Comparative analysis of vital signs in acutely hospitalized patients according to the pain intensity

L. Suso-Martí[1,2], F. Cuenca-Martínez[1,2], A. Arredondo-López[1] y A. Gil-Martínez[1-3]

[1]Departamento de Fisioterapia. Centro Superior de Estudios Universitarios La Salle. Universidad Autónoma de Madrid. [2]Grupo de Investigación Motion in Brains. Instituto de Neurociencia y Ciencias del Movimiento (INCIMOV). Centro Superior de Estudios Universitarios La Salle. Universidad Autónoma de Madrid. [3]Unidad de Fistioterapia. Hospital Universitario La Paz (idiPAZ). Madrid. España

ABSTRACT

Objectives: A relevant aspect in hospitalized patient is pain intensity measurement. The objectives were firstly the identification of associated variables to pain and secondly if there was any association between the intensity of pain and the modification of the vital signs.

Materials and methods: The present research was a cross-sectional study was carried out in different areas of acute hospitalization in the University Hospital La Paz. Main variable was intensity of pain measured with numeric verbal scale, and secondary variables were vital signs, body temperature, systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate, capillary blood glucose and oxygen saturation from the data obtained in the hospital monitoring instruments. The Student's T test was used for comparison between groups. The effect size was measured by the Cohen d and the association size by the Pearson r.

Results: A total of 180 patients were included. No statistically significant differences were found for any of the vital signs according to pain intensity levels (p > 0.05) divide in two groups. No statistically significant differences were found between vital signs as a function of pain intensity and the moment to collect measurements (morning/afternoon/evening) (p > 0.05). No statistically significant associations were found between pain intensity and vital signs except a statistically significant weak and negative association was observed between the diastolic blood

RESUMEN

Objetivos: El dolor es un aspecto de amplia repercusión en la calidad de vida de los pacientes y se ha propuesto incluirlo entre las constantes o signos vitales para que sea siempre recogido en la evaluación del paciente hospitalizado. El objetivo principal del presente estudio fue evaluar las constantes vitales en función de la intensidad de dolor en pacientes agudos hospitalizados, y el objetivo secundario fue observar si existen posibles asociaciones entre la intensidad del dolor y las constantes vitales.

Material y métodos: El presente estudio fue un estudio transversal realizado en diferentes áreas de hospitalización aguda en el Hospital Universitario La Paz. La variable principal fue la intensidad de dolor y las variables secundarias fueron las constantes vitales: temperatura corporal, tensión arterial sistólica, tensión arterial diastólica, tensión arterial media, frecuencia cardiaca, glucemia capilar y saturación de oxígeno. Se utilizó la prueba t de Student para comparación entre grupos. El tamaño del efecto se midió mediante la d de Cohen y el tamaño de asociación mediante la r de Pearson.

Resultados: Se incluyeron un total de 180 pacientes. No se encontraron diferencias estadísticamente significativas para ninguna de las constantes vitales en función a los niveles de intensidad de dolor (p > 0,05) divididos en 2 grupos. Tampoco se hallaron diferencias estadísticamente significativas entre las constantes vitales en función de la intensidad de dolor en el turno de mañana, tarde y noche (p > 0,05). No se hallaron asociaciones estadísticamente significativas entre la intensidad de dolor y las constantes vitales, excepto

Correspondence: Alfonso Gil Martínez
fongilmar@gmail.com

pressure and the patients pain intensity (r = -0.219; p = 0.032).

Conclusions: Our results suggest that there are no differences between the vital signs according to the pain intensity and there are not associations between them.

Key words: Pain intensity, vital signs, acute patient, in-patient.

una asociación débil y negativa entre la tensión arterial diastólica y la intensidad de dolor percibido por los pacientes (r = -0,219; p = 0,032).

Conclusiones: En base a los resultados obtenidos en el presente estudio, no existen diferencias entre las constantes vitales en función la intensidad de dolor. Las variaciones de las constantes vitales parecen no ser una buena estimación de la intensidad de dolor en pacientes con dolor leve y dolor moderado-severo. Son necesarios análisis prospectivos en muestras de mayor tamaño para confirmar estos resultados.

Palabras clave: Intensidad de dolor, constantes vitales, paciente agudo, hospitalizado.

INTRODUCTION

Currently, pain is considered a major public health problem (1). The prevalence of chronic pain in Spain is estimated to be at 17% according to the scientific literature, presenting a great impact at an economic, social and personal level (2). Pain is the main reason for consultation in hospital emergency services and, in addition, inpatients have high rates of pain (3,4). The prevalence of pain in inpatients affects directly the hospitalization process, delaying recovery and, therefore, increasing the use of hospital resources (5).

The presence of pain in inpatients is widely related to the pathological process of the patient, finding high rates of pain in acute patients, both by healing processes and in postsurgical patients (6). Therefore, monitoring and control of pain in acutely hospitalized patients is presented as a relevant measure, being pain considered as the fifth vital sign (7). The most commonly used tools to assess pain intensity are self-reported subjective scales. Scales commonly used in pain measurement, such as the visual analog scale or the verbal numerical scale, offer a mainly subjective assessment of pain and require the patient's collaboration and ability to communicate. Therefore, currently, other measures are sought to allow a measurement that offers larger objectivity and reliability of pain intensity. One of these measures are the vital signs or physiological variables, which have been suggested as indicators of the increased activity of the sympathetic-excitatory nervous system in the presence of pain (8). It should be considered that this system can vary its activity according to the time slot in which it is evaluated and, therefore, the pain could also vary it in the same way. These variables are used in children in preverbal age due to the impossibility of making self-reported subjective measures and these variables have been able to predict acute pain in this population (9).

The hypothesis of the present study states that acute pain could modify some of the vital signs and these signs could be used for the measurement of pain. Therefore, the main objective of the present study was to evaluate the vital signs according to the intensity of pain in acute inpatients. The secondary objective was to analyze the relationship between pain intensity and vital signs in patients with mild or moderate-severe intensity of pain.

MATERIAL AND METHODS

Study design

The present research was an observational cross-sectional study following the design of the STROBE statement for observational studies (10). The study protocol was previously approved by the Clinical Research Ethics Committee of La Paz University Hospital (PI: 2283); an encoding that prevented the violation of the participants' right to anonymity.

Participants

All the information of the participants was obtained at different acute admission areas of La Paz University Hospital of the Community of Madrid. The inclusion criteria were the following: a) acutely hospitalized patients whose stay was equal to or more than 48 hours and, b) adults (> 18 years old). The measurement and recording of all the variables studied was performed at the same time. The exclusion criteria were the following: a) patients admitted to chronic units, b) minor patients (under 18 years of age) and c) patients with a medical diagnosis of chronic degenerative musculoskeletal pathology.

Procedures

The data collection was performed at La Paz University Hospital of the Community of Madrid between February and March 2017. A simple random sampling was performed among patients admitted to acute care units between 2012 and 2015 (last 3 years available

at the time of the study), who met the inclusion criteria of the study.

Main variable: pain intensity

The assessment of pain intensity was performed from the data obtained by the healthcare staff using the verbal numerical scale (VNS) [11,12] on a scale from 0 to 10, being 0 "painless" and 10 "the worst pain imaginable". The patient was asked what would be the score that would assign to his/her level of pain at that moment.

The median of the results obtained for the pain intensity variable (m_e = 4) was calculated to classify the sample according to the levels of pain perceived by acutely admitted patients, considering mild pain when the VNS score was below 4 points, and moderate-severe pain when the score was greater than or equal to 4 points. We analyzed the data of 180 patients, which were divided into two groups, a group with mild pain (n = 87) and a group with moderate-severe pain (n = 93). In addition, the sample was divided between the morning, afternoon and evening shifts in order to verify the existence or not of differences in pain intensity at different time slots.

Secondary variables

Body temperature (T) was measured in the axillary region and in degree Celsius [13] according to the existing protocols.

Blood pressure was measured and divided into three variables (systolic blood pressure [SBP], diastolic blood pressure [DBP] and mean arterial pressure [MAP]), and a standardized formula was used to calculate blood pressure: (2 x DBP + SBP)/3. The millimeters of mercury were used as a unit of measure (mmHg) for all of them [14].

