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Physical Restraints in Critical Care Units: Impact of a Training Program on Nurses' Knowledge and Practice and on Patients' Outcomes

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Abstract

The use of physical restraints is a common practice in various clinical settings, especially in intensive care units (ICUs). The aim of this study was to improve nurses' knowledge and practice regarding physical restraining, with the ultimate goal of reducing the number of consequent complications among ICU patients. A quasi-experimental design with pre-post assessment was used on 38 nurses working in the ICUs and Critical Care Medicine at the Zagazig University Hospitals and 100 patients under their care. A self-administered questionnaire was used to assess nurses' knowledge, an observation checklist for their practice, and a physical assessment sheet for patients. The researcher developed a training intervention based on analysis of assessment data and using pertinent literature to teach nurses guidelines for dealing with restrained patients. This was delivered to nurses in 7 sessions. Evaluation was done immediately (post-test), and two months after implementation (follow-up), along with evaluation of the patients. The results showed marked deficiencies in nurses' knowledge and practices before the program, with significant improvements at the post and follow-up evaluations. Additionally, statistically significant improvements were revealed in patients' signs and physical findings, with much less complications. Therefore, a relatively short-term in-service training in guidelines can significantly improve nurses' knowledge and practice concerning physical restraining of ICU patients, with subsequent reductions in the frequency of related complications among these patients. Therefore, these guidelines should be adopted and its booklet should be available in each department using restraint in the hospital.

Keywords: Physical restraints, Critical care units, Training, Nurses

Introduction

Physical restraints are defined as any devices or materials attached to or near patients' body that could not be controlled by patient [1]. Their use is a common practice in various clinical settings, with 7-17 % of hospital patients having been subjected to physical restraints [2]. In clinical settings they help control disruptive behavior and wandering, maintain treatment plans, and prevent patients to fall from hospital beds [3]. In intensive care, restraints are most commonly used to prevent the removal of invasive tubes and devices [4]. In a study in the United States, the intensive care units (ICUs) accounted for 56% of all restraint days despite having only 16% of all the patient-days [5].

The literature reports a wealth of evidence on the detrimental physical and psychological effects of physical restraints. Patients have strong emotional reactions to being restrained, and feel angry and upset [6]. The consequences include hypertension, tachycardia, increased agitation, impaired circulation, aspiration, nerve and skin injury [7], decline in functional and cognitive state, increased agitation [1,6] and other complications associated with immobility as pressure sores and constipation [8]. Restraints also make patients and their families feel embarrassed in remembering this experience [9].

Although physical restraints are often seen as a simple solution to the problem of the treatment interference in critically ill patients, one of the common themes is that physical restraints are impending freedom [10]. Moreover, it has been shown that patients exhibit the same amount or more agitated behaviors even when restrained [11]. Restraints may, however, be temporarily required to control violent behavior or to prevent the removal of important equipment, such as endotracheal tubes, intra-arterial devices, and catheters [12]. Guidelines for use suggest using the least restrictive device necessary, reassessing the patient's response frequently, removing the restraint periodically, and renewing orders every 24 hours only after evaluation by a physician. There is a need for care plan modification to compensate for restraint use, including frequent position changes and skin care, provision of adequate range of motion, and assistance with activities of daily living. Ongoing assessment of the underlying condition that prompted restraint use, early referral to a multidisciplinary team, and staff education are the key to appropriate restraint use [13].

Nurses are closely involved in caring for restrained patients. According to De Jonghe et al. [14], the common absence of medical orders for starting or removing physical restraints indicates that these decisions are mostly made by the nurses. Their roles start with the selection of the least restricting arm restraint device available. Then, they are the ones responsible for modifying the care plan based on hourly assessment of patient's response, and removing the restraints every two hours. Their roles also include frequent change of patient's position, with assistance in activities of daily living, in addition to assessing the patient for any physical and/or psychological effects of restraining. Moreover, they must look for other causes of agitation and treat accordingly, inform relatives of the need for restraint, and review orders every 4 hours [15-18].

