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Medication administration and anxiety: an observational study with nursing students

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Abstract. *Background and aim:* Medication administration errors represent a topic of great scientific interest. Medication administration is considered by nursing students a complex process during which it is easy to make mistakes; therefore, institutional measures have been adopted in order to reduce medication errors. However, it remains a critical issue in nursing practice for which several causes have been identified, including environmental factors and individual knowledge. Mistakes can be made by nurses and especially by students who must cope with additional causal factors including anxiety management. The aim was to investigate state anxiety levels among nursing students when it comes to medication administration. *Research design and methods:* An observational study involving a convenience sample of 150 nursing students from a Northern Italy University has been conducted; they were asked to complete a questionnaire to measure the levels of state anxiety in relation to medication administration. *Results:* There were no particularly high levels of state anxiety among students associated with medication administration; however, state anxiety levels were slightly higher in third-year students than in second-year students, and this is most likely due to the growing complexity of the medication administration process compared to the lack of experience. *Conclusions:* Although the results don't show statistically significant data, the effectiveness of nursing education plays a crucial role in reducing medication errors, which is why it is essential to provide suitable tools for the professionals of the future and invest in clinical simulations. (www.actabiomedica.it)

Key words: Nursing studen*, state anxiety, medication administ* errors, near mis*, medication knowledge, nursing studen* skills

Introduction

A medication error is a preventable event that may cause patient harm as a result of the actions performed by a healthcare professional. Medication errors are associated with the so-called "near misses", that is to say, errors that are recognized before they can actually cause harm to the patient. Both phenomena are part of the medication administration process, which consists of five stages: 1. Prescription; 2. Documentation; 3. Dispensing; 4. Administration; 5. Monitoring. The first stage is a medical responsibility, while nurses are totally responsible for the remaining four stages, according to the Italian legislature, which is based on current International regulations. Nurses are not only the healthcare professionals that administer medication, but they also make themselves the "guarantors" of the correct medication administration process, summarized and shared

at first nationally and then worldwide in the "7G" rules: right patient, right drug, right dose, right time, right route of administration, right documentation, and right monitoring. There are about 1.3 million drug-related injuries/damages that happen every year because of medication errors in the U.S. (1), and they represent 2-5% of all hospital admissions worldwide (2). Medication administration procedure is first introduced to nursing students during their 2nd year internships and this procedure is always supervised by a clinical nurse tutor/mentor who has legal responsibility for the administration itself and has to supervise at every stage of the process (3). For nurses, some of the factors leading to committing errors are fatigue due to workload, distractions (4), work shifts and unfamiliarity with certain drug classes (5). In addition to the above-mentioned factors, nursing students make mistakes because of inadequate knowledge of the medication or tutors' intimidating behavior (6). During their internship, students find themselves not only in a new environment, but they are also involved in tasks and situations that can affect their performance due to lack of experience, insecurity and all the above-mentioned factors, thus contributing to the possible increase in the incidence of the phenomenon. Nevertheless, literature is more specifically focused on administration errors made by healthcare professionals than by students. In order to better understand the problem, the main causes leading to error have been identified; these can be extrinsic or intrinsic to the student. Among the extrinsic factors there can be the environment, which is often perceived as unfamiliar (7), and all the environmental distractions such as interruptions during medication administration due to questions from relatives (4, 6); in addition to this, there is stress resulting from workload (5, 7, 8), as students are not often used to deal with certain contexts and pressures. Intrinsic factors include inadequate training and insufficient knowledge which can make it difficult to solve drug dosage calculations (5, 8) and the so-called gap in knowledge, that is to say, learning gaps in the student's individual training (9). A crucial aspect is also represented by the skills that students have gained during their training: students who were able to practice more tended to make fewer mistakes than those who had fewer opportunities, and this depends also on the hospital Unit/Ward of assignment (10, 11). Literature has also showed that students who are about to graduate, report high levels of self-esteem and low levels of state anxiety, which is the exact opposite of 1st year students who are less experienced and practical; there also seems to be a positive correlation between critical thinking and self-esteem, and a negative correlation between critical thinking and state anxiety, which could be likely explained by participants' low confidence in their own critical thinking (12). Other studies aimed at investigating students' thought process during medication administration showed that the main aspects on which students focus are assessing their own knowledge and feeling safe during drug administration in order to ensure patient safety (13). Finally, it was highlighted that an appropriate level of supervision during administration can help to prevent errors (14-16). Nurses themselves, who had to supervise the students, gave emphasis to the importance of the proper level of supervision to encourage students to become more confident, so that they could promote learning and ensure patient safety (3, 17). In order to reduce the incidence of errors, guidelines aimed at standardizing the medication administration process have been developed, through the correct identification of the patient; checking carefully the dosage, route and time of administration; checking that the medication has been administered. Despite this, some individual limits persist, such as environmental and situational stressor, or related to the healthcare worker's knowledge and thus even more in the student where inexperience is added (5).