The heart rate (HR) was measured in beats per minute [15]. Capillary glucose (CG) in milligrams per deciliter (mg/dl) [16] and capillary oxygen saturation (SpO2) data were collected as percentages [17], according to previously published protocols.

The assessment of these vital signs was performed using the hospital monitoring equipment, the Dinamap Carescape V100 multiparameter monitor and the Welch Allyn Propaq CS monitor, recorded according to manufacturer's protocols and obtaining the average of several measurements.

Sample size calculation

A bivariate normal correlation model corresponding to the GPower software of the University of Düsseldorf was used (version 3.1.9.2) for the calculation of the sample size. Assuming an α error of 0.05, a power of 95% and a possible association size of r = 0.25 (obtained from a previous pilot analysis on 30 records between the pain intensity variables and the DBP), a total of 170 records would be needed to detect statistically significant differences.

Statistical analysis

The statistical package for social sciences (SPSS 22, SPSS Inc., Chicago, IL, U.S.A.) was the software used for the statistical analysis. The level of significance for all tests was established at $p < 0.05$. In the data analysis, descriptive statistics were used to show the data of the continuous variables that are presented as mean ± standard deviation (SD), 95% confidence interval (CI) and relative frequency (percentage) in the case of categorical variables. Because each group consisted of more than 30 participants, it was decided not to perform the normality tests and to use parametric tests according to the central limit theorem [18]. Even so, it was found that the variables followed a normal distribution using a Kolmogorov-Smirnov test. The Student's t test for independent samples was applied as a statistical test to compare the continuous variables between both groups. The effect size (Cohen's d) was calculated for the variables studied. According to the Cohen's method, the effect was considered small (0.20 to 0.49), medium (0.50 to 0.79) or large (> 0.8) [19].

The Pearson's correlation coefficient was used to test the correlations between quantitative variables. A Pearson's correlation coefficient greater than 0.60 indicates a strong correlation, a coefficient between 0.30 and 0.60 indicates a moderate correlation, and a coefficient less than 0.30 indicates a weak correlation.

RESULTS

Regarding the descriptive data, statistically significant differences were found regarding pain intensity (p <0.001), but no differences were found regarding age or sex (p> 0.05) (Table I).

No statistically significant differences were found for any of the vital signs according to pain intensity levels (p > 0.05) (Table II). In addition, we analyzed whether there were statistically significant differences in the vital signs according to pain intensity depending on the shift in which the measurements were conducted. No statistically significant differences were found in the vital signs based on the pain intensity in the morning, afternoon and evening shifts (p > 0.05).

Finally, with regard to the analysis of correlations, no statistically significant correlations were found between the variables of age, temperature, SBP, MAP, HR, CG and SpO2 in relation to the intensity of pain perceived by acutely admitted patients (p > 0, 05). However, a weak negative statistically significant association was obtained between the DBP and the pain intensity perceived by the patients (r = -0.219, p = 0.032) (Table III).

DISCUSSION

The main objective of the present study was to evaluate the vital signs according to the pain intensity in acutely hospitalized patients. The results of this study suggest that there are no differences in vital signs based on the intensity of pain in acutely hospitalized adults, regardless of whether they present mild pain or moderate-severe pain.

TABLE I
DESCRIPTIVE DATA OF THE SAMPLE

Variables	Mild pain (n = 87)	Moderate-severe pain (n = 93)	p-value
Age (years)	63,58 ± 18,56	67,18 ± 17,29	0,181
Pain (VNS)	3,00 ± 0,76	5,37 ± 1,22	< 0,001[†]
Sex Man Woman	 42 (48,3) 45 (51,7)	 44 (47,3) 49 (52,7)	 0,410

*p < 0,05. [†]p < 0,001. Values expressed as mean ± standard deviation and n (%). VNS: verbal numerical scale (0-10).

