Monitoring of Non-Invasive Blood Pressure

Patricia Vendramim, RN, MSc
Charge Nurse of Pediatric Intensive Care, Hospital Samaritano, São Paulo, Brazil

Abstract
This lecture was presented at the 1st International Symposium of Nursing in Pediatric and Neonatal Intensive Care in the city of São Paulo - Brazil (June 2006). The author offers supporting evidence for understanding non-invasive blood pressure measurement methods. Also examined are studies that search for methods that minimize measurement errors.The oscillometric method is often cited in the literature. Although it the most frequently used method, it also seems to result in less accurate values. Additional studies on pediatric patients are required to validate these findings.

Key words: blood pressure, non invasive blood pressure, pediatric nursing

The topic I was asked to present at this Symposium refers to indirect blood pressure measurement methods. When taking into consideration this vital sign within the complex environment of pediatric intensive care, you may possibly underestimate its importance, due to the special and sophisticated equipment that the technical market has to offer; especially in the past 10 years. But it is as from the Systemic Arterial Pressure (SAP), many times obtained only through an indirect method, that a series of therapeutic measures are taken when caring for a critically ill child.

It is possible to note in the literature a large number of scientific reports that examine responses to medical treatment of systemic arterial hypertension or shock. However, many do not address, or even, state explicitly the method used to measure the blood pressure. We basically have four methods for non-invasive blood pressure (NIBP) measurement. These include 1. auscultation, 2. oscillometric, 3. ultrasonic, and 4. plethysmographic methods.

The non-invasive measurement of blood pressure began with the introduction of the sphygmomanometer with a mercury column by Riva-Rossi, in 1896. However, it was in 1905 that the auscultation method (Korotkoff) was introduced in the clinic and is still being used, without any significant changes[1-3].

Progress in NIBP measurement can be attributed to various difficult to control factors that can modify the result, jeopardizing the accuracy of the measure[4].

Use of the auscultation method has been diminished because of several factors: use of the mercury manometer has been discouraged for ecological reasons, difficulties with calibration of aneroid gauges, pressure sores resulting from the cuff, debates regarding appropriate body sites for measurement, the clinician skill and controversies regarding cuff size. Studies have indicated that the ratio between the brachial circumference and the cuff width (resulting in reduced error as the ratio approaches the optimal value) should be 0.46[4-6].

When analyzed for their theoretical significance, these concerns usually make their application more difficult in practice, especially when referring to pediatric intensive care[4].

Ultrasonography is another available technique for blood pressure measurement. The speed of the blood floww is measured via Doppler, resulting in a blood pressure value. This method has been used to visualize the thickness and compliance of arteries, mainly as a specific exam to measure predictors of heart disease, rather than measuring SAP[7].

Although it is used in research with good accuracy, it may not be as viable in clinical practice due to the high cost and specialized expertise required for accurate measures[7-8].

Automatic measurement equipment for non-invasive blood pressure through the oscillatory method arose on the market around 1970, little after microprocessors appeared. Thus, sensors replaced the stethoscope, in order to detect the Korotkoff sounds. Up to the end of the seventies, this method was implemented mainly in surgical theatres, to enable the clinical patient monitoring when undergoing anesthesia[3,9].

Bio-engineering developments gradually made this method attractive to the hospital community (and outside as well), by offering an objective instrument that is not conducive to the influence of the observer, not dependant on external auscultation devices, while allow a series repeated measures. Another positive aspect is the simplicity in executing the technique and the low risks involved with its use, compared to the auscultation method, concerning the frequency or severity of purpuric lesions[10-11].

Nevertheless, a case was reported in the United Kingdom describing the development of skin necrosis by hypoperfusion, in an elderly critical patient, which occurred due to automatic cuff inflation every 15 minutes (with alternation of the arms every four hours)[12]. Other reported complications include: compressive neuropathy, petechial rash, ecchymoses, thrombophlebitis and venous stasis[13].

Regardless of these potential risks, the use of this method in clinical practice was accepted and incorporated ino our environment during the last 20 years, but apparently without related scientific investigations and/or standardization through guidelines[3,14]. Confirming this fact, a British study revealed that 90% of the monitors available in the European Market were not validated by clinical studies[15].

The trend observed in research has indicated that use of the oscillometric method commonly fails regarding the ratio of cuff sizes and arm circumference. Also, it reproduces values with a smaller variation than the conventional method, though lower. This can be noticed especially in the diastolic pressure, for adults or children. It can also result in an arterial hypertension (around 17%), if the pressure decrease is treated indiscriminately[9, 14].

An alternative to this bias is the use of the mean arterial pressure. The literature agrees that this data is less affected by change of blood vessels tone than with systolic and diastolic pressures, because it is obtained when the variations reach their biggest amplitude in the cuff deflation[3, 9]. Given the elative lack of accuracy associated with NIBP methods, direct measurements are still required for critically ill children or neonates in the intensive care setting[16].

Regardless of the problems outlined above, oscillometric SAP measuring devices are still commonly used in practice. However, they present a problematic accuracy. It is therefore necessary to conduct additional randomized clinical studies in order to better analyze the measures in different groups[15].

Regarding accuracy, studies with adults and children have been conducted to evaluate if the modified oscillatory method (which generates continuous values of the pressure with a waveform) provided more satisfactory results. However, these studies are still in progress and with limited samples. They therefore require further replication[17].

The plethysmography model described by Penaz in 1973 has been used for continuous measurement. The plethysmographometer is adjusted on the middle finger of the hand through pneumatic regulation, registering a reading in mmHg through the infrared light, which records immediate pressure variations. Some scholars who have evaluated this method, concluded that when compared to invasive measures, it presents slightly higher systolic pressures – a difference that is statistically yet not clinically significant. Correlational data demonstrated that mean arterial pressure is more accurate data[18-19].

Besides the efforts to demonstrate the accuracy of this procedure, researchers have also tested devices for the ankle and arm in adults. This remains a method that is scarcely disseminated in practice, especially in Brazil, since clinical research

has involved limited samples and do not consider carefully examine the pediatric patient[20]. This raises some important questions: How to adjust a sensor on a middle finger of a newborn's hand? What are the risks of causing a burn?

Although oscillometric method NIBP measurement is the most used method in professional practice, scientific data suggest it has limited reliability[21].

Another big question to consider is the scarcity of original studies and their replication to the pediatric and neonate intensive care population. Therefore, the big challenge has been to seek the integration of scientific evidence with practice, which can support the complexity of the nursing, without separating art from science.

We consider it extremely important that the nurse be aware of such knowledge concerning SAP measurement. This relies on science and not on ritual, as it was for the beginnings of the profession, constituting the essence of nursing care and for this reason cannot be seen as common sense.

References

1. Looney J. Blood pressure by oscillometry. Med Electron. April 1978:57-63.
2. Ramsey III M. Non-invasive automatic determination of mean arterial pressure. Med Biol Eng Comput, 1979; 17: 11-18.
3. Jilek J, Fukushima T. Oscillometric Blood Pressure Measurement: The Methodