



Journal of Nursing

Revista de Enfermagem

UFPE On Line

ISSN: 1981-8963

CASE REPORT ARTICLE

THE USE OF OPTICAL PLETHYSMOGRAPHY FOR EVALUATION OF ARTERIAL PULSE: AN EXPERIENCE REPORT

A UTILIZAÇÃO DA PLETISMOGRAFIA ÓPTICA NA AVALIAÇÃO DE PULSO ARTERIAL: RELATO DE EXPERIÊNCIA

EL USO DE LA PLETISMOGRAFÍA ÓPTICA EN LA EVALUACIÓN DE PULSO ARTERIAL: ESTUDIOS DE CASO

Rulio Glecias Marçal¹, Solange Silva Lima², Bikterline Lana Freitas³

ABSTRACT

Objective: reporting about the experience of an intensive care nurse on the use of optical plethysmography as a tool for the arterial pulse evaluation. **Method:** a descriptive study type experience report conducted by experiences in an Intensive Care Unit of a private hospital in the East Zone of São Paulo/SP, in 2013. **Results:** monitoring of vital functions is one of the most important and essential tools in the management of critically ill patients in ICU. Today, it is possible to detect and analyze a wide variety of physiological signals through various invasive and noninvasive techniques. The arterial pulse oximeter is a form of a simple non-invasive monitoring and inexpensive and provides data by spectrophotometry and optical plethysmography of the characteristics of the arterial pulse. **Conclusion:** we saw the ease, speed and reliability of the plethysmograph in arterial pulse assessment and preponderance in the scientific production regarding spectrophotometry and facing shortage monitoring by optical plethysmography. **Descriptors:** Nursing; Monitoring; Arterial Pulse.

RESUMO

Objetivo: relatar sobre a experiência de um enfermeiro intensivista na utilização da pletismografia óptica como instrumento para avaliação de pulso arterial. **Método:** estudo descritivo, tipo relato de experiência realizado por meio da vivência em uma Unidade de Terapia Intensiva em um Hospital particular da Zona Leste da Cidade de São Paulo/SP, em 2013. **Resultados:** a monitorização de funções vitais é uma das mais importantes e essenciais ferramentas no manuseio de pacientes críticos na UTI. Hoje, é possível detectar e analisar uma grande variedade de sinais fisiológicos através de diferentes técnicas invasivas e não invasivas. O oxímetro de pulso arterial é uma forma de monitorização não invasiva simples e de baixo custo e que oferece dados por meio da espectrofotometria e da pletismografia óptica das características do pulso arterial. **Conclusão:** foi possível perceber a facilidade, rapidez e fidedignidade do pletismógrafo na avaliação do pulso arterial assim como uma preponderância na produção científica no tocante a espectrofotometria e uma escassez voltada a monitorização por meio da pletismografia óptica. **Descritores:** Enfermagem; Monitorização; Pulso Arterial.

RESUMEN

Objetivo: informar acerca de la experiencia de una enfermera de una unidad de cuidados intensivos en el uso de la pletismografía óptica como una herramienta para la evaluación del pulso arterial. **Método:** un relato de experiencia tipo estudio descriptivo realizado por experiencias en una unidad de cuidados intensivos en un hospital privado de la zona este de la ciudad de São Paulo/SP, en 2013. **Resultados:** el monitoreo de las funciones vitales es uno de las herramientas más importantes y esenciales en el manejo de pacientes en estado crítico. Hoy en día, es posible detectar y analizar una amplia variedad de señales fisiológicas a través de diversas técnicas invasivas y no invasivas. El oxímetro de pulso arterial es una forma sencilla de monitorización no invasiva y de bajo costo y proporciona datos por espectrofotometría y la pletismografía óptica de las características del pulso arterial. **Conclusión:** vimos la facilidad, rapidez y fiabilidad del pletismógrafo en la evaluación del pulso arterial y la preponderancia de la producción científica en relación con espectrofotometría y frente a la escasez de vigilancia por pletismografía óptica. **Descriptores:** Enfermería; Vigilancia; Pulso Arterial.