Aims

The aim of the study conducted on a sample of nursing students from a University in Northern Italy was to analyze the levels of state anxiety and trait anxiety during the medication administration. There are very few contributions to literature that take nursing students as an element of investigation in relation to the variables considered (trait and state anxiety) associated with the process of medication administration, therefore this aspect represents the innovation of the current study.

Methods

Setting

Nursing students enrolled in a Northern Italy University were involved in the study. The study took place over a three-month period, from April 2021 to June 2021.

Design

Observational study that was conducted using semi structured self-report questionnaire.

Sample

The study involved a convenience sample of 150 university nursing students. Only 2nd and 3rd year nursing students (the nursing degree course lasts three years) who completed at least two internships were involved in the study; 1st year students were excluded from the analysis as the medication administration procedure is taken starting from the 2nd year of University.

Procedure

The study was briefly described during a University lecture and students were invited to participate in the research, explaining that the participation was absolutely voluntary. It was also explained that they would receive both the link to the questionnaire and the guidelines for anonymity by e-mail. An explicit mention to the legislation on data protection and privacy was made, specifying that: 1) the research project did not involve intrusive or invasive methods for data collection; 2) the research project did not involve collection or dissemination of sensitive data, that could lead to tracing and identification of the authors, therefore guaranteeing absolute anonymity. After that, students were invited to fill in the questionnaire created using Google Drive®, and the answers were automatically saved. The questionnaire required all the fields to be filled in as an essential requirement, so it was important not to leave blank spaces. Of the 243 questionnaires emailed (125 to 2nd year students and 118 to 3rd year students, that is to say the whole nursing students' population), a total of 151 (total response rate 62.1%) were fully completed and collected. All questionnaires were examined and then only one of them eliminated because of ceiling/floor effect (18); eventually, 150 questionnaires (61.7%) were considered valid, and they were chosen to represent the survey sample.

Instrument

The questionnaire used is based on the STAI scale (State Trait Anxiety Inventory) developed by Spielberg et al. (1970) (19) and validated in Italian by Pedrabissi & Santinello (1989) (20). It consists of 40 items on a 4-point Likert scale, from 1 to 4, where point 1 corresponds to "never" and point 4 correspond to "always". The questionnaire is made up of two parts: the first 20 items assess trait anxiety (STAI-TR) which is defined by the author as a relatively stable personality trait; an example of item is "I'm satisfied with myself"; the other 20 items assess state anxiety (STAI-ST) which is, according to the author, a transitory emotional state felt while coping with threatening situations, that is why students were asked to "contextualize" their answers thinking exactly of the drug administration moment; an example of item is "I'm feeling under pressure". The state anxiety scale was the first to be submitted because the score can be influenced if the trait anxiety scale is the first to be introduced (19). According to the authors, scores range from 20 to 80 (high scores correlate with greater anxiety). A cut point of 40 has been suggested to detect anxious symptomatology (20-40 points "no or low anxiety"), 41-50 points = "mild anxiety", 51-60 points "moderate anxiety", > 60 points = "serious anxiety".

