In the last 6 months (during the App experimentation) did you change your attitude towards reporting violent acts?
- ❏ Yes, I'm more inclined to report*
- ❏ No, my attitude has remained the same as before
- ❏ Yes, I am less inclined to report*
   *Item #6.1) If Yes, why?

NOTE: Item #4, #5, #6, and #6.1 were administered only at time T_1