¹Nurse, Master's Student of Nursing, Teaching at the University Ibirapuera/UNIB. São Paulo (SP), Brazil. Email: ruliog@bol.com.br; ²Nurse, Specialist Professor of Health Management, University of Mato Grosso State - Campus of Cáceres. Cáceres (MT), Brazil. Email: solmellima@gmail.com; ³Nurse, Teaching at the University Anhanguera/UNIAN, Master's Student of Rehabilitation of Body Balance and Social Inclusion. São Paulo (SP), Brazil. Email: ana.nurse@yahoo.com.br

INTRODUCTION

The Intensive Care Unit (ICU) was created by the Danish anesthesiologist Bjorn Ibsen Aage, in 1953, in the city of Copenhagen (Denmark) because of an outbreak of polio, in order to provide ventilatory assistance continuous and monitored. Brazil had its first unit deployed in 1971 in the Syrian-Lebanese Hospital in Sao Paulo-SP, designed to house critically ill patients who require complex and specialized care. It aims to concentrate human and material resources to meet critical customer permanently by appropriate technological resources that enable observation and monitoring of vital conditions.¹

As a result of the global socioeconomic changes observed over the years, especially the appearance of new diseases, micro-organisms, non-healthy behaviors and habits, Intensive Care Units (UTI's) become able to constantly meet the growing and diverse number of emergencies. For it, embraced the constant improvement of their working teams and technological innovations, but that, when unknown, may have no function, be characterized as stressful or generate an emotionally committed atmosphere for both professionals and for patients and their family.²

It is emphasized that the work in the ICU need to be organized and multidisciplinary team scheme because of the nature and magnitude of the tasks that involve intensive treatment, as stated earlier. An intensive multidisciplinary team proposes the presence and integration between different areas (doctors, nurses, assistants, physical therapists, psychologists, social workers, dieticians, speech therapists, administrative assistants, etc.) as facilitator in the management of patients, in its complexity, enabling a more dynamic and multidimensional performance.

The nurse, as well as composing the multi-frame, is a compulsory occupational (DRC n.7/2007)³ for the functioning of the sector, as coordinates and supervises its staff (nursing) and directly develops high complexity assistance. To this end, must be prepared to meet at any time patients with significant hemodynamic changes, which require specific knowledge and great ability to make decisions and implement them in a timely manner. Thus, it can be assumed that the intensivist nurses need to be trained in the scientific field as an assistant. Thus, training and preparation of this worker is

essential to the achievement of expected results and satisfactory especially when it involves the use of technologies created for these purposes.⁴

The monitoring of physiological parameters of serious patients can be made in clinical form, but especially with the use of devices which allow the assessment by observing vital signals, such as: temperature, respiration rate, heart rate, and blood pressure or level saturation of oxygen in the blood, predicting and determining physiological stress situations.⁵

The arterial pulse oximeter (OPA) is one of the most pervasive technologies in our UTI's. By oximetry is possible to evaluate the pulse amplitude (optical plethysmography) and the level of oxygen in arterial blood (spectrophotometry) is suitable for the needs of tissues. It is a useful measure to assess acute changes in clinical status of the patient and make as much oxygen flow settings as in volemic and heart patterns.⁶

Commonly are nurses making use only of spectrophotometry, ie saturation of arterial hemoglobin (SpO²), ignoring, perhaps unaware, plethysmography.

The objective of this study is to reporting about the experience of an intensive care nurse in the use of optical plethysmography as a tool for the arterial pulse evaluation.

METHOD

This is an experience report conducted through the experience of an intensive care nurse in the Intensive Care Unit of a private Hospital of Eastern São Paulo City during the year 2013, so that other professionals recognize the experience of using optical plethysmography as a tool for the arterial pulse evaluation and then taking advantage of the technology available in all intensive care units in order to improve the nursing care provided by the intensive care nurse.