Significance of the study

Physical restraints are a common practice in healthcare, with prevalence rates ranging between 15% and 66% in nursing homes and between 33% and 68% in hospital settings [19]. In intensive care units (ICUs), the main reason for their use is to prevent dislodgement of medical equipment, and for this reason ICU nurses have positive attitudes towards restraining. However, the physical restraining

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practices and tools (such as; Belt, Vest, Wristlet, Mittens, Restraining Net, Helmet, Jacket, Geri Chair, Merry Walker, and Water mattress) used in our ICUs are inappropriate for good patient care. Since nurses' perceptions and knowledge play an important role in this care practice, it was deemed important to develop a restraint policy and educate nurses to implement it because hospitals in Egypt have not any policies and there are illegal uses of restraint. Recent studies carried out in Mansoura ICUs revealed most of the patient was restrained due to the removal of medical device, and developed pressure sore, limb edema, restricted circulation, and skin laceration at restraint site, lack of knowledge and documentation of physical restraining and recommended that there is a need for standard guidelines and policies for physical restraint practices in Egyptian ICUs [20,21].

The aim of this study was to improve nurses' knowledge and practice regarding physical restraining, with the ultimate goal of reducing the number of consequent complications among ICU patients. The research hypotheses were that the implementation of a nursing guideline for restraining patients in ICU will lead to statistically significant 1) improvements in their knowledge, 2) improvements in their practice, and 3) reduction in patients' related complications.

Subjects and Methods

Research design and setting

A quasi-experimental uncontrolled design with pre-post assessment was used. Nurses were evaluated at three time intervals: before the intervention, at its completion, and 12 weeks after completion, whereas the effect on patients' complications was assessed before and after implementation. The study was conducted at the Intensive Care Units and Critical Care Medicine at the Zagazig University Hospitals.

Participants

The study involved a group of nurses, and another group of patients. The nurses' group consisted of all 38 nurses (5 males and 33 females) working in the study settings who are dealing with physically restrained patients. This sample size was large enough to demonstrate an improvement from a baseline of 40% satisfactory knowledge or adequate practice to an expected level of 75% with 95% level of confidence. The patients' group included 100 patients selected by convenience sampling of restrained patients before the program. Patient with physical and/or mental disablements were excluded. The sample size was calculated to demonstrate a reduction of any patient's complication from a baseline of 40% to an expected level of 20% or less, with 95% level of confidence and compensating for a dropout rate of about 10%. Their age ranged between 39 and 50 years, with more males (62%), and 43% being illiterate. About two thirds were admitted with a neurological problem (67%), and had a co-morbid chronic disease (65%). The duration of restraining was mostly less than one (43%) or two (40%) weeks, and in two limbs (79%). The majorities of the patients were confused (73%) and tried to remove medical devices (81%).

Tools for data collection

The researchers developed a self-administered questionnaire to assess nurses' knowledge, an observation checklist for their practice, and a physical assessment sheet for patients.

The self-administered questionnaire included a section for nurse's demographic characteristics such as age, sex, marital status, qualification, and years of experience in unit, in addition to questions regarding awareness of physical restraints and related policies in hospital, and the sources of their information. The second section consisted of closed questions to assess nurse's basic knowledge regarding physical restraining as definition, indications, alternatives, types, contraindications, release, precautions, complications, and barriers for use. The questions were based on pertinent literature [22-24]. Nurse's responses were checked with model answers and given 1 point if correct and 0 if incorrect. The points were summed up and converted into percent score. A total score of 60% or more was considered as satisfactory knowledge.

The nursing practice observation checklist was developed by the researchers based on related literature [25,26]. It included assessment of performance with wrist and leg restraining, each having 19 items. The observed practice was compared with standardized procedures. Accordingly, the nurse was given 1 point if the step or item was correctly done, and zero if incorrectly done or not done. The points were summed up and converted into percent score. A total score of 60% or more was considered adequate practice.

The patient assessment sheet was developed by the researchers to identify any adverse physiological or psychological consequences of patient's physical restraining. It had a section for patient's socio-demographic data such as age, gender, marital status, level of education, and job status. The second section involved patient's medical history, along with the indication for restraining, its duration and location, and patient's behavioral state. The third section included patient's physical assessment such as skin color, part movement (range of motion), sensation (neuro-vascular check), capillary refill, vital signs, behavior, and hygienic care for restrained parts. Any abnormal finding was scored one. The last section dealt with the consequences of restraining in the form of problems or complications such as direct injury (nerve injury, ischemic injury, strangulation and sudden death), indirect injury (nosocomial infection, pulmonary embolism, thrombophlebitis, decline in social behavior, pressure sores, falls, or failure to be discharged home. The potential effects included urinary retention, incontinence, dehydration, skin abrasions and/or bruising, orthostatic hypotension, restricted circulation, lower-extremity edema, and constipation, while the negative psychological effects included anger, agitation, depression and no sense of humanity. Any present complication was scored one.

