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THE EFFECT OF COLD APPLICATION ONUNCONSCIOUS PATIENTS' PHYSIOLOGICAL PARAMETERS DURING ARTERIAL PUNCTURE

Sara Elsayed Hegazy[1], HendElsayed Mansour[2], NahedAttia Kandeel[3]

[1] Demonstrator of Critical Care and Emergency Nursing, Faculty of Nursing, MansouraUniversity, Egypt.sarahegazy35@gmail.com

[2] Lecturer of Critical Care and Emergency Nursing, Faculty of Nursing, Mansoura University, Egypt.hend_egypt_2011@yahoo.com

[3]Professor of Critical Care and Emergency Nursing, Faculty of Nursing, Mansoura University, Egypt.nahed_kandeel2000@yahoo.com

Abstract

Background: *Arterial puncture is a common procedure performed for unconscious patients in intensive care units to assess their respiratory conditions. It is usually associated with pain resulting in significant physiological changes that can affect patients' recovery and progression. Pain killers are the first choice for controlling pain in intensive care units but medications themselves have many adverse physiological effects on the body. Non-pharmacological pain management strategies have been advocated to control pain and avoid the side effects of medications.* ***Aim:*** *This study aimed to investigate the effect of the cold application onunconscious patients' physiological parameters during arterial puncture.* ***Method:*** *A quasi-experimental research design was utilized to conduct this study among 86 unconscious patientsin the surgical intensive care unit of the Critical Care and Convalescence Hospital at Mansoura University in Egypt. One tool was used to collect data for this study; unconscious patients'physiological parameters assessment tool.* ***Result****s: A statistically significant improvement was noted in the participants' heart rate, respiratory rate, and oxygen saturation post-implementation of the cold application ($p \leq 0.05$). However, there were no significant changes in the participants' systolic or diastolic blood pressure after the cold application.* ***Conclusion:****Cold application is an effective method for improving unconscious patients' physiological parameters during arterial puncture. Hence, critical care nurses can include the cold application in the routine nursing care of arterial puncture for unconscious patients in intensive care units.*

Keywords *Arterial puncture, Cold application, Physiological parameters,Unconscious patients*

Introduction

Unconscious patients in intensive care units (ICUs) are usually prone to several clinical procedures to improve the hemodynamic and respiratory functions, maintain patients' life, and promote recovery **(Devlin et al., 2018)**. Arterial puncture is one of the invasive proceduresperformed in ICUstoassess patients' respiratory and acid-base problems **(Gupta,Jain, Rehman, & Choubey, 2016)**. The arterial sample can be obtained from different arteries such as the radial, brachial, axillary, and femoral **(Zinchenko, Prinsloo, Zarafov, Grzesiak, & Cohn, 2016)**. These arteries have a high nerve supply, and penetrating them can be associated with painthat affects different body systems as it stimulates the autonomic, endocrine, and immune responses **(Damico,**

Macchi, Murano, & Molinari, 2020; Pour, 2017).

Paincanlead topatients'hemodynamic instability resulting in prolonged mechanical ventilation (MV) and length of stay in the ICU, increased morbidity and mortality, and subsequent complications **(Moitra, Guerra, Linde-Zwirble, & Wunsch, 2016)**. It produces a certain physiological stress response that increases the heart rate (HR),respiratory rate (RR),and blood pressure (BP), and decreases the oxygen and other nutrients to the vital organs **(Carli, 2015)**.Additionally, two studies evaluatedpain in the ICU and noted that pain is directly affecting patients' BP, HR, and RR **(Jafari, Courtois, Van den Bergh, Vlaeyen, & Van Diest, 2017; Ye, Chuang, Tai, Lee, & Hung, 2017)**.

