Exploring the Knowledge Regarding Pain Management among Nursingstudents in Kuwait: A Neural Network Andsemantic Analysis Approach

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Abstract Pain is an unpleasant and highly uncomfortable experience patients can have. It causes stress, decreased quality of life and alterations in the physical, emotional and spiritual aspects of a patient's well-being. Deficient knowledge toward pain management hinders effective pain management among nurses and future nurses such as nursing students.This research aims to explore on the essential concepts on pain management cognition among nursing students on pain management. The research employed a descriptive, exploratory design using semantic network analysis and artificial neural network approach. Data were obtained using the knowledge and attitudes survey regarding pain (KASRP) tool. Descriptive and inferential statistics were utilized to interpret data. Findings revealed that the concepts of pain, analgesia, assessment and patient were important concepts related to the knowledge on pain management among nursing students in Kuwait. Further, their current study status, work experience and exposure to pain management books were crucial in their education regarding pain management. Pain management should be integrated and comprehensively discussed in the undergraduate nursing program to enhance the knowledge on pain management of the future nurses.

Keywords: pain, pain management, nursing students, semantic analysis, artificial neural network

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1. Introduction

Pain is an unpleasant and highly uncomfortable experience patients can have [1]. It causes stress, decreased quality of life and alterations in the physical, emotional and spiritual aspects of a patient's well-being [2]. Physiologically, pain is a result of reduced pain threshold due to the effect of chemical substances such as bradykinin, serotonin and prostaglandin secondary from damaged cells and tissues [3,4].

The negative effects of pain on a patient, holistically, are major concerns for nurses. Thus, pain management among nurses is crucial [5]. Nurses' need to be proficient in their knowledge on pain management such as assessment, interventions, and prevention in order to provide prompt and effective pain relief [6]. Pain has been widely studied internationally [7,8], however, in spite of the developments in pain management, many patients, globally, still receive inadequate and inappropriate treatment.

Similarly, in Kuwait, the prevalence of pain is ubiquitous thereby necessitating a reform in health care organizations and improve pain management practices [9]. Further, musculoskeletal problems, overweight and obesity have been identified as common factors that contribute to pain in Kuwaitis [10,11]. There is a deficiency in the knowledge of nurses in the concept of pain management [12,13,14]. A study was conducted by Dessie et al [15] to assess the Knowledge and attitudes of 433 Ethiopian nurses regarding post-operative pain management. Results determined that 56.5% of the study sample had adequate knowledge on pain management and only 8.9% had a positive attitude towards pain management.

Indeed, knowledge on pain management is vital in the nurses' competency development in providing efficient and adequate pain management. Literature is sparse regarding nurses' knowledge on pain management in the Arab world including Kuwait. This research focuses on determining the essential knowledge-based concepts on pain management important among nursing students' pain competency in Kuwait.It aims to explore on concepts or factors that may be crucial in enhancing pain management skills. This research utilized unconventional approaches in the study of knowledge on pain management in the form of artificial neural network and a semantic analysis

approach to probe on the important factors or concepts regarding pain management.

This research used the process of ANN as a novel approach in determining the important factors and concepts that may be affective in the cognition of pain management among nursing students in Kuwait. Artificial neural network (ANN) is commonly used to ascertain the linear relationship of data using a perceptron. It aims at eliciting the connection pattern and network topology among data which mimics the action of a biological neuron [16,17]. Meanwhile, Semantic network analysis is used to seize the relations among key concepts and explore the context of the main topic [18]. This research utilized the process of semantic network analysis to accurately determine which concept in pain management is important and be the focus of future pain management courses for the nursing students.

2. Methods

2.1. Design

This research utilized a descriptive, exploratory approach in probing the knowledge on pain management among nursing students in Kuwait. A total of 106 nursing students completed the survey having a response rate of 83% as a result of convenience sampling. This research was done in the Nursing college of the Public Authority of Applied Education and Training in Kuwait. Data collection started in October 2019 and ended in December 2019. The inclusion criteria were set to those nursing students currently having their clinical duty and have voluntarily agreed to participate.

2.2. Instrument

A demographic data sheet was used to gather data from the nursing students. Information about the participant's gender, age, educational qualification, current study status, participation in a training course on pain, work experience, and have read a book on pain management were elicited from the participants.

This research utilized the Knowledge and Attitudes Survey Regarding Pain (KASRP) tool developed by Betty Ferrell. It is a 37- item questionnaire composed of 21 true or false questions and 16 multiple choice questions regarding the concept of pain [19]. It encompasses concepts such as pain management, pain assessment, and the use of analgesics. The instrument was validated by four experts in the field with a doctorate degree in the field of nursing. Thereafter, it was subjected for reliability testing with 10 nursing students who were not included in the actual data gathering.

