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Attitudes and Perceptions Surrounding Arterial Puncture for Blood Gas Testing: Differences Between Nurses in the Emergency Department and the Pulmonology Department☆

Actitudes y percepciones frente a la técnica de punción arterial para gasometría: diferencias entre enfermeras de los servicios de urgencias y de neumología

Dear Editor,

Guidelines have been published to provide protocols standardizing clinical activity and procedures in direct puncture arterial blood collection for the determination of arterial blood gases (ABG).[1,2] However, some earlier studies[3] and clinical experience seem to indicate that the techniques used by professionals still vary and that guidelines for the performance of this procedure are not always followed, especially those aimed at reducing pain caused by the procedure.

In this article we aim to explore and compare attitudes and perceptions surrounding the arterial puncture technique for determining ABG in adults among nursing professionals in the pulmonology and emergency departments of several third-level hospitals in the Basque Country (Spain).

A cross-sectional analytical study was conducted using a voluntary, anonymous survey of active nursing professionals from 4 hospital emergency departments (ED) and 5 pulmonology inpatient departments (PID) from 5 third-level hospitals in the Basque Country, with a staff of 285 emergency nurses and 79 pulmonology nurses.

The survey was prepared *ad hoc* by the researchers, using other previous studies as a model.[3,4] Content validation was performed sequentially by way of a review of the initial questionnaire by the researchers, a critical analysis by a group of experts, and a pilot survey completed by 10 nursing professionals to verify adequate understanding by the study subjects. The final questionnaire comprised a section of social and vocational variables and a series of questions centered on self-perception/self-evaluation of different attitudes toward the technique, using open- and closed-ended questions and descriptive rating scales.

The questionnaire was distributed between January and February 2020 by institutional email among the nursing staff who were working at the time in the units selected for study. A reminder was sent 15 days after the initial invitation.

Categorical variables are expressed as absolute frequencies and percentages. To test the hypothesis, the X^2 test or Fisher test with a 2-tailed significance level of 95% (P<.05) was applied. The magnitude of the association with the effect variable "no local anesthesia used" according to different covariables was evaluated by crude calculation of the odds ratio (OR) and 95% confidence interval (95% CI). Data analysis was performed using SPSS 25 and OpenEpi 3.01.

A total of 185 nurses from EDs and 58 from PIDs participated in the survey (65.9% participation rate). Table 1 describes the main characteristics of the respondents and their responses to questions on their attitudes and perceptions regarding the ABG technique.

While the Allen maneuver is rare in both departments, the use of strategies to control iatrogenic pain was significantly higher in PIDs, where the proportion of nurses who believe that the systematic use of local anesthesia is recommendable is also higher. However, there were no differences between departments in nurses' perception of pain caused by the procedure: 73.7% of respondents estimated that the puncture generated more than 4 points on the 0–10-point NRS-11 numeric pain scale.

The factors most strongly associated with the non-routine use of anesthesia were not knowing other colleagues in their department who used it (OR 66.7; 95% CI 22.2–273.8); performing ABG in the ED (OR 28.2; 95% CI 13.1–63.8); perception of iatrogenic puncture pain less than or equal to 4 points on the NRS11 scale (OR 3.6; 95% CI 1.5–9.7), and high or very high self-perceived arterial puncture skill by the professionals themselves (OR 2.3; 95% CI 1.2–4.5).

The use of the Allen test as a screening method for deficits in palmar collateral circulation is described in most of the reference guides,[1,2] but this maneuver is highly controversial, and some authors have advised against it.[5]

There is some scientific consensus that any pain scoring more than 3 points on the NRS11 scale should be treated.[6] In the case of ABG, the pain generated by the technique is evaluated by the patients at between 2 and 5 points and, while differences emerge depending on the difficulty of the procedure,[7–9] it is widely agreed that the use of measures to mitigate iatrogenic pain should be evaluated. Local injection of mepi/lidocaine is the most common practice used to mitigate this type of pain,[10,11] but it is rarely applied in EDs.

The reason for poor adherence to anesthesia most often given is the perception that the routine injection of mepi/lidocaine at the site of arterial puncture offers no therapeutic advantage. Indeed, although clinical guidelines advocate its systematic administration, the scientific evidence in this regard is inconclusive[12] and some authors currently propose as an alternative the use of selective anesthesia based on criteria of patient preference, professional expertise, and technical difficulty of the puncture.[13] In our study, we observed that nurses who considered themselves expert or who felt that the pain caused by their punctures was less than 4 points on the NRS11 scale were more reluctant to use anesthesia on a regular basis.