Data analysis

All data were first displayed on Microsoft Excel® and then they were transferred to a database in SPSS; the IBM SPSS® statistical software, Statistics Version 23.0 software package (IBM Corp. 2014) was used for all statistical analysis. Subsequently frequencies, measures of central tendency and dispersion (mean and 95% C.I., median, standard deviation and standard error), skewness and kurtosis indexes and the related S.E. were calculated. In order to confirm the correlation

between the variables and the sample adequacy, the Bartlett test and the KMO test were performed. To explore the structure of the instrument and assess its factorial composition, an exploratory factorial analysis (EFA) with oblimin rotation with principal axis factoring was conducted since the variables appeared to be correlated as confirmed by the excellent saturation coefficients (21). For the assessment of the internal consistency of the items (of the scale and of the individual factors per scale) the Cronbach alpha (α of Cronbach) was calculated. The comparison on the aggregate data of state and trait anxiety levels was performed through the non-parametric χ^2 test and related standardized residuals (significance level +/- 1.96); to determine the normal distribution the Shapiro-Wilk test was used, on the basis of which the parametric test-t for two independent samples was chosen and it was applied based on the year of study. For the correlation analysis the r-Pearson test was used. Finally, results of $p < 0.05$ were considered significant.

Results

Ethical implications

The voluntary nature of participation in the study was reiterated. The participants, who were nursing students, were first informed directly; then they were informed by email that the information provided was strictly confidential and used solely for research purposes and that no personal information would be used to identify the authors (in compliance with EU regulation no. 2016/679, that was issued on 27th April 2016, published in the Official Journal of the European Union on 4th May 2016, came into force in 25th May and became effective from 25th May). Completion and submission of the questionnaire indicated consent to participate in the study.

Sample characteristics

Table 1 shows the frequencies by year of course and gender. The final sample consisted of 150 elements; distribution was homogeneous by course year, there were 80 (52.6%; UB = 0.61, LB = 0.45) 2nd year students and 70 (46.1%; UB = 0.54, LB = 0.38) 3rd year students; when it comes to the gender, an important imbalance between the female gender 132 (86.8%; UB = 0.92, LB = 0.82) and the male gender 18 (11.8%; UB = 0.18, LB = 0.07) was highlighted, although this reflects the gender ratio of students enrolled in the nursing degree course which is about 1:5.

Table 2 shows the age distribution of the participants which were distributed over a range of values from 20 to 52 years; the most represented ages were 21

Table 1. Students sample characteristics.

Year of course	**N**	**%**	**UB**	**LB**
2nd year students	80	52.6%	0.61	0.45
3rd year students	70	46.1%	0.54	0.38
Total	150	100.0%		
Gender	**N**	**%**	**UB**	**LB**
Female	132	86.8%	0.92	0.82
Male	18	11.8%	0.18	0.07
Total	150	100%		

Note: UB = Upper Bound; LB = Lower Bound

Table 2. Age distribution.

Age	**N**	**%**	**Cumulative %**
20	28	18.4	18.7
21	43	28.3	47.3
22	33	22.0	69.3
23	12	7.9	77.3
24	11	7.2	84.7
25	5	3.3	88.0
26	1	.7	88.7
28	6	3.9	92.7
30	1	.7	93.3
31	1	.7	94.0
32	1	.7	94.7
33	2	1.3	96.0
35	2	1.3	97.3
38	1	.7	98.0
40	1	.7	98.7
51	1	.7	99.3
52	1	.7	100.0
Total	150	100.0	

(n = 43; 28.3%), 22 (n = 33; 22.0%), 20 (n = 28; 18.4%), and 23 years (n = 12; 7.9%); minimum frequencies were observed > 24 years (frequencies MIN = 1, e.g. 26 years; MAX = 6, e.g. 28 years).

Instrument dimensions and psychometric properties

The reliability of the correlation estimates between variables were assessed on both scales (STAI_ST, KMO index = .858, Bartlett sphericity test χ^2=1236.28, df=190, p<0.05; STAI_TR KMO index = .916, Bartlett sphericity test χ^2 =1651.65, df=190, p<0.01); the reverse score on 11 items (after checking the corrected item total correlation) for the state anxiety scale (STAI_TR) and on 9 items (after checking the corrected item total correlation) for the trait anxiety scale (STAI_TST) was calculated. The respective sum items (to classify anxiety levels) and mean items (for other statistical analysis) were calculated. The exploratory factor analysis (EFA) with an eigenvalue >1 on STAI_ST highlighted 4 factors explaining 58.14% of the variance with determinant >.05 and saturation coefficient >.400; overall Cronbach alpha was very good α = .880, and so were the coefficients on each of the 4 extracted factors F1 (5 items) α = .789; F2 (5 items) α = .789; F3 (4 items) α = .758; F4 (6 items) α = .793. STAI_TR exploratory factor analysis (EFA) showed 3 factors that explained 62.08% of the variance with determinant >.05 and saturation coefficient >.400; overall Cronbach alpha was excellent (α = .921), and so were the coefficients on each of the 3 factors F1 (11 items) α = .933; F2 (8 items) α = .888; F3 (1 item) α = .769. The visual inspection of histograms of both scales, normal QQ plots, box plots and the fact that kurtosis and skewness did not simultaneously show values greater than 1 or less than -1 (and thus do not present any particular distribution problem) (22) showed that data were approximately normally distributed between the two groups of students; as for STAI_ST its skewness = .099 (S.E. = .198) and kurtosis = -.178 (S.E. = .394) and Shapiro Wilk test p > 0.05; with regard to STAI_TR skewness = -.157 (S.E. =. 198) and kurtosis = -.609 (S.E. = .394) with Shapiro-Wilk test p > 0.05.