The face and content validity of the tools was established by a panel of seven experts in medical/surgical nursing and in medicine who reviewed them for clarity, relevance, comprehensiveness, understanding, applicability, and ease for administration. Minor modifications were required.

Pilot study

A pilot study was carried out on four nurses and 10 patients to assess the applicability of the tools. It helped in detection of difficulties in some items. This led to omission of certain items and addition of others. Therefore, the patients and nurses who shared in the pilot study were not included in the main study sample.

Study maneuver

The study was implemented through assessment, planning, implementation, and evaluation phases. The study lasted from November 2011 to September 2012. The researchers were available three days weekly.

Assessment phase: Upon finalization of the tools and getting official permissions, the researchers started to recruit the samples. A sample of 100 restrained patients was recruited according to eligibility and exclusion criteria. After obtaining their consent to participate, they were assessed for physical signs and complications of restraining using the physical

assessment sheet. Then, the 38 nurses working with these physically restrained patients were invited to participate. Their knowledge was assessed using the self-administered questionnaire. This was followed by observing their practice with restrained patients in different shifts using the observation checklist. This phase lasted from January to March 2012.

Planning phase: Based on analysis of the collected data, and using pertinent literature, the researcher developed a training program to teach nurses guidelines (in form of handout booklet in Arabic language) for dealing with restrained patients. The objectives were to improve nurses' awareness, knowledge, and practice regarding physical restrain. It covered definition, indications, alternatives, types, contraindications, precautions, complications, and barriers of use of restraining. The practical part covered part movement (range of motion exercise), part sensation (neuro-vascular check), capillary refill, vital signs, behavior, hygienic care for restrained parts and how to apply physical restraint.

Implementation phase: The program was delivered to nurses in seven teaching sessions. The teaching/training methods involved questioning, discussions, demonstration, and re-demonstration. The teaching media included illustrative pictures, videotapes and handouts. Each session took 30-45 minutes. The guidelines were designed and presented in Arabic language. This phase lasted for three months from April to June 2012. At the beginning of the first session, an orientation to the health guideline and its purpose was presented. Each session started by a summary about what had been taught in the previous session and the objectives of the new one, taking into consideration the use of simple language to suit the level of nurses. The researchers used motivation and reinforcement during the educational sessions to enhance learning. Direct reinforcement in the form of a copy of the guidelines was offered for each nurse to use it as future reference.

Evaluation phase: The evaluation of the guidelines' effects on nurses' knowledge and practice, and consequently on patients' complications was carried out using the same assessment tools. Each nurse was evaluated immediately after implementation of the guidelines (post-test), and two months after implementation of the guidelines (follow-up), and these were compared to pre-test levels. For patients, the evaluation was done by comparing the assessment done after guidelines' implementation with the pre-guidelines complications.

Administrative design and ethical considerations

To carry out this study, the necessary approvals were obtained from the Head of Critical Care Department, and from the General Director of the Zagazig University Hospitals. Letters were issued to them from the Faculty of Nursing, Zagazig University explaining the aim of the study in order to obtain permission and cooperation. The study protocol was approved by competent committees. At the initial encounter with each patient or nurse, an oral consent was secured from each subject after being informed about the nature, purpose, procedures, and benefits of the study, and that participation is voluntary. Confidentiality and anonymity of any obtained information were ensured through coding all data. The researcher reassured participants that the data collected would be used only for the purpose of the study and to improve patients' health. No harm could be anticipated from any maneuver in the implementation of the study.

Statistical analysis

Data entry and statistical analysis were done using SPSS 16.0 statistical software package. Quantitative continuous data were compared using Student t-test in case of comparisons between two groups. When normal distribution of the data could not be assumed, the non-parametric Mann-Whitney test was used instead. Qualitative categorical variables were compared using chi-square test. Whenever the expected values in one or more of the cells in a 2x2 tables was less than 5, Fisher exact test was used instead. Pearson correlation analysis was used for assessment of the inter-relationships among quantitative variables, and Spearman rank correlation for ranked ones. In order to identify the independent predictors of knowledge And practice scores and the number of complications, multiple linear regression analysis was used after testing for normality and homoscedasticity, and analysis of variance for the full regression models was done. Statistical significance was considered at p-value <0.05.