Physiological parameters such as HR, RR, BP, and oxygen saturation (SPO_2) are used in addition to the face, activity, and guarding behaviors for appropriate assessment of pain especially in neurosurgery patients **(Kapoustina, Echegaray-Benites, &Gélinas, 2014)**. These parameters are considered easy and accessible for critical care nurses (CCNs) to indicate whether apatient is in pain during the clinical procedures **(Erden,Demir, Ugras, Arslan, & Arslan, 2018)**. Moreover, a study conducted to assess CCNs' practices regarding pain assessment and management, reported that more than 70% of nurses usevital signs to assess pain in the ICU**(Rose et al., 2012)**

According to **Taylor (2013)** effective pain assessment and management promotepatient comfort, improvemobilization, decreasepulmonary and cardiac complications such as tachycardia andhypertension, and reduce the risk of deep vein thrombosis (DVT).As most patients in ICUs are unconscious, they can't communicate their pain and need systematic assessment and care to stabilize and support their condition**(Jacob & Paul, 2017)**. CCNshave an integral part inassessing and managing unconscious patients' pain in the ICU. They play a key role in developing and implementing a plan of care that includes assessment, interventions, and individualizedstrategies to control the unconscious patient's pain**(Hayes & Gordon, 2015)**.

According to the literature, there are twomethods to reduce patients' pain and enhance their recovery in ICUs; pharmacological and non-pharmacological**(Gelinas, Arbour, Michaud, Robar, &Côté, 2013)**.For the pharmacological methods,many drugs are available for controlling pain in the ICU and can be classified into; opioid analgesics, non-opioid analgesics, and analgesic adjuncts **(Wampole& Smith, 2019)**. Medications are effective in treating pain but have many adverse physiological effects on the body. Additionally, they can causetolerance, suppression of cough reflexes, and respiratory depression especially for mechanically ventilated patients**(Martyn, Mao, & Bittner, 2019)**.

Non-pharmacological strategies are advocated to minimize patients' pain with fewer side effects**(Şahiner, Inal, &Akbay, 2015)**. These methodsare simple, safe, non-invasive, and inexpensive **(Khalil, 2017)**.Cold application is one of the cutaneous stimulationnon-pharmacological strategies that are widely used in patient care.Itrefers tothe application of ice to produce analgesia to a certain skin area**(Raggio, Barton, Grant, &McCoul, 2018)**. It increases the pain threshold, provides anesthesia of the selected area, and maintains intact nerve cells allowing these nerves to regenerate and regain their normal function over time **(Bellini&Barbieri, 2015; Rupam, Sheoran, & Sharma, 2018)**.

The cold application was proved to be effective in reducing pain and stabilizing patients' hemodynamic parametersduring chest tube removal and wound care **(Hsieh, Chen, & Lu, 2017; Yarahmadi, Mohammadi, Ardalan, Najafizadeh, &Gholami, 2018)**. In Egypt, many studies had assessed the effect of the cold application on physiological parameters during different painful procedures such as the venipuncture**(Abd El-Gawad&Elsayed, 2015)**, puncture of arteriovenous fistula**(Attia & Hassan, 2017)**, and arterial puncture**(Badr, Gaafer, & Ahmed, 2020; Khalil, 2017)**.These investigations clarified that patients' physiological parameters (HR, RR, BP, and SPO_2) showed significant improvements toward the normal values after using the cold application.

These studies were performed among conscious children or adult patients in the internal or emergency departments. Onlya few studies addressedthe effect of the cold applicationon unconscious patients' physiological parameters during painful proceduresin ICUs. Hence, this study was thoughtto cover this issue and contribute to the body of knowledge related to unconscious patients' care. Therefore, this study aimed to investigate the effect of the cold application on unconscious patients' physiological parameters during arterial puncture.The research hypothesized that there will be an improvement in the unconscious patients' physiological parameters after the cold application during arterial puncture.

Method

Research Design

A quasi-experimentalresearch designwas utilized to conduct the current study.This design is mainly used to estimate the effect of an intervention on some outcomes with no or slight randomization. Additionally, multiple observations are assessed for several consecutive points in time before and after the intervention within the same group**(Handley, Lyles, McCulloch, &Cattamanchi, 2018)**.

Setting

The current study was conducted in the surgical ICU of Critical Care and Convalescence Hospital at Mansoura Universityin Egypt. The unit is well equipped with advanced technology and manpowerrequired for patients' management. This unit receives patients after major surgeries such as prostate surgery, cholecystectomy, a partial colectomy,and amputation. It also provides care forpatients who have postoperative complications such as sepsis, respiratory failure,or severe bleeding.

Subjects

A convenience sample of 86 patients was recruited in this studyaccording to the following criteria; adult ≥ 18 years old, males and females, and unconscious patients (according to the Modified Glasgow Coma Scale (MGCS) were from 3-8). Additionally, we excluded consciousor sedatedpatients and thosewho hada local infection, Raynaud's syndrome, cold and bluish extremities, or traumatic brain injury (TBI).

Sample Size Calculation

The MedCalc program (https://www.medcalc.org/index.php) was used to calculate the size of the sample. Based on an80%study power, 5%alpha error, and 20% beta error of a previous study,the sample size should be 71. To compensate for dropout, 20% were added. Thus, the final sample was 86.

Instruments/ Tools

Data were collected using one tool 'unconscious patients' physiological parameters assessment tool'. This tool consisted of two parts as follows:

PartI: patient's demographic and clinical data. This part wasdeveloped by the primary investigator(PI) after reviewing recent literature**(Badr et al., 2020; Damico et al.,2020; Khalil, 2017)**. It involvedthe participants'characteristics including age and gender.It also covered patients'health-relevant data including previous ICU admission, the need for an arterial puncture, and the number of arterial punctures per day.

PartII:physiological parameters assessment tool. This partwas developed by the PI based on the related literature**(Erden et al., 2018; Jafari et al., 2017; Ye et al., 2017)**. It includedparticipants' physiological parameterssuch as SBP, DBP, HR, RR, and SPO_2which were evaluatedfour times before and after the intervention; before the puncture, duringthe puncture, five and 20 minutes after the arterial puncture.

Validity and Reliability

The content validity of the developed tool was tested by a panel of five experts in critical care nursing (five lecturers of critical care and emergency nursing department). Accordingly, the necessary modifications were made. The reliability of the tool was tested by using Cronbach's alphatest that was 0.762for the intubated patients which is accepted and 0.857for the non-intubated patients which indicates a reliable tool.

Pilot Study

A pilot study was conducted including nine patients (10% of the study sample) to investigate and ensure the feasibility, objectivity, applicability, clarity, and adequacy of the study tools. Participants involved in the pilot study were excluded from the main study sample.

Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of the Faculty of Nursing – Mansoura University. Permission to conduct the study was taken from the responsible authorities of the study setting after explaining the aim and procedure of the study. Written informed consent was obtained from the relatives of the participants (next of kin) after providing them with details about the study's aim, procedure, benefits, and risks. They were informed that participation in the study was voluntary. It was emphasized to them that refusing to allow the patient to take part in this investigation would not affect the treatment or care the patient receives in the hospital. Moreover, they were assured that the patient's data would be kept confidential and that they had the right to withdraw the patient from the study at any stage without responsibility.

Data Collection/Procedure

Data were collected by the PIbetween June and September 2019.The PI communicated with the patientsin two sessions; before and after the cold application.The PI carried out an initial assessment to confirm that the patients were free from the exclusion criteria and met the inclusion criteria**.** In the first session(before cold application), the PI assessed thepatients' level of consciousness (LOC). Participants'characteristics were obtained from their medical records. Thepatientsreceived routine care before the arterial puncture. Then, the physiological parameters (SBP, DBP, HR, RR, and SPO_2) were measured electronicallyusing the bedside monitors.

In the second session (cold application),the ice pack was prepared by crushing small pieces of ice and wrapping it up in a piece of gauze. The PI assessedthe participants' LOC to ensure that they were still unconscious.The prepared ice pack was placed over the selected artery (radial, brachial, or femoral) for five minutes alongside the standard care and removed immediately before the puncture. The physiological parameters were evaluated immediately before the puncture. Then, the nurse palpated the artery and inserted the needle and the physiological parameters were reassessed during the puncture and five and 20 minutes after the puncture.