Table 3 shows descriptive statistics concerning the two scales, considering sum items for each subject of the sample (MIN = 20, MAX = 80). The STAI_TR has a mean of 45.26 (MIN = 22, MAX = 67; St. Dev. = 10.60) which allows it to be placed at the "mild anxiety" level. Conversely, the STAI_ST presents a mean of 53.99 (MIN = 29, MAX = 76; St. Dev. 9.65) which places it at the higher level of "moderate anxiety".

Table 4 describes anxiety levels per year of study. As for STAI_TR, it was observed that most of 2nd year students were on the "moderate" level (N = 29), then on the "no or low anxiety" level (N = 25), then "mild" (N = 21), with the smallest number on the "serious" level (N = 5); on the other hand, 3rd year students focused more on the "no or low anxiety" level (N = 29),

Table 3. STAI_TR & STAI_ST descriptive statistics.

Item	N	MIN	MAX	Mean	St.Dev.
SUM_STAI_TR	150	22	67	45.26	10.60
SUM_STAI_ST	150	29	76	53.99	9.65

Table 4. STAI_TR & STAI_ST anxiety levels.

STAI_TR		**20-40 no or low anxiety**	**41-50 mild**	**51-60 moderate**	**61-80 serious**	**Tot**
	2nd year	25	21	29	5	80
	3rd year	29	22	14	5	70
		54	43	43	10	150
STAI_ST		**20-40 no or low anxiety**	**41-50 mild**	**51-60 moderate**	**61-80 serious**	**Tot**
	2nd year	8	23	33	16	80
	3rd year	4	18	30	18	70
		12	41	63	34	150

then "mild" (N = 22), then "moderate" (N = 14) and finally the smallest number on the "severe" (N = 5). Finally, data aggregated showed that the greatest number was observed on the "no or low anxiety" level (N = 54) and the minimum on "severe" (N = 10). With regard to STAI_ST, there was a trend inversion regarding minimum frequencies. 2nd year students were focused on the "moderate" level (N = 33), then "mild" (N = 23), then "severe" (N = 16) with the lowest frequencies on the "no or low anxiety" level. The trend of 3rd year students was almost the same with the greatest number on the "moderate" level (N = 30), equal distribution on the "mild" and "severe" levels (both N = 18) and minimum frequencies on the "no or low anxiety" level (N = 4). Finally, data aggregated, that clearly highlighted the differences between the two scales, showed that the largest number was at "moderate" level (N = 63) and the smallest on "no or low" (N = 12).

Lastly, table 5 highlights the comparison on the data aggregation of the two scales where the χ^2 analysis on anxiety levels, meant as frequencies, highlights significant differences $\chi^2(3) = 43.693 = P<0.01$. Adjusted standardized residuals show the comparisons that determine the statistical significance of the data, placing emphasis on the shift in anxiety levels between STAI_TR and STAI_ST. If, on one hand, the values on the "absent" level were significantly different (STAI_TR vs STAI_ST Adj. Res. -5.9 / + 5.9), the differences on the "severe" level were equally significant (STAI_TR vs STAI_ST Adj. Res. -3.9 / +3.9), and this can be a clear sign of the influence of the contingency linked to the medication administration.