Results

The majority of the study sample of nurses consisted of females (86.8%, with age below 35 years (73.7%), and were married (78.9%)) as seen in Table 1. Slightly more than half of them were diploma nurses (57.9%), and had their experience was 3 years (52.6%). Approximately two-thirds of the nurses were aware of physical restraining (65.8%), and more than three quarters were aware of absence of related policies.

Table 2 demonstrates that only 3 (7.9%) nurses had total satisfactory knowledge before implementation of the guidelines. The least knowledge was regarding the types (7.9%) and complications (13.2%) of restraints. On the other hand, more than two-fifth of the nurses (42.1%) had satisfactory knowledge about the release of the restraint. At the post guidelines phase, statistically significant improvements were noticed in nurses' knowledge, with all nurses having satisfactory knowledge in all areas and in total knowledge ($p<0.001$). This improvement persisted during the follow-up period with no decline in any of the areas of knowledge ($p<0.001$). Similarly, the table indicates that none of the nurses had total adequate practices of wrist or leg restraining before the guidelines. The post guidelines phase showed statistically significant improvements in nurses' practices ($p<0.001$), with all the nurses' having adequate practice. As in knowledge, the improvement in practice persisted throughout the follow-up.

Items	Frequency	Percent
Age (years):		
<35	28	73.7
35+	10	26.3
Gender:		
Male	5	13.2
Female	33	86.8
Marital status:		
Single	8	21.1
Married	30	78.9
Nursing qualification:		
Diploma	22	57.9
Bachelor	16	42.1
Experience years in unit:		
2	6	15.8
3	20	52.6
4	12	31.6
Aware of physical restrain	25	65.8
Source of information (n=25):		
Training	8	32.0
Reading	2	8.0
Practice	15	60.0
Aware of absence policies in hospital	31	81.6

Table 1: Demographic characteristics of nurses in the study sample (n=38).

Satisfactory knowledge & adequate practice (60%+) of:	Time						X^2 Test (p-value) Pre-post	X^2 Test (p-value) Pre-FU
	Pre n=38)		Post (n=38)		FU (n=38)			
	No.	%	No.	%	No.	%		
Definition	8	21.1	38	100.0	38	100.0	49.57(<0.001*)	49.57(<0.001*)
Indications	12	31.6	38	100.0	38	100.0	39.52(<0.001*)	39.52(<0.001*)
Alternatives	8	21.1	38	100.0	38	100.0	49.57(<0.001*)	49.57(<0.001*)
Types	3	7.9	38	100.0	38	100.0	64.88(<0.001*)	64.88(<0.001*)
Contraindications	9	23.7	38	100.0	38	100.0	46.89(<0.001*)	46.89(<0.001*)
Release	16	42.1	38	100.0	38	100.0	30.96(<0.001*)	30.96(<0.001*)
Precautions	12	31.6	38	100.0	38	100.0	39.52(<0.001*)	39.52(<0.001*)
Complications:								
Direct	5	13.2	38	100.0	38	100.0	58.33(<0.001*)	58.33(<0.001*)
Indirect	5	13.2	38	100.0	38	100.0	58.33(<0.001*)	58.33(<0.001*)
Potential	9	23.7	38	100.0	38	100.0	46.89(<0.001*)	46.89(<0.001*)
Total physical	6	15.8	38	100.0	38	100.0	55.27(<0.001*)	55.27(<0.001*)
Psychological	15	39.5	38	100.0	38	100.0	32.98(<0.001*)	32.98(<0.001*)
Barriers	7	18.4	38	100.0	38	100.0	52.36(<0.001*)	52.36(<0.001*)
Total knowledge:								
Satisfactory	3	7.9	38	100.0	38	100.0		
Unsatisfactory	35	92.1	0	0.0	0	0.0	64.88(<0.001*)	64.88(<0.001*)
Adequate practice Wrist restraining:								
Adequate	0	0.0	38	100.0	38	100.0		
Inadequate	38	100.0	0	0.0	0	0.0	76.00(<0.001*)	76.00(<0.001*)
Leg restraining:								
Adequate	0	0.0	38	100.0	38	100.0		
Inadequate	38	100.0	0	0.0	0	0.0	76.00(<0.001*)	76.00(<0.001*)

(*) Statistically significant at p<0.05

Table 2: Nurses' knowledge and practice of physical restraining before and after the study intervention.