Data Analysis

Data were coded and analyzed by the Statistical Package of Social Sciences (SPSS) version 24. Qualitative data were presented as numbers and percentages. Quantitative data were described as mean ±standard deviation (SD) as appropriate and checkedfor normality by the Kolmogorov-Smirnov test. Moreover, repeated measure ANOVA was used to illustrate differences between more than two related groups (successive observations of physiological parameters). Statistical significance was set at *P*-value equal to or less than *0.05*.

Results

Table 1 presents the patients' demographic and clinical data.It showed that slightly more than half of the participants were males and their age was ≥ 61 years old (52.3% &54.7% respectively).Additionally,mostof them (88.4%) had not been admitted to the ICU before. The vast majority of them had a scheduled arterial puncture during the study and had only one puncture per day (94.2% &95.4%, respectively).

Table 1:*Patients' Demographic and Clinical Data*

Variables	N(86)	%
Age		
• 18-<31	4	4.6
• 31-<41	4	4.6
• 41-<51	9	10.5
• 51-<61	22	25.6
• ≥61	**47**	**54.7**
Gender		
• Male	**45**	**52.3**
• Female	41	47.7
Previous ICU admission		
• Yes	10	11.6
• No	**76**	**88.4**
Number of arterialpuncture per day		
• One	**82**	**95.4**
• Two	4	4.6
• More than two	0	0
Need for an arterialpuncture		
• Emergent	5	5.8
• Scheduled	**81**	**94.2**

Table 2illustrates the mean scores of patients' physiological parameters before and after the cold application. It showed that there were no statistically significant changes in the participants' SBP and DBP after the cold application throughout the four phases (it was still within the baseline values). Concerning the HR, it was noted that there was a significant reduction in participants' HR after the cold application throughout three phases; during the puncture ($\bar{X}$±SD, 95.22±22.07), after five minutes ($\bar{X}$±SD,95.76±2.27), and after 20 minutes of the puncture ($\bar{X}$±SD,95.72±2.09). A reduction of participants' RR within the baseline values was noted after the cold application throughout two phases; during the puncture ($\bar{X}$±SD,27.31±7.77) and five minutes after the puncture ($\bar{X}$±SD, 26.67±7.52). Moreover, it was noted that theparticipants' SPO_2 was significantly increased to the normal baseline values after the cold applicationduring the four phases ($p \leq 0.05$).

Table 2: *Patients'Physiological Parameters Throughoutthe Four Phases of the Study Before and AftertheCold Application*

Variable		Before puncture $\bar{X}$± SD	During puncture $\bar{X}$± SD	5 minutes after the puncture $\bar{X}$± SD	20 minutes after the puncture $\bar{X}$± SD	Test of significance *F*	*P*
SBP	**Pre-application**	121.8±22.37	122.82±21.9	121.84±21.62	120.06±24.63	1.95	0.119
	Post-application	121.24±20.00	119.68±22.7	120.5±19.5	120.18±19.5		
DBP	**Pre-application**	74.58±15.7	73.79±15.36	73.37±14.57	73.36±14.85	0.571	0.685
	Post-application	74.4±14.62	74.17±14.54	73.76±15.52	73.96±15.02		
HR	**Pre-application**	97.39±22.80	101.86±22.23	97.68±21.34	97.13±21.95	**8.1**	**0.000***
	Post-application	97.60±21.48	95.22±22.07	95.76±2.27	95.72±2.09		
RR	**Pre-application**	27.51±8.76	30.16±8.77	27.40±7.91	26.20±7.86	**18.55**	**0.000***
	Post-application	27.59±7.57	27.31±7.77	26.67±7.52	26.52±7.37		
SPO_2	**Pre-application**	94.73±4.84	92.22±5.28	93.94±4.88	94.84±4.73	**39.1**	**0.000***
	Post-application	95.32±4.22	94.97±4.35	95.47±4.23	95.50±4.26		

$\bar{X}$:mean, SD: standard deviation, F:Annova test, (*) statistically significant at $p \leq 0.05$

Discussion

Pain can be associated with several changes in the body's physiological measures as aresponse of the autonomic nervous system to pain sensation. These physiological changes have direct effects on patients' condition and progression **(Cowen, Stasiowska, Laycock, &Bantel, 2015)**. The physiologic parameters such as HR, RR, SPO_2, SBP, and DBP canreliably assess the effect of different stimuli on body systems**(Goepfert et al., 2017; Ö. Ovayolu, Seviğ, Ovayolu, &Sevinç, 2014)**.Therefore, this study focused on investigating the effect of the cold application on unconscious patients' physiological parametersduringarterial puncture.