EXCHANGING EXPERIENCES

During a training conducted in December 2012 by the representatives of a company selling appliances for arterial pulse monitoring, pulse oximeters called, to employees of Intensive Care Unit, there were explained, among others, the available functions of the device. At the time, one of the functions mentioned was the optical plethysmography, available in all devices currently used in UTI's for evaluation and continuous noninvasive monitoring of arterial pulse.

Marçal RG, Lima SS, Freitas BL.

The use of optical plethysmography for evaluation...

Facing personal ignorance about available technology mentioned and later realized after discussion also by the Unit Team, the institution of colleagues who work in other institutions and even in the available literature, research was initiated on the topic and its use in comparison with the traditional method used to assess the extent of the arterial pulse of hospitalized patients during the months of January to December 2013.

Each day during the physical examination of hospitalized patients, when evaluated the arterial pulse, more specifically its breadth, it was compared, although empirically, with the findings by palpation technique with those observed on the monitor on the optical plethysmography. It was possible to find similarities between them.

There were criteria for the adoption of comparisons in order to control possible biases: the radial pulse of the right and left limb non-paretic, non-plegic, without bone or soft tissue lesions, without the presence of edema and that used oximetry devices from different manufacturers.

It comes to the exchange of information and experience over that year, was contacted the professionals resort of data provided by the OPA to determine their interventions. But what was observed was a constant consideration only spectrophotometry disregarding the optical plethysmography. Also, along the academy as during working life, the use of arterial pulse oximetry is taught to be used in clinical cases where there is a change in breathing pattern being that the assessment and care are based almost exclusively on spectrophotometry.

In most cases a lack of training, even by the lack of knowledge by professional nursing teachers and nurses, the optical plethysmography has been disregarded, losing valuable clinical information on the pulse quality and volume status.

It can be seen in nursing bibliographies available, the shortage in the production of studies investigating, encourage and guide about what is the optical plethysmography, its ease, convenience and importance in assessing the arterial pulse.

RESULTS AND DISCUSSION

The arterial pulse oximeter is a device that has a receptacle to accommodate the anatomical portion with one side having a light source - composed of two photoemitters (LED) and the other hand a photodetector. One LED emits red light and the other infrared light.⁷

The interaction between light and human tissues can cause photochemical, thermal, photoablatives and electromechanical effects, depending on the irradiation and the exposure time of light.⁶

The amount of light in the red and infrared spectrum absorbed by the blood can be used to calculate the oxygenated hemoglobin rate related to total hemoglobin in arterial blood, being presented on the equipment monitor in the form of SpO₂, what we refer to as spectrophotometry. Normal values lie between 95% and 100%.

Many of the oximeters on the market and in our institutions offer, beyond spectrophotometry, optical plethysmography. This in turn reflects the pulse amplitude and the pulse waveform; that is, a method which records the variations in volume segments of the members in relation to ventricular systole. Spectrophotometry is represented by the monitor.

The digital-optical plethysmographs findings can be useful for occlusion of small arteries such a finding of hypovolemia, as well as a ventricular failure.

The cardiac cycle consists of two main phases: the diastole and systole. During diastole or relaxation phase, the blood flows into the atria, causing a decrease in pressure in blood vessels. During systole or contraction phase, ventricular blood is pumped and distributed throughout the body, causing an increase in pressure in blood vessels. The measurement of the pressure variation as a function of heart cycle phase makes it possible to estimate the heart rate.⁶

The variation of the optical signal received by the sensor is essentially a consequence of the variation of the optical path due to blood flow changes and the spatial orientation of red blood cells during the cardiac cycle.⁸

Red blood cells are biconcave disks, which during the diastolic phase are aligned parallel to the direction of blood flow, whereas during the systolic phase, due to an increase in pressure in the arteries, red blood cells are aligned perpendicular to the direction of cardiac output, causing an increase in the optical path and therefore, an increased absorption.⁹

Increased heart rate and pulse wave amplitude reflects the increased blood flow due to contraction of the left ventricle of the heart. The range varies with the arterial vascular elasticity and essentially depends on the interaction of the wave of initial pressure when the heart contracts, and the pressure