Abnormal findings in physical assessment	Time				X^2 Test	p-value
	Pre (n=100)		Post (n=100)			
	No.	%	No.	%		
Abnormal:						
Skin color	75	75.0	51	51.0	12.36	<0.001*
Skin warmth	72	72.0	46	46.0	13.97	<0.001*
Part movement	68	68.0	60	60.0	1.39	0.24
Part sensation	31	31.0	31	31.0	0.00	1.00
Capillary refill	71	71.0	71	71.0	0.00	1.00
Body temperature	72	72.0	46	46.0	13.97	<0.001*
Pulse	56	56.0	56	56.0	0.00	1.00
Blood pressure	37	37.0	37	37.0	0.00	1.00
Respiration rate	58	58.0	58	58.0	0.00	1.00
Behavior	48	48.0	48	48.0	0.00	1.00
Personal hygiene	93	93.0	0	0.0	173.83	<0.001*
Total assessment:						
Free	1	1.0	11	11.0		
Abnormalities present	99	99.0	89	89.0	8.87	0.003*
No. of abnormal findings:						
Range	1-12		0-11			
Mean ± SD	8.0±3.3		6.4±3.1		U=12.92	<0.001*
Median	9		7			

(*) Statistically significant at p<0.05
(U) Mann Whitney test

Table 3: Physical assessment findings among restrained patients before and after the study intervention.

Concerning the physical assessment findings among restrained patients, Table 3 shows a high prevalence of abnormal findings among them, with almost all of them having evidence of poor personal hygiene (93%). After guidelines' implementation, statistically significant improvements were revealed in the signs related to skin color, skin warmth, body temperature, and personal hygiene (p<0.001). In total, only one patient had no abnormalities at the pre-guidelines phase, compared to 11 at the post-phase, and the difference was statistically

significant (p<0.003). Moreover, the median number of abnormal findings decreased from nine at the pre-guidelines phase to seven at the post-guidelines phase (p<0.001).

Table 4 also points to statistically significant improvements in the total complications of physical restraining after the study intervention, with the median total complications decreasing from seven to five at the post-guidelines phase. The improvements were noticed in all types of direct (p=0.003), indirect (p=0.01), potential

Total complications	Time				X^2 Test	p-value
	Pre (n=100)		Post (n=100)			
	No.	%	No.	%		
Direct: Present	15	15.0	3	3.0	8.79	<0.001*
Nerve injury	8	8.0	0	0.0	Fisher	0.007*
Ischemia	10	10.0	1	1.0	7.79	0.005*
Strangulation	1	1.0	1	1.0	Fisher	1.00
Sudden death	0	0.0	1	1.0	Fisher	1.00
Range	0-2		0-1			
Mean ± SD	0.2 ± 0.5		0.03 ± 0.2		U=8.91	0.003*
Median	0		0			
Indirect: Present	88	88.0	82	82.0	1.41	0.23
Acquired infection	50	50.0	47	47.0	0.18	0.67
Pulmonary embolism	3	3.0	1	1.0	Fisher	0.62
Thrombosis	24	24.0	24	24.0	0.00	1.00
Declining social behavior	12	12.0	12	12.0	0.00	1.00
Bed sores	64	64.0	45	45.0	7.28	0.007*
Falling	54	54.0	45	45.0	1.62	0.20
Failure to be discharge home	25	25.0	7	7.0	12.05	<0.001*
Range	0.0-5.0		0.0-5.0			
Mean ± SD	2.3 ± 1.4		1.8 ± 1.3		U=6.52	0.01*
Median	2		2			
Potential: Present	99	99.0	85	85.0	13.32	<0.001*
Urine retention	8	8.0	4	4.0	1.42	0.23
Constipation	75	75.0	60	60.0	5.13	0.02*
Incontinence	6	6.0	0	0.0	Fisher	0.03*
Dehydration	27	27.0	22	22.0	0.68	0.41
Skin laceration	69	69.0	42	42.0	14.76	<0.001*
Orthostatic hypotension	11	11.0	11	11.0	0.00	1.00
Restricted circulation	70	70.0	39	39.0	19.38	<0.001*
Limb edema	79	79.0	39	39.0	33.07	<0.001*
Range	0.0-7.0		0.0-5.0			
Mean ± SD	3.5 ± 2.4		2.2 ± 2.1		U=31.13	<0.001*
Median	4		2			
Psychological: Present	97	97.0	96	96.0	Fisher	1.00
Anger	22	22.0	22	22.0	0.00	1.00
Agitation	79	79.0	70	70.0	2.13	0.14
Depression	2	2.0	2	2.0	Fisher	1.00
Frustration	2	2.0	2	2.0	Fisher	1.00
Range	0.0-2.0		0.0-1.0			
Mean ± SD	1.1 ± 0.3		1.0 ± 0.2		U=5.40	0.02*
Median	1		1			
Total complications:						
Absent	0	0.0	2	2.0		
Present	100	100.0	98	98.0	Fisher	0.50
Range	1.0-12.0		0.0-10.0			
Mean ± SD	6.8 ± 2.5		4.9 ± 2.3		U=25.55	<0.001*
Median	7		5			