2.3. Ethical Consideration

This study has been approved by the authorities of the nursing college. Written informed consent from the participants has been sought.

2.4. Data Analysis

Data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics was used to describe the participants' profile. Semantic analysis was used to determine the significant key concepts in the KASRP tool and was correlated with the participants' response using Pearson's Coefficient of Correlation. Meanwhile, artificial Neural Network analysis was used to identify the factors and themes that are highly predictive and significant to the nursing students' knowledge on pain management.

3. Results

Most of the nursing students were female (70%; n=74) with an average age of 20-25 years old (92%; n=98). Majority of them hold a secondary school certificate (97%; n=103) and are currently in Level 4 (69%; n=73). There were 80 nursing students (75%)witha training course on pain. Most of them do not have work experience (82%; n=87). Of the 106 nursing students participating in the study, 61 (58%) have read a book on pain management while 45 (42%) have not. (Table 1)

Table 1. Profile of Respondents

Characteristics (N=106)		n (%)
Gender		
	Male	32 (30)
	Female	74 (70)
Age		
	Below 20 years	7 (7)
	20 - 25 years	98 (92)
	26 - 30 years	0
	31 - 35 years	0
	Above 36 years	1 (1)
Educational qualification		
	Secondary School Certificate	103 (97)
	Nursing Service Technician Certificate (Graduate Institute of Nursing)	3 (3)
Current study status		
	Diploma (Level 4)	73 (69)
	Diploma (Level 5)	33 (31)
Attendance to training course on diagnosis and treatment of pain		
	With training course	80 (75)
	Without training course	26 (25)
Work experience		
	No work experience	87 (82)
	One month to one year	6 (6)
	13 months to 2 years	10 (9)
	Above 25 months	3 (3)
Reading a book on pain management		
	Read a book	61 (58)
	Not read a book	45 (42)

The concepts in the KASRP tool were derived based on its occurrence in the items of the tool using semantic analysis. Concurrently, the average percentage of the knowledge scores were obtained based on the responses of the nursing students. This resulted in the identification of concepts that are meaningful in the representation of the knowledge base of the nursing students in Kuwait regarding pain management which were (from highest to lowest) "analgesic" (55.09%), "opioid" (54.98%), "opioid analgesic" (53.21%), "patient" (51.23%), and "pain" (49.69%). Meanwhile, the concept of "significant respiratory depression" (9.69%) has the least relevance(Table 2).

Table 2. Semantic Analysis of KASRP Tool and Knowledge Scores

Clusters	Themes/Concepts	Similarities Across Items	Weights	Items	Total	Mean (%)
1A	"opioid"	7	1.88	6,7,9,10,11,12,15,18,21,22,23,28,36,37	14	54.98
1B	"patient's pain"	3	3.22	1,18,31	3	49.69
2A	"analgesic"	4	2.94	5,7,9,15,22,23,24,26,27,28	10	55.09
2B	"pain"	18	0.91	1,2,3,4,5,7,11,12,13,14,16,18,19,20,22,23,24,26,27,28,29,30,31,32,33,38A,38B,39A,39B	29	49.69
3A	"assessment"	5	0.29	13,38A,38B,39A,39B	5	27.36
3B	"year"	4	0.77	13,38A,39A	3	41.05
4	"analgesia"	3	0.65	8,38B,39B	3	27.18
5	"hour"	6	0.12	8,25,28,38B,39B	5	31.89
6	"injection"	3	0.50	16,38B,39B	3	24.66
7	"morphine"	7	0.22	8,17,25,28,34,35,38B,39B	8	43.54
8	"opioid analgesic"	5	0.58	9,15,22,23,28	5	53.21
9	"pain relief"	6	0.46	11,19,38B,39B	4	37.26
10	"patient"	15	0.83	1,3,4,6,10,11,12,14,15,16,22,23,24,28,29,31,32,33,38A,39A	20	51.23
11	"severe pain"	4	1.80	3,4,23,24	4	44.81
12	"significant respiratory depression"	3	0.16	28,38B,39B	3	9.69
13	"time"	4	0.68	34,35,38B,39B	4	28.77
Overall						44.02 ±10.64

Note. *Ave. of individual outcomes, where: (Item1 x cluster weight1) + (Item2 x cluster weight2) + (Item... x cluster weight…) / (Total cases x No. of concepts) x 100