Marçal RG, Lima SS, Freitas BL.

wave that is reflected due to peripheral arteries.⁶

The monitoring of physiological parameters is essential to conduct the treatment, especially for critical patients. Thus are closely related to the technique used and the acquired data to be of the greatest possible accuracy since it will result in the choice of assistance to be provided. Thus, health team members directly involved in critical patient care are concerned about the indiscriminate use of equipment, and question their influence, treatment and results obtained.¹⁰⁻¹¹

Keeping the blood oxygenated, preventing hypoxia is one of the priorities in Intensive Care Units (ICUs). Invasive and non-invasive procedures enable us to make a hemodynamic assessment by measuring some variables and calculation of others. However, invasive procedures, very useful in measuring the consumption and supply of oxygen increase the risk of worsening the condition of the patient.¹²⁻¹³

Arterial pulse oximetry allows us to measure continuously and noninvasively the oxygen saturation (SpO₂) and also examine the amplitude and pulse rate as well as being a low-cost equipment, easy use and portable.¹⁴ Yet, it allows for continuous monitoring and noninvasive of SpO₂ of arteriolar hemoglobin in a region that allows the measurement, among which one can mention the digital of the hands and feet, hands, feet, ear lobe, among others.¹⁵

With it, also can monitor and estimate the heart rate based on the principle of optical plethysmography, i.e., measurement of changes in blood flow using an optical method. In the particular case of optical plethysmograph sensor that measures the amount of infrared light absorbed or reflected by the blood, the volume change is caused by changes in blood pressure in the vessels that occur during the cardiac cycle. Given the relationship between the volumes of the vessels, the blood pressure and the amount of light absorbed or reflected is possible to observe the change in volume based on the light detected by the sensor.

It is worth emphasizing that, as well as other technologies used in the care in critically ill patients, has its technical flaws and therefore cannot but influence our meaning of work, care for, but also be seen as the solution to all the patient's problems.¹⁶⁻¹⁷

With the meaning of efficiency and quality not always proven or even evaluated, technology acts as legitimizing the act of health professionals and the institution that

The use of optical plethysmography for evaluation...

adopts, from even being used as a quality assessment criterion of health services provided by hospitals.¹⁶

However, some authors adopt a critical and reflective attitude to it, because, in the pursuit of rationalization, acquisition and incorporation of new technologies, an assessment is needed, from an ethical point of view of costs, quality of care, benefits, limitations, risks and suitability of the population's needs.¹⁷

CONCLUSION

It is for the nurse of intensive care develop all Systematization of Nursing Assistance (SAE), advising and teaching, in order to maintain and/or seek health maintenance and/or continuity of care as well as coordinate and supervise the nursing staff through knowledge and scientific and technical training. Among these we emphasize the use of massively present technologies in this sector, highlighting the arterial pulse oximeter that reflects both spectrophotometric vital data as plethysmographic.

The optical plethysmography is a fast, easy, economical and non-invasive hemodynamic monitoring to critical customer. It is generally accepted by the scientific community as a source of information about the cardiovascular system (SpO₂, heart rate, blood pressure, cardiac output and respiration), vascular assessment (pulse transit time, compliance and arterial vascular age, endothelial dysfunction, evaluation of veins, vasospastic conditions, microvascular blood flow and viability of tissue) and evaluation of the autonomic nervous system (vasomotor and thermoregulatory function, heart rate variability and orthostatic stress).

REFERENCES

1. Gomes AM. Enfermagem na unidade de terapia intensiva. 3rd ed. EPU. São Paulo-SP; 2008.
2. Padila KG, Kimura M. Aspectos éticos da prática de enfermagem em Unidade de Terapia Intensiva. Sobeti em Rev [Internet]. 2010 [cited 2014 Mar 10]; 1(1): 8-11. Available from: <http://www.sobetiemrevista.br/revista/index/article/view/886/pdf>
3. RDC n. 7, de 24 de fevereiro de 2010. Sociedade Brasileira de Brasileira de Terapia Intensiva. [cited 2014 May 14]. Available from: <http://www.medicinaintensiva.com.br/resolucao-07-anvisa-uti.htm>

Marçal RG, Lima SS, Freitas BL.