The current study found no significant difference inparticipants'SBP and DBP before and after the cold applicationduring the four phases of the study. This could be becauseunconscious patients in the ICU usually receive medications controlling their BP to avoid cellular dysfunction and injuries to multiple body organs **(Ghosh, Feng, Nguyen, & Li, 2015)**. In the same line, **Lasocki et al. (2020)** reported that there was no significant change in the patients' BP after doing a massage for the arterial puncture site with an anesthetic cream. However, **Alalo, Ahmad, and Sayed (2016)** reported that the mean value of the patients' SBP and DBP was decreased among the study group and increased among the control groupafter using the ice application before the venipuncture. This contradiction may be due to the nature of the study population as their study was conducted among conscious children.

The results clarified that the participants'HR was decreased toward the normal values over time (during the puncture and five and 20 minutes after the puncture) after the cold application.According to the literature, arterial puncturepain leads to increasing the oxygen demand that consequently increases the HR **(Suh & Lee, 2018)**. Hence, the reduction of patients' HR can be attributed to the effect of the cold application.Our results are aligned with the results of **Khalil(2017)**which revealed that the patients' HRwas differed significantly between the two groups during the arterial puncture, as the study group had lower HR compared to the control group.However,this is contradicting the findings of **M.Shehata and Shahata (2017)** who found no significant differences in the HR among the study and control groups after using the cutaneous stimulation (ice application) during the arterial puncture among critically ill patients (CIPs). This contradiction may be due to the nature of the study population as their study included conscious patients.

The current study noted that most of the participants' experienced a major decline in their RR toward the normal valuesduring arterial puncture with a slight decline noticed after five and 20 minutes of the puncture after using the cold application.According to the literature,arterial puncture causes pain and this leads to increasing secretions of the chemical substances that increase the respiratory demands leading to tachypnea **(Sahni, Gonzalez, &Tulaimat, 2017)**. Hence, the decline of the participants'RR in the current study may be due to the effect of the cold application.

Our findings are matched with **Abozeid,Elshamy, Salama, and Emadeldin(2019)** who investigated the effect of the cold application on hemodialysis fistula pain and showed that the patients had more stabilized RR after the ice application. On the other hand, **Badr et al. (2020)** compared the effect of cold application and foot reflexologyon painduring arterial punctureandreported that there were no statistically significant differences in the patients' RR between the study and control groups during the puncture following the cold application. This disagreement may be due to the study population as Badr's studyinvolved critically ill children.

As regards the SPO_2, there was an elevation in patients' SPO_2 reaching the normal values throughout the four phases of the study. This could be due to increased oxygen consumption associated with arterial puncture pain before using the cold application leading to a decreasein tissue perfusion causing hypoxia **(Weledji, Ngomba, &Njie, 2020)**.These results are inconsistent with the findings of **Alalo et al. (2016)** who found no significant differences among the study and control groups as the values of oxygen saturation were constituted within the normal range. This discrepancy may be due to the study population as it involved conscious children.

Limitations

Limited generalizability of the research findings due to the small sample size and the study was conducted in one ICU in one universityteaching hospital.

Conclusion and Recommendations

The findings of the current study contribute to the body of knowledge related to the effect of the cold application on unconsciouspatients' physiological parameters during arterial puncture. The cold application is a simple and cost-effective method that can be used in the ICU to reduce the unconscious patients' physiological changesassociated witharterial puncture pain. CCNs need to be aware of and apply such simple applications for unconscious patients in the ICU without compromising their safety. Hence, CCNs can include the cold application in the routine nursing care of arterial puncture for unconscious patients in ICUs.

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Declaration of Conflicting Interests

The authors declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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