Summary measures of central tendency and descriptive statistics

Measures of central tendency (Mean and related lower/upper bound C.I. 95%, and Median), variability index (Standard Deviation) as well as skewness and kurtosis were used to analyze the distribution of the measures (table 6). In order to define the previous measures and to statistically compare 2nd and 3rd year nursing students, the summary scores of the measures were calculated by calculating the average of the individual items relating to the specific dimensions (measures expressed on Likert 1-4 scale). The STAI_ST score is above the theoretical median score (M = 2.70, SD = .482; theoretical median score = 2.5); conversely, the STAI_TR scores are below the theoretical median score (M = 2.38, SD = .560; theoretical median score = 2.5).

Table 5. χ^2 test on anxiety levels.

			STAI_ST	**STAI_TR**	
Anxiety levels	*20-40 (no or low anxiety)*	Count	12	54	66
		Expected count	33.0	33.0	66.0
		Adj. Res.	**-5.9**	**5.9**	
	41-50 (mild)	Count	41	43	84
		Expected count	42.0	42.0	84.0
		Adj. Res.	-.3	.3	
	51-60 (moderate)	Count	63	43	106
		Expected count	53.0	53.0	106.0
		Adj. Res.tato	**2.4**	**-2.4**	
	61-80 (serious)	Count	34	10	44
		Expected count	22.0	22.0	44.0
		Adj. Res.	**3.9**	**-3.9**	
Total		Count	150	150	300

Note: Adj. Res. = Adjusted Residuals; Adj. Res. in bold are those that exceed +/- 1.96

Table 6. STAI-ST and STAI-TR overall measures of central tendency and dispersion.

Tool Measures		Statistics	S.E.
STAI_ST	*Mean*	**2.70**	.039
	Mean C.I. 95% LB	2.62	
	Mean C.I. 95% UB	2.78	
	Median	2.68	
	St.Dev.	.482	
	Skewness	-.099	.198
	Kurtosis	-.178	.394
STAI_TR	*Mean*	**2.38**	.045
	Mean C.I. 95% LB	2.29	
	Mean C.I. 95% UB	2.47	
	Median	2.42	
	St.Dev.	.560	
	Skewness	-.157	.198
	Kurtosis	-.624	.394

Note: STAI_TR = Trait Anxiety tool; STAI-ST = Status Anxiety tool; S.E. = Standard Error; C.I. = Confidence Interval; LB = Lower Bound; UB = Upper Bound; St.Dev. = Standard Deviation

Table 7. STAI-ST and STAI-TR measures of central tendency per year of course.

Year	Tool	Measures	Statistics	S.E.
2nd year	*STAI_ST*	*Mean*	2.65	.055
		St.Dev.	.494	
		Skewness	-.070	.269
		Kurtosis	-.212	.532
	STAI_TR	*Mean*	2.44	.059
		St.Dev.	.528	
		Skewness	-.337	.269
		Kurtosis	-.529	.532
3rd year	*STAI_ST*	*Mean*	2.76	.056
		St.Dev.	.465	
		Skewness	.194	.287
		Kurtosis	-.137	.566
	STAI_TR	*Mean*	2.30	.069
		St.Dev.	.580	
		Skewness	.060	.287
		Kurtosis	-.566	.566

Note: STAI_TR = Trait Anxiety tool; STAI-ST = Status Anxiety tool; S.E. = Standard Error; St.Dev. = Standard Deviation

As it can be observed in table 7, if the sample is divided by year of study the STAI_TR, scores are in both cases lower than the theoretical median (2nd year M = 2.44; 3rd year M = 2.30); on the other hand, the STAI_ST scores, that are related to the medication administration process, are both higher than the theoretical median (2nd year M = 2.65; 3rd year M = 2.76). While 3rd year students reported a lower STAI_TR mean score than 2nd year students, there is a trend reversal when it comes to STAI_ST mean scores. Both groups of students presented homogeneous levels of trait anxiety (independent samples t-test(148)=-1.386, p>.05). As already said, although there is a growth in the average levels of state anxiety in 3rd year students, the statistical comparison with 2nd year students (independent samples t-test(148)=1.610, p>.05) did not highlight statistically significant differences.

Correlation analysis

The Pearson correlation coefficient for the total scores of both STAI_TR and STAI_ST was calculated; unlike what is found in the literature, a moderate negative correlation (r(148) = -.595 = p < 0.01) is observed between the two constructs, which means that higher levels of STAI_TR correspond to lower levels of STAI_ST.