Table 3. Relationship of Themes/Concepts According to Knowledge Scores

Themes/Concepts		Pearson's r	Interpretation
"analgesic"	"pain"	0.68	Strong Positive
"pain"	"patient"	0.85	Very Strong Positive*
"assessment"	"year"	0.92	Very Strong Positive*
"analgesia"	"hour"	0.73	Strong Positive
"hour"	"morphine"	0.80	Very Strong Positive*
"morphine"	"time"	0.61	Strong Positive
"patient"	"severe pain"	0.66	Strong Positive
"significant respiratory depression"	"analgesia"	0.60	Strong Positive
"significant respiratory depression"	"hour"	0.64	Strong Positive

Note. "Very Strong," 0.80-1.00; "Strong," 0.60-0.79; "Moderate," 0.40-0.59; "Weak," 0.20-0.39; "Very Weak," 0-0.9

Results revealed a "very strong positive" correlation between the concepts of "pain" and "patient" (r=0.85), "assessment" and "year" (r=0.92) and "hour" and "morphine" (r=0.80). This finding may pertain to significant relevance of getting correct answers when the concepts (e.g. "pain" and "patient") are present in the KASRP tool. A value of Pearson Correlation Coefficient (r) of +1 is indicative of a positive relationship [20]. (Table 3)

Using the neural network analysis, the data set was generally partitioned in the following: 70% training, 20% testing and 10% holdout (Table 4 and Table 5).

Table 4. Importance of Demographic Variables to KASRP Total Scores in a Two-Layer Neural Networks (Perceptron/Regression) Model

Factors	Importance	Normalized Importance (%)
Gender	.107	40.5
Age	.124	47.2
Educational Qualification	.030	11.4
Current Study Status	.207	78.6*
Training Course	.079	30.1
Work Experience	.189	71.7*
Reading Book	.264	100*

Note. * statistically significant
IBM SPSS Statistics 25

Table 5. Importance of Themes to Actual Outcomes in a Two-Layer Neural Networks (Perceptron/Regression) Model

Factors	Importance	Normalized Importance (%)
"opioid"	.093	83.70*
"patient's pain"	.112	100*
"analgesic"	.107	95.40*
"pain"	.099	88.60*
"assessment"	.056	49.90
"year"	.046	41.20
"analgesia"	.037	32.70
"hour"	.056	49.90
"injection"	.031	28.10
"morphine"	.055	49.50
"opioid analgesic"	.038	34.20
"pain relief"	.053	47.40
"patient"	.079	70.40
"severe pain"	.066	59.20
"significant respiratory depression"	.032	28.90
"time"	.041	36.30

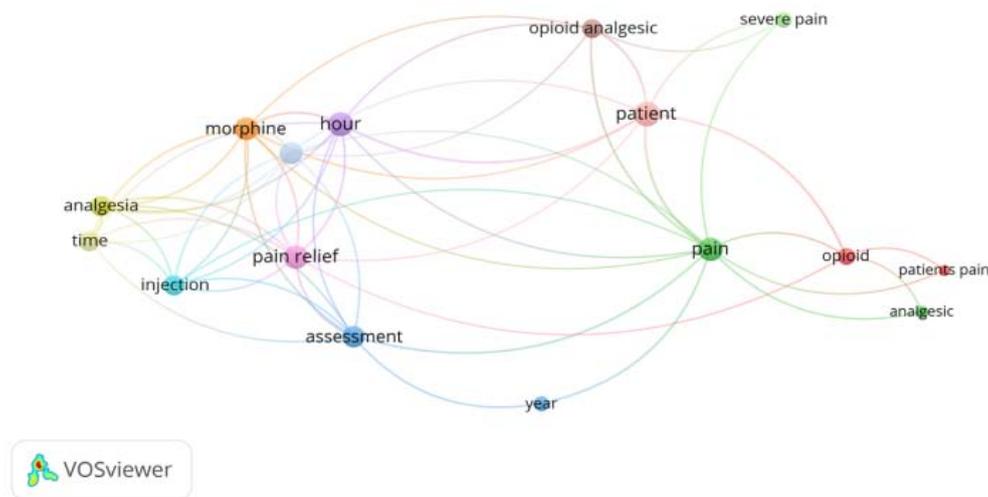Note. * statistically significant
IBM SPSS Statistics 25

Figure 1 shows the semantic linkages of the concepts in the KASRP tool. Findings reveal that the concepts of patient, pain, morphine, pain relief, and assessment are essential in the comprehension of pain management.

Table 4 shows the demographic variables that are highly predictive of affecting the knowledge of the nursing students regarding pain management. Specifically, data partitioning were automatically calculated into 74.3% training, 18.1% testing, and 7.6% holdout. The network structure was composed of the Input layer(48 units), hidden layer(9 units), and output layer (1 unit). Based from the importance coefficients obtained, three variables were statistically significant: "reading a book on pain" (100%), "current study status" (78.6%) and "work experience" (71.7%). The relative errors were 0.990 training, 0.954 testing and 1.002 holdout.