(*) Statistically significant at p<0.05
(U) Mann Whitney test

Table 4: Total complications of physical restraining among patients before and after the study intervention.

(p<0.001), and psychological (p=0.02) complications. The most prominent improvement was in potential complications, where the median decreased from 4 at the pre-guidelines phase to 2 at the post-phase, with significant improvements in constipation, incontinence, skin laceration, restricted circulation, and limb edema. In the direct complications, the nerve injury and ischemia significantly improved, whereas in the indirect complication only bed sores showed significant improvement.

The study findings revealed statistically significant strong positive correlations between nurses' scores of knowledge and practice (Table 5). However, no significant correlations could be demonstrated between knowledge or practice scores and nurses' age, qualification, or experience.

As Table 6 shows, the results of multivariate analysis revealed that the intervention was a statistically significant independent predictor of the improvement in nurses' knowledge and practice scores, with the models explaining more than 90% of the variations in these scores. The married status was an additional negative predictor of the knowledge score. On the other hand, nurses' age, qualification, and years of experience had no influence on their knowledge and practice scores.

The same table displays the best fitting multiple linear regression models for the number of complications experienced by the patients throughout intervention. It is evident that the intervention was a statistically significant negative independent predictor of the number of complications. Conversely, the presence of chronic diseases and the duration of restrain were positive predictors. Other patient's characteristics such as age, sex, education, and marital status had no influence on the number of complications.

Discussion

This study was carried out to test the hypotheses that implementing guidelines for restraining patients and training nurses in their application would improve their related knowledge and practice, with consequent positive effect on the incidence of complications among restrained patients in ICUs. The study results demonstrated significant improvements in nurses' knowledge and practice, associated with significant decreases in the number of complications related to physical restraining. The findings lead to accepting the set hypotheses, with confirmation of the effectiveness of the guidelines.

The study involved a sample of 38 nurses, mostly middle age females with diploma degrees in nursing. This is the often reported pattern representing nurses' characteristics in similar settings [2]. The higher percentage of female nurses may explain the high prevalence of use of physical restraints since females are less physically able to control agitated patients compared with males. However, the study could not identify any influence of nurses' gender on their practice of physical restraining.

Moreover, only eight of the nurses in the current study sample reported having information about physical restraining through training, i.e. less than one-fourth, whereas almost double of this

	Pearson correlation coefficient				
	Age	**Qualification@**	**Experience**	**Knowledge**	**Practice**
Knowledge	-.023	.055	-.042		
Practice (wrist)	-.022	.006	-.016	.948**	
Practice (leg)	-.015	.013	-.027	.955**	.984**

(@) Spearman rank correlation
(**) Statistically significant at p<0.01

Table 5: Correlation matrix between nurses' scores of knowledge and practice and their age, qualification, and experience.