The lack of time available to apply anesthesia (attributed to high demand for care or emergency situations) has also been highlighted as an argument for omitting anesthetic treatment. The emergency situation is the main contraindication for anesthesia use during ABG procedures, but patients who attend EDs and who are classified with triage levels higher than II on the Manchester scale should

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Table 1
Perceptions and Attitudes Toward Arterial Puncture for Arterial Blood Gases Determination Among Nurses in the Emergency Departments and Pulmonology Inpatient Departments.

	Total*n*=240	Emergency Dept. (%)*n*=182	Pulmonology*n*=58	*P*
Characteristics of respondents				
Time employed in the department; n (%)				
≤2 years	63 (26.3)	42 (23.1)	21 (36.2)	<.001
3–9 years	108 (45)	82 (45.1)	26 (44.8)	
≥10 years	69 (28.7)	58 (31.8)	11 (19)	
Arterial blood gases performed in the last month; n (%)				
<10 blood gas tests	97 (40.4)	56 (30.7)	41 (70.6)	<.001
≥10 blood gas tests	143 (59.5)	126 (69.2)	17 (29.3)	
Attitudes				
Puncture artery of choice; n (%)				
Radial	227 (94.6)	169 (92.9)	58 (100)	.036
Humeral	13 (5.4)	13 (7.1)	0	
Allen maneuver performed prior to puncture; n (%)				
Frequently/(almost) always	34 (14.1)	21 (11.5)	13 (22.4)	.1
Sometimes	65 (27.1)	52 (28.6)	13 (22.4)	
(Almost) never	141 (58.8)	109 (59.9)	32 (55.2)	
Local anesthesia with mepi/lidocaine given prior to puncture; n (%)				
Frequently/(almost) always	38 (15.8)	1 (0.6)	37 (63.8)	<.001
Sometimes	17 (7.1)	13 (7.1)	4 (6.9)	
(Almost) never	185 (77.1)	168 (92.3)	17 (29.3)	
Perceptions				
Self-perceived technical skill in arterial puncture; n (%)				
(Very) high	171 (71.2)	138 (75.8)	33 (56.8)	.006
(Very) low/normal	69 (28.7)	44 (24.1)	25 (43.1)	
Practitioners' perception of iatrogenic pain; n (%)[a]				
≤4 points	63 (26.2)	52 (28.5)	11 (18.9)	.15
>4 points	177 (73.7)	130 (71.4)	47 (81)	
Knows colleagues who usually apply anesthesia prior to puncture; n (%)				
Yes	80 (33.3)	34 (18.6)	46 (79.3)	<.001
No, none	160 (66.6)	148 (81.3)	12 (20.6)	
Reasons for not routinely using anesthesia; n (%)[b]				
Lack of technical knowledge or habit	50 (24.8)	44 (24.3)	6 (28.6)	.66
Lack of time	65 (32.1)	60 (33.1)	5 (23.8)	
Does not consider anesthesia to be advantageous	81 (40.1)	74 (40.9)	10 (47.6)	
Believes that local anesthesia with mepi/lidocaine is recommendable				
Yes, unless contraindicated	48 (20)	19 (10.4)	29 (50)	<.001
No	56 (23.3)	55 (30.2)	1 (1.7)	
Not sure	81 (33.7)	61 (33.5)	20 (34.4)	
Depending on the case	55 (22.9)	47 (19.5)	8 (13.7)	

Note: The final numbers may not account for 100% of the sample due to missing values.

[a] Practitioner's self-perception of puncture pain on the NRS11 scale.

[b] Question answered by subjects who responded that they administered anesthesia "never, almost never or occasionally" (*n*=202).

not be deprived of this resource, since the use of anesthesia does not involve a clinically relevant investment of time.

Finally, lack of training in local anesthesia administration and poor organizational culture (measured by whether the practitioner knows other colleagues who use anesthesia) are other causes of low adherence to iatrogenic pain management that are easily addressed through education and awareness programs.

In conclusion, it is clear that the arterial puncture technique for ABG is significantly different if it is performed in the ED or the PID. In general, some technical heterogeneity exists in the collection of arterial blood, and pain management is, in particular, an area that must be improved if we are to reduce suffering in the practice of a nursing procedure as common as ABG.

Conflict of Interests

The authors declare that they have no conflicts of interest in relation to this article.

Appendix A. Supplementary Data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.arbr.2020.03.011.