The use of optical plethysmography for evaluation...

4. Gratton L. Palavras ao vento. 719th ed. Exame; 2004.
5. Nishide VM, Cintra EA, Nunes WM. Assistência de Enfermagem ao paciente gravemente enfermo. EPU, 2ª ed. São Paulo-SP, 2003.
6. Morton PG, Fontaine DK. Cuidados críticos de enfermagem: uma abordagem holística. 9th ed. Guanabara koogan. Rio de Janeiro-RJ; 2011.
7. Alexander CM, Teller LE, GROSS JB. Principles of pulse oximetry. Theoretical and practical considerations. Anaesth Analg [Internet]. 1989 [cited 2014 June 13];68(3):368-7. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC137227/pdf/cc341.pdf>
8. Nishide VM, Cintra EA, Nunes WM. Assistência de Enfermagem ao paciente gravemente enfermo. Atheneu, 2nd ed. São Paulo; 2001.
9. Padilha KG, Silva SC, Vattimo MFF. Enfermagem em UTI. Cuidando do paciente crítico. 1st ed. Manole. Baruer-SP; 2009.
10. Goldenheim PD, Kazeni H. Cardiopulmonary monitoring of critically ill patients (part 1). N Engl J Med [Internet]. 2004 [cited 2014 May 23];311(11):717-21. Available from: <http://www.nejm.org/doi/full/article/10.1056/NEJM198409133111106/pdf>.
11. Hanning CD, Alexander W. Pulse oximetry a practical review. BMJ [Internet]. 2005 [cited 2014 Apr 10];311(11):367-70. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2550433/pdf>
12. Ewards JD. Oxygen transport in the critically ill. Intens. Crit Care Digest [Internet]. 1991 [cited 2014 May 10];10(2):23-5. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3247683/pdf>
13. Tulli G, Vignali G, Guadagnucci A, Mondello V. The oxygen status of the arterial blood in the critically ill. Scand. J. Lab. Invest [Internet]. 2010 [cited 2014 June 17];203(Suppl 50):107-18. Available from: <http://informahealthcare.com/doi/abs/10.3109/00365519009087498.pdf>
14. Pierce LNB. Guide to mechanical ventilation and intensive respiratory care. 1st ed. WB Saunders Company [Internet]. 2005 [cited 2014 Mar 10]. Available from: <http://portalneonatal.com.br/outras-especialidades/arquivos/InsuficienciaRespiratoria.pdf>
15. Frey B, Shann F. Oxygen administration in infants. Arch dis child fetal neonatal [Internet]. 2003 [cited 2014 May

- 21];88(2):F84-8. Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1721518/pdf/v088p00F84.pdf>
16. Peixoto MRB. Tecnologia no setor saúde: critérios de avaliação de qualidade dos serviços hospitalares. [dissertação]. Belo Horizonte (MG): Faculdade de Ciências Econômicas/UFGM; 1990.
17. Peixoto MRB. O uso da tecnologia no processo diagnóstico-terapêutico: ótica do enfermeiro e do usuário. Rev Esc Enferm USP [Internet]. 1994 [cited 2014 May 21]; 28(3):53-62. Available from: <http://bases.bireme.br/cgi-bin/wxislind.exe/iah/online/?IscScript=iah/iah.xis&src=google&base=LILACS&lang=p&nextAction=lnk&exprSearch=166337&indexSearch=ID>

Submission: 2014/10/21

Accepted: 2015/03/31

Publishing: 2015/05/15

Corresponding Address

Rulio Glecias Marçal
Rua Barata Ribeiro, 260 / Ap. 124
Bairro Cerqueira César
CEP 01308-000 – São Paulo (SP), Brazil