Variables	**Unstandardized Coefficients**		**Standardized Coefficients**	**t-test**	**p-value**	**95% Confidence Interval for B**	
	B	**Std. Error**				**Lower**	**Upper**
Score of knowledge throughout intervention							
Constant	48.034	3.681		13.048	.000	40.739	55.329
Marital status (reference: single)	-6.313	1.914	-.085	-3.299	.001	-10.105	-2.521
Intervention (reference: pre)	61.200	1.655	.958	36.980	.000	57.921	64.479
r-square=0.92 Model ANOVA: F=689.21, p<0.001 Variables entered and excluded: age, sex, qualification, experience							
Score of practice throughout intervention							
Constant	46.974	.537		87.451	.000	45.909	48.038
Intervention (reference: pre)	47.039	.658	.989	71.503	.000	45.736	48.343
r-square = 0.98 Model ANOVA: F=5112.71, p<0.001 Variables entered and excluded: age, sex, qualification, experience, marital status, knowledge score							
Number of complications experienced by patients throughout intervention							
Constant	5.872	.668		8.791	.000	4.554	7.189
Chronic disease	1.133	.330	.210	3.436	.001	.483	1.784
Intervention (reference: pre)	-1.880	.312	-.365	-6.031	.000	-2.495	-1.265
Duration of restrain	.270	.055	.299	4.900	.000	.161	.378

r-square = 0.28
Model ANOVA: F=25.85, p<0.001
Variables entered and excluded: age, sex, education, marital status

Table 6: Best fitting multiple linear regression models for the score of knowledge, practice and number of complications experienced by patients throughout intervention.

number reported practice as their source of information. This means that the wrong practices or misconception would extend to nurses from previous generations, and this will be perpetual. In agreement with this, Cannon et al. [27] and Hafez EM [20] found in their studies that most of the nurses did not receive any special education or in-service training about physical restraint practices. This present study result may be due to that there are no special policies that regulate the application of physical restraint in ICUs and critical care.

In view of the foregoing, it was quite expected to find very low levels of knowledge among the nurses in the present study before implementation of the guidelines. This was noticed in all the tested areas of knowledge. This lack of knowledge would have a negative impact on the nursing care provided to these patients. Additionally, it might lead to complications among the patients that may lead to legal problems to the nurse providing the care. The finding is in congruence with Mamun and Lim [28] in their study which assessed nurses' knowledge about physical restraints in Singapore.

The significant improvements demonstrated at the post-guidelines phase indicate that these nurses were in real need for such information. Moreover, the acquired knowledge was retained with no declines throughout the two-month follow-up. The effect of the intervention was confirmed through multivariate analysis that identified the program attendance as a strong positive independent predictor of the knowledge score. The finding further indicates that the nurses continually use their knowledge and apply it to their daily practice, which helps recall and memorization. It also shows that they were eager to learn and know about correct information regarding this practice of daily work. This eagerness to learn might be explained by the fact that many nurses believe that the restraining procedure is not ethically accepted; however, feel it is required in some situations for the benefit of the patient. They consider it as a "necessary evil" [29]. Therefore, if they are forced to do it, they need to know how to do it properly without harming the patient. Our findings are in agreement with Kontio et al. [30] who showed improvement in nurses' knowledge that was sustained after implementing their educational endeavor.

The improvement in nurses' practices after the intervention was also noticeable since their practices before the guidelines were even worse compared with knowledge. In fact none of them had adequate practice at the pre-guidelines phase. Like knowledge, the adequate practice continued throughout the follow-up, and the attendance of the program was the only independent predictor that positively influenced the practice score. In agreement with our findings, Huang et al. [31] examined the effectiveness of a short-term 90-minute in-service education program in improving nurses' knowledge, attitudes, and self-reported practices related to physical restraint use. The results demonstrated significant improvements after program completion. The findings of the current study as well as this one highlight the need to provide short-term in-service education programs in acute care settings.

According to the present study findings, nurses' age, qualification, and experience had no influence on their knowledge and practice scores' improvements. This indicates that the intervention program was beneficial to all nurses regardless their qualification or experience. This might be explained by the fact that the knowledge and practice scores were very low at the pre-guidelines phase, so that no relation could be detected. Only the marital status had a negative impact on nurses' knowledge score change; this indicates that single nurses got more benefit from the program compared to married ones, which might be due to the fact that singles may spend more time in learning and studying compared with the married ones who have other responsibilities. These findings are consistent with those of Hantikainen and Kappeli [32] who found no differences in the perceptions of restraint use between qualified and unqualified nurses. However, in disagreement with this, Al-Khaled et al. [33] revealed that nurses' higher qualification was associated with better performance in applying and maintaining physical restraints.