Using ANN, concepts such as "patient's pain" (100%), "analgesic" (95.4%), "pain" (88.6%) and "opioid" (83.7%) were highly predictive of affecting the knowledge on pain management among the nursing students in Kuwait. Meanwhile, the concepts of "injection" (28.1%) and "significant respiratory depression" (28.9%) yielded the lowest importance coefficients. Data set were specifically partitioned into 76.5% training, 15.7% testing, and 7.8% holdout. Subsequently, network structure was composed of several layers (Input layer=92 units; hidden layer= 27 units; output layer=1 unit). Based from the importance coefficients obtained, three variables were statistically significant: "patient's pain" (100%), "analgesic" (95.4%), "pain" (88.6%) and "opioid" (83.7%). The relative errors were 0.49 (training), 0.221(testing) and 0.209(holdout). (Table 5)

4. Discussion

This present research determines the knowledge-based concepts on pain management important among nursing students' pain competency in Kuwait. It aims to explore on concepts or factors that may be crucial in enhancing pain management skills. The present finding reveal that the concepts of analgesic, opioid, opioid analgesic, patient and pain as the most meaningful in relation to the nursing students' responses in the KASRP tool. It may indicate

that these identified concepts must be given priority and extensively discussed in a pain management training course. In a study conducted by Ferrell [21], nursing textbooks were analyzed of its concept of pain content and it was found that only 0.05 percent of the total text content of 50 nursing textbooks contained a discussion on pain management. Newly graduate nurses must be educationally prepared to be responsive of contemporary needs of patients in the clinical setting including managing patient pain [22]. Thus, there is a need that the aforementioned concepts need to be integrated in the concept of pain in order for the nursing students to have a full understanding as regards pain management. This helps students to strategize their safe intervention when dealing pain management.

This research focused on finding the essential concepts in relation to pain management as knowledge in pain management involves understanding of pain theories, facts regarding pain assessment and pain treatments that must be embedded throughout the nursing curricula [23]. According to Weber & Kelley [24], the ability of nurses to assess and treat patients pain and achieve positive outcomes is depended on the nurses' level of knowledge in pain management that would encompass the physiological, psychological, pharmacological and non-pharmacological aspects of pain management. The low level of knowledge among nurses [12,13,14] may be due to minimal concepts on pain management in the undergraduate nursing program.

Moreover, results show the very strong relationship with pain and pain assessment which entails higher tendencies of nursing students getting correct answers when these concepts are encountered in the KASRP tool. Inadequate and inappropriate pain management is the result of poor and inaccurate pain assessment by nurses [25]. This is concurred by Ferrell & McCaffrey [26], objectivity in pain assessment with continued education results into elimination of personal opinions and biases among nurses. Meanwhile, Rose et. al [27] found that 42 percent of nurses suffer from lack of education and training on the use of pain assessment tools. This may indicate the necessity to intensify the concept of pain

management and assessment in international nursing programs.

Results also identified that current study status, work experience and having read a book on pain are important factors affecting the knowledge of nursing students in pain management. Most of the respondents are having their theoretical concept regarding pain and clinical rotation during the conduct of the study, which may indicate that exposure in the clinical setting promotes better understanding and application of pain management practices and interventions. This confirms the study of Sigsby [28] that baccalaureate nursing students learn pain management best in the clinical setting. Nursing students improve their knowledge on pain as they progressed through the program and that the concept of pain should be comprehensively be integrated into the study plan for consistency and enhance effectiveness [29].

The artificial neural network result on the important themes relevant to the knowledge of nursing students on pain management supports the result of the semantic network analysis. ANN is used in various sectors in health care for clinical diagnosis, image analysis and interpretation and including prediction of key indicators [30]. Thus, in this research, ANN was used to predict the key indicators related to knowledge on pain management. On the other hand, Semantic Network Analysis was used in this research as a method of extracting meaning from the text or in this case the KASRP tool through network building of the concepts that occur in close proximity [18].

4.1. Limitation

This research was limited to having a small sample size.

4.2. Conclusion

This research has shown that the concepts of pain, patient's pain, opioid, and analgesia are meaningful in the enhancement of knowledge among nursing students in pain management. These concepts are strongly correlated to the concepts of assessment, year, hour and morphine. Further, this research identified that current study status, work experience and reading a book regarding pain are important variables that may affect the knowledge of nursing students in pain management. It is recommended that these identified concepts be given more focus in pain management courses in continuing education and undergraduate curricula. Further studies are needed to evaluate the effectiveness of pain management courses.

4.3. Disclosure

There are no conflicts of interest.

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