TABLE II
INTER-SUBGROUP ANALYSIS ACCORDING TO PAIN INTENSITY USING STUDENT'S T TEST

Variables	Mild pain (n = 87)	Moderate-severe pain (n = 93)	Mean difference (95 % IC)			p-value	Cohen's d
			Difference	Lower	Upper		
T (°C)	36,11 ± 0,59	36,28 ± 0,63	-0,16	-0,35	0,01	0,08	d = -0,27
SBP (mmHg)	122,38 ± 20,48	120,76 ± 21,06	1,61	-4,54	7,77	0,60	d = 0,08
DBP (mmHg)	70,94 ± 11,33	67,83 ± 11,61	3,11	-0,28	6,51	0,07	d = 0,27
MAP (mmHg)	88,08 ± 13,27	85,47 ± 13,55	2,60	-1,36	6,58	0,19	d = 0,19
HR (bpm)	79,55 ± 15,82	79,24 ± 15,27	0,31	-4,28	4,91	0,89	d = 0,02
CG (mg/dl)	123,27 ± 34,45	146,16 ± 56,28	-22,89	-56,64	10,86	0,06	d = -0,49
SpO$_2$ (%)	94,94 ± 3,28	94,81 ± 3,04	0,13	-1,37	1,64	0,85	d = 0,04

*p < 0,05. [†]p < 0,001. CI: confidence interval. T: temperature. SBP: systolic blood pressure. DBP: diastolic blood pressure. MAP: mean arterial pressure. HR: heart rate. CG: capillary glucose. SpO2: capillary oxygen saturation. mmHg: millimeters of mercury. bpm: beats per minute.

TABLE III
ANALYSIS OF PEARSON'S CORRELATIONS

	Mild pain (n = 87)	Moderate-severe pain (n = 93)
	VNS (m$_e$ < 4)	VNS (m$_e$ > 4)
Age (years)	0,091	0,035
T (°C)	0,080	-0,006
SBP (mmHg)	-0,058	-0,074
DBP (mmHg)	-0,219*	-0,135
MAP (mmHg)	0,125	-0,115
HR (bpm)	-0,004	0,039
CG (mg/dl)	0,188	0,117
SpO$_2$ (%)	-0,104	-0,191

*p < 0,05. [†]p < 0,001. T: temperature. SBP: systolic blood pressure. DBP: diastolic blood pressure. MAP: mean arterial pressure. HR: heart rate. CG: capillary glucose. SpO2: capillary oxygen saturation. PI (VNS): pain intensity (verbal numerical scale). bpm: beats per minute. me: median.

The results obtained are consistent with those described in most of the scientific literature. Daoust *et al.* conducted a cohort study, where they did not find differences between vital signs and pain in patients in the emergency department [20]. Furthermore, Bruijns *et al.* conducted an investigation in which they subjected healthy subjects to an acute painful process, finding that the perception of pain by the participants was not related to a variation in vital signs [21]. In addition, Ledowski *et al.* did not find significant correlations between postsurgical pain intensity and hemodynamic and neuroendocrine changes recorded in the resuscitation units, suggesting that the absence of variation in vital signs or autonomic variables should not be interpreted as guaranteeing the absence of significant pain [22].

In contrast, Bendall *et al.* conducted a study where they found associations between the vital signs, respiratory rate, HR and SBP with respect to pain intensity, although these associations were weak. In addition, they obtained that the increased respiratory rate was a predictor of the presence of severe pain [23]. The value of the mean pain intensity obtained in the mentioned study was 8 points in the VNS, while the values of the means obtained in the present study were

3 in the group of mild pain, and 5.37 in the group of moderate-severe pain, both less than 8 points. In this regard, the results of a review of the current scientific literature about the procedures for assessing the intensity of pain in adult patients in intensive care units suggests that the variations of vital signs in the presence of severe pain represent reliable way to estimate its intensity (24). Therefore, based on the results of the present study and those found in current scientific evidence, the authors suggest that the use of vital signs in the presence of mild-moderate pain are not reliable for predicting the intensity of pain; however, there is controversy regarding the presence of severe pain, because studies in favor, but also against this estimate have been found. Therefore, more studies and of higher methodological quality are needed to give solid answers to this question.