In order to assess the impact of the improvement of nurses' knowledge and practice on patients' outcomes, the present study compared the frequency and types of complications experienced by physically restrained patients before and after the intervention. A sample of 100 patients, mostly aged above 50 years and with neurological problems was included for this purpose. This age group is comparable to that reported in previous work for physically restrained patients in terms of age [34], and diagnoses where most of these patients were reported to be bedridden, aggressive, disoriented, and agitated [35], and having neurological defects [36].

The most common indications for restraining among the current study patients was the removal of medical devices, self-harm, and harming others. The duration of restraining was longer than two weeks in only less than one-fifth of them, which is consistent with a national survey in Japan that revealed that the majority of physical restraining were for periods less than 2-4 weeks [37]. On the same line, Eşer et al. [38] reported similar results regarding the indications and duration of physical restraining although those who exceeded two weeks restrained were less (7%). The location of restraining patients in the present study was mostly two limbs, and a few had their four limbs restricted. The findings are in congruence with Choi and Song [8] and Martin and Marthisen [39] who mentioned that bilateral wrist restraints were used the most in ICUs for physical restraining.

Before the implementation of the guidelines, the current study patients were found to suffer from all types of problems and complications related to physical restraining. Thus, only one patient was free from any abnormal physical findings, and the total number of complications ranged between one and twelve, with median 7. The most commonly encountered problems were the lack of personal hygiene, constipation, bed sores and skin lacerations, in addition to the psychological problems of agitation and anger. Similar problems were reported by Mamun et al. [40] and Bassi and Ceresola [41] with emphasis on skin lacerations, incontinence of urine and stool, fecal impaction, decreased functional status, and psychological problems. On the other hand, serious complications such as ischemia, nerve injury, strangulation, and death were much less frequent.

The implementation of the present study guidelines led to significant improvements in all types of complications among physically restrained patients. This is certainly due to the effect of the educational guidelines which improved nurses' knowledge and practice. In fact, nurses' knowledge and practice scores turned to be strongly and positively correlated. The findings were confirmed through multivariate analysis that identified the intervention as a negative independent predictor of the number of complications among patients. This is in fact an objective proof of the success of the guidelines intervention and the authenticity of our third hypothesis.

The reduction in the frequency of complications among restrained patients in the current study may be attributed to the changes in nurses' practice which became adequate and based on satisfactory knowledge acquired during the program. Thus, the improvements in vital signs and the decreases in the frequencies of skin laceration and infections are certainly due to the learnt practice of releasing the restraint at 2-hour

intervals, along with the nurse performing a massage and range-of-motion exercises on the restrained joints. The findings are in agreement with Lewis et al. [42] and Maccioli et al. [43] who demonstrated that such nursing care procedures led to significant improvements in physically restrained patients.

Two other predictors were identified in the present study that had their impact on the number of complications experienced by the patients. These were the presence of a chronic disease and the duration of restraining. This latter is quite obvious since prolonged restraining lead to more shortage of blood flow, more pressure on nerves and tissues with consequent more damage. Additionally, it increases the duration of immobilization, with subsequent negative effects on patients' physical and psychological state. Regarding chronic diseases, it is known that these patients are more prone to complications due to lower immunity and more susceptibility to infections [44].

Conclusions and Recommendations

The study concludes that relatively short-term in-service guidelines can significantly improve nurses' knowledge and practice concerning physical restraining of ICU patients, with subsequent reductions in the frequency of related complications among these patients. This success is attributed to that the guidelines are based on needs assessment and integrate updated technology. However, the findings should be interpreted cautiously because of limitations of the study being quasi-experimental rather than non-randomized design, and also because of possibility of observer's bias in the assessment of the nurse's practices. However, the objective assessment of patients' outcomes might show that the possibility of this bias to have occurred is rather low. Therefore, these guidelines should be adopted as an essential component of the care provided to physically restrained patients to promote these patients' safety. Orientation programs should be utilized for newly jointed nurses to improve their related knowledge and practice, along with continuous supervision and feedback. Booklets about physical restraint should be available in each department using restraint in the hospital. A randomized double blind clinical trial is suggested to further confirm the study findings.

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