Discussion

The current study broadens research horizons on the topic, and it represents an interesting reminder for discussion. The sample, as already said, was made up of 150 questionnaires filled by 2nd and 3rd year students (TAB 1); this active participation (72% of the whole students' population) can indicate that the topic is deeply felt by nursing students: the greater influence has a topic (not only on professional life), the more participation it gets, as explained in literature (23). The comparison between the means (TAB 3) shows that the medication administration process is associated with higher levels of anxiety, with a mean of 53.99 on the STAI_ST, which is defined as "moderate anxiety", while a mean of 45.26 is observed on the STAI_TR

scale, and this corresponds to "mild anxiety". These results place emphasis on the statistically significant differences between the levels of anxiety in both scales; higher response rates are observed for the "no or low anxiety" in STAI_TR (n = 54 vs n = 12 STAI_ST), while higher response rates for the "serious level" are given in STAI_ST (n = 34 vs n = 10 STAI_TR), so it is likely that the rising levels of state anxiety are influenced by the medication administration process. Other considerations can be made starting from the comparison of 2nd and 3rd year students using the average summary scores as a reference. TAB 6 showed that trait anxiety levels are below the theoretical median score (STAI_TR M = 2.38; St. Dev = 0.560) and state anxiety levels are above the theoretical median score (STAI_ST M = 2.70; St. Dev = 0.482). Interestingly, although no statistically significant differences were found, state anxiety seem to be higher among 3rd year students (STAI_ST M =2.76; St. Dev = 0.465) than in 2nd year students (STAI_ST M = 2.65; St. Dev = 0.494), as shown in Table 7. Whether the acquisition of skills and competencies and the anxiety levels are influenced by the educational path is still a rather heated debate in literature. On one side, some studies suggest a positive influence of critical thinking (which develops as training and experience progress) that may help reduce anxiety levels (12, 24), thus leading to lower levels of anxiety in highly capable students; on the other side, other sources do not go in the same direction (25, 26). However, this can be explained looking at the students' educational path: 3rd year students, given the increasing complexity of the hospital wards of 3rd year internship (A&E, ICUs, pediatric units and/or operating theaters) have to face realities for which they gained no experience in the previous years. Complexity also refers to the medication administration process, which is far more complicated than in the previous years of study, and that requires skills to calculate proportions in a relatively short time or even at the same time of an emergency (27-30). Lastly, there is a significant negative statistical correlation between trait and state anxiety ($r(148) = -.595 = p < 0.01$): students who claim to have a less anxious personality, showed higher anxiety levels during medication administration. In this case, the results wound turn out to be rather in contrast with the findings in literature and, in particular, with Spielberg's basic assumption, according to which a positive correlation between trait and state anxiety is to be expected (19).

Conclusions

Literature suggests that there are several causes contributing to errors during medication administration: distractions and work environment (4), stress and fatigue due to workload and work shifts (6), inexperience and the so-called gap in knowledge among students (9), and a poor level of supervision by clinical tutors (3, 26). There also seems to be the need of clinical simulations for the medication administration process as a useful tool for managing emotions among students (30, 31), who express insecurity and seek reassurance during the process (13). Moreover, low self-esteem among students seems to be related to state anxiety (12). This study investigates a little-discussed aspect in literature: assessing state anxiety in nursing students during the medication administration process. According to the results, the considered sample should place itself in the "moderate" state anxiety levels regarding the procedure, and this may contribute, along with other factors, to the growing incidence of medication administration errors. Contrary to literature, which showed a correlation between on-field experience and low levels of state anxiety, the current study underlines higher state anxiety levels in 3rd year students, who have a greater practical experience. The limitations of this study are represented by the relatively small number of participants, therefore the conclusions cannot be extended to broader realities. Furthermore, the use of a self-report scale does not allow for objectivity of response as answers may have been influenced by social desirability (32). Another limitation is that the questionnaires were filled in at a later time than when the actual medication administration process occurred, which may not reflect the *hic-et-nunc* emotion experienced. In this regard, it might be interesting to repeat the survey at the same time as the trigger event. Moreover, it could be useful to administer this questionnaire during clinical simulations as well, in order to assess students' comfort levels when performing the procedure, as already experimented by Uslu et al. (31).

Using the current study as a starting point, assessment tools to help future healthcare professionals to face work-related emotions can be introduced.

Conflicts of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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