Moreover, the measurement of vital signs in newborn infant patients is also an aspect that has been studied in the scientific literature, suggesting that this is a reliable way to estimate pain intensity, unlike that found in the literature regarding adult patient. In fact, the vital signs, in conjunction with the behavioral aspects in this newborn population, are widely used for the evaluation of the intensity of infant pain (25,26). The authors of this study suggest that the differences between the infant population and the adult population regarding the differences between the vital signs and the intensity of pain may be motivated by cognitive-evaluative and affective-emotional aspects present to a greater extent in the adult patient. In this regard, Block *et al.* found that catastrophic thoughts have a larger relationship with respect to pain than vital signs, thus giving a possible explanation to the differences found in the validity of these constants between the adult patient and the infant patient (27).

LIMITATIONS OF THE STUDY

There are limitations in the present study that should be taken into account for the interpretation of the results.

First, the mean pain intensity in the moderate-severe pain group was 5.37 points in the VNS. It would have been interesting to obtain a sample with higher scores on pain intensity in order to segment it into moderate pain (between 3 and 6 points) and severe pain (> 6 points) because, despite studies analyzing the relationships between vital signs and pain intensity are not available to date in Spain, the main controversy described in the current scientific literature is found in acutely hospitalized adults who present severe pain.

Secondly, all the patients included in the present study presented acute pain and were undergoing analgesic pharmacological treatment according to the intensity of pain presented and the relevant medical assessment. However, records of other types of medication added due to causes other than pain management were not included.

Furthermore, the results of the present study should be taken with caution, since neither the total clinical characteristics of the patients nor the exact treatment for their pain were recorded, and which in turn could be interfering with the evaluation of the vital signs.

Finally, due to the design of the study itself, it was impossible to determine the exact time of the measurements, as well as the age and/or experience of the professionals who obtained the non-monitored variables.

CONCLUSIONS

Based on the results obtained in the present study, there are no differences in the vital signs according to the intensity of pain. Variations in vital signs do not appear to be a reliable estimate of pain intensity in patients with mild or moderate-severe pain. Prospective analyzes are needed to confirm these results.

ACKNOWLEDGMENTS

CONFLICT OF INTEREST

The authors of the present study have no conflict of interest to declare.

REFERENCES

1. Goldberg DS, McGee SJ. Pain as a global public health priority. BMC Public Health. 2011;11(1):770. DOI: 10.1186/1471-2458-11-770.

2. Torralba A, Miquel A, Darba J. Situación actual del dolor crónico en España: iniciativa "Pain Proposal". Rev Soc Esp Dolor. 2014;21(1):16-22. doi: 10.4321/S1134-80462014000100003.

3. Todd KH, Ducharme J, Choiniere M, Crandall CS, Fosnocht DE, Homel P, et al. Pain in the Emergency Department: Results of the Pain and Emergency Medicine Initiative (PEMI) Multicenter Study. J Pain. 2007;8(6):460-6. DOI: 10.1016/j.jpain.2006.12.005.

4. Vallano A, Malouf J, Payrulet P, Baños JE, Catalan Research Group for Studying Pain in Hospital. Prevalence of pain in adults admitted to Catalonian hospitals: a cross-sectional study. Eur J Pain. 2006;10(8):721-31. DOI: 0.1016/j.ejpain.2005.11.003.

5. Levenson JL, Hamer RM, Rossiter LF. Psychopathology and pain in medical in-patients predict resource use during hospitalization but not rehospitalization. J Psychosom Res. 1992;36(6):585-92.

6. Rico P. El dolor y su impacto en la calidad de vida y estado anímico de pacientes hospitalizados. Univ Psychol Bogotá, Colomb. 2013;(1):55-62.

7. Timsit CA, Bouchene K, Olfatpour B, Herman P, Tran Ba Huy P. Epidemiology and clinical findings in 20,563 patients attending the Lariboisière Hospital ENT Adult Emergency Clinic. Ann Otolaryngol Chir Cervicofac. 2001;118(4):215-24.

8. Cowen R, Stasiowska MK, Laycock H, Bantel C. Assessing pain objectively: the use of physiological markers. Anaesthesia. 2015;70(7):828-47. DOI: 10.1111/anae.13018.

9. de Jesus JA, Tristao RM, Storm H, da Rocha AF, Campos D. Heart rate, oxygen saturation, and skin conductance: A comparison study of acute pain in Brazilian newborns. 2011 Annu Int Conf IEEE Eng Med Biol Soc. 2011;1875-9. DOI: 10.1109/IEMBS.2011.6090532.

10. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. Directrices para comunicación de estudios observacionales. Gac Sanit. 2008;22(2):144-50.

11. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies comparing numerical rating scales, verbal rating scales, and visual analogue scales for assessment of pain intensity in adults: A systematic literature review. J Pain Symptom Manage. 2011;41(6):1073-93. DOI: 10.1016/j.jpainsymman.2010.08.016.

12. Díez Burón F, Marcos Vidal JM, Baticón Escudero PM, Montes Armenteros A, Bermejo López JC, Merino García M. Concordancia entre la escala verbal numérica y la escala visual analógica en el seguimiento del dolor agudo postoperatorio. Rev Esp Anestesiol Reanim. 2011;58(5):279-82.

13. Romanovsky AA. Skin temperature: Its role in thermoregulation. Acta Physiol (Oxf). 2014;210(3):498-507.

14. MacDougall JD, Brittain M, MacDonald JR, McKelvie RS, Moroz DE, Tarnopolsky MA, et al. Validity of predicting mean arterial blood pressure during exercise. Med Sci Sports Exerc. 1999;31(12):1876-9.

15. Achten J, Jeukendrup AE. Heart rate monitoring: applications and limitations. Sports Med. 2003;33(7):517-38. DOI: 10.2165/00007256-200333070-00004.

16. Tablado MÁM, Martínez CM, Pérez JS. Nuevos dispositivos para determinar la glucemia. FMC Form Medica Contin en Aten Primaria. 2015;22(8):440-5.

17. Garde A, Karlen W, Dehkordi P, Ansermino JM, Dumont GA. Oxygen saturation resolution influences regularity measurements. In: 2014 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE; 2014; 1:2257-60.

18. Tanushev MS, Arratia R. Central Limit Theorem for Renewal Theory for Several Patterns. J Comput Biol. 1997;4(1):35-44. DOI: 10.1089/cmb.1997.4.35.

19. Cohen J. Statistical power analysis for the behavioral sciences. Lawrence Erlbaum Associates Inc., editor. Hillsdale; 1988.

20. Daoust R, Paquet J, Bailey B, Lavigne G, Piette É, Sanogo K, et al. Vital Signs Are Not Associated with Self-Reported Acute Pain Intensity in the Emergency Department. CJEM. 2016;18(01):19-27.

21. Bruijns SR, Guly HR, Wallis LA. Effect of spinal immobilization on heart rate, blood pressure and respiratory rate. Prehosp Disaster Med. 2013;28(3):210-4. DOI: 10.1017/S1049023X13000034.

22. Ledowski T, Reimer M, Chavez V, Kapoor V, Wenk M. Effects of acute postoperative pain on catecholamine plasma levels, hemodynamic parameters, and cardiac autonomic control. Pain. 2012;153(4):759-64. DOI: 10.1016/j.pain.2011.11.002.

23. Bendall JC, Simpson PM, Middleton PM. Prehospital vital signs can predict pain severity. Eur J Emerg Med. 2011;18(6):334-9. DOI: 10.1097/MEJ.0b013e328344fdf2.

24. Gelinas C. Pain assessment in the critically ill adult: Recent evidence and new trends. Intensive and Critical Care Nursing. 2016;34:1-11. DOI: 10.1016/j.iccn.2016.03.001.

25. Hatfield LA, Ely EA. Measurement of acute pain in infants: a review of behavioral and physiological variables. Biol Res Nurs. 2015;17(1):100-11. DOI: 10.1177/1099800414531448.

26. Witt N, Coynor S, Edwards C, Bradshaw H. A Guide to Pain Assessment and Management in the Neonate. Curr Emerg Hosp Med Rep. 2016;4(1):1-10. DOI: 10.1007/s40138-016-0089-y.

27. Block PR, Thorn BE, Kapoor S, White J. Pain Catastrophizing, rather than Vital Signs, Associated with Pain Intensity in Patients Presenting to the Emergency Department for Pain. Pain Manag Nurs. 2017;18(2):102-9. DOI: 10.1016/j.pmn.2016.12.001.