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Metabolic Acidosis Caused by Laxatives in a Patient with Duchenne Muscular Dystrophy Receiving Non-Invasive Mechanical Ventilation☆

Acidosis metabólica por laxantes en paciente con distrofia muscular de Duchenne y ventilación mecánica no invasiva

Dear Editor,

Patients with Duchenne's muscular dystrophy (DMD) have a high incidence of constipation, and the chronic use of laxatives is an important component of their treatment. It has been postulated that the underlying cause of constipation in these patients is the functional deterioration of the smooth muscles of the gastrointestinal tract, which can cause gastric dilation, slowing of gastric and ileal emptying, and even intestinal pseudo-occlusion. Pathological and functional smooth muscle abnormalities appear to be derived from dystrophin deficiency, the locus-encoded protein associated with DMD.[1] Gastric or intestinal dilation may be aggravated specifically in patients with hypercapnic respiratory failure, due to the ingestion of air during non-invasive ventilation (NIV).[2] It is well known that treatment with laxatives can lead to the development of metabolic acidosis,[3,4] an electrolyte disturbance that could have respiratory consequences in patients with chronic hypoventilation.

We report the case of a 37-year-old DMD patient with chronic hypercapnic respiratory failure, who required NIV 12 h a day. A stable phase lung function study showed: FEV_1/FVC 94%, FVC 26%, FEV_1 30%, MIP 12%, MEP 8%, peak cough flow 149 L/min, pH 7.37, pO_2 86.1 mmHg, pCO_2 49.2 mmHg, HCO_3 27.9 mEq/L. Routine outpatient monitoring revealed iron deficiency anemia, so oral iron was added to his usual treatment (betahistine, dihydrochloride, and paracetamol). The patient's chronic constipation worsened, so magnesium hydroxide [$Mg(OH)_2$] was started as a laxative. Successive follow-ups detected a worsening of the acid-base balance with the appearance of metabolic acidosis (see Table 1) and an increase in ventilatory support needs of up to 18–20 h a day. The patient's targeted clinical history showed no focus of infection. Blood gases also showed a decrease in pCO_2 and bicarbonate (HCO_3). Correct renal function and the presence of a normal anion gap (sodium 139 mmol/L, chlorine 102 mmol/L) were confirmed. Given the suspicion of metabolic acidosis caused by the use of magnesium hydroxide, this compound was replaced with bisacodyl and lactitol. Subsequent blood gas monitoring showed the correction of acidosis, presenting results similar to the baseline status. Two years later, the patient reinitiated magnesium hydroxide treatment for persistent constipation, resulting in a new episode of metabolic acidosis (see Table 1).

The chronification or worsening of metabolic acidosis can have several consequences, including cardiac contractility changes with decreased cardiac output, increased incidence of arrhythmias, arterial and venous vasodilation, increased pulmonary vascular resistance, metabolic demands, insulin resistance, anaerobiosis due to reduced adenosine-triphosphate synthesis (ATP), hyperkalemia, and alterations in the level of consciousness.[5,6]

Specifically, magnesium hydroxide is an osmotic laxative that can disturb the acid–base balance by the loss of bicarbonate, and the higher the loss, the greater the degree of acidosis.[3,7,8] The initial response to bicarbonate loss is decreased pCO_2 due to the stimulation of ventilation, producing hyperventilation to normalize pH. On average, the loss of 1 mEq/L of HCO_3 is compensated by a 1.2 mmHg drop in pCO_2,[9] but this response cannot be maintained, whether metabolic acidosis becomes chronic or if the patient is unable to respond to the respiratory demand, and may result in muscle fatigue, altered ventilation mechanics and increased NIV needs. Based on this mechanism, the use of acidifying drugs as part of the treatment of residual hypercapnia in patients receiving home mechanical ventilation has been proposed.[10] However, in patients with neuromuscular diseases, the compensatory hyperventilation mechanism could lead, as in this case, to an increase in the work of breathing.

Table 1
Course of Blood Gases.

	Stable Phase	Treatment With $Mg(OH)_2$	Discontinuation of $Mg(OH)_2$	Reintroduction of $Mg(OH)_2$
pH	7.37	7.33	7.35	7.32
pCO_2 (mmHg)	49.2	45.4	47.5	43
pCO_2 (mmHg)	86.1	93.3	87.4	108
HCO_3 (mEq/L)	27.9	22.5	25.6	21.5
Base excess (mEq/L)	3	−1.7	0.7	−3.7

HCO_3: bicarbonate; $Mg(OH)_2$: magnesium hydroxide; pCO_2: partial pressure of carbon dioxide; pO_2: partial pressure of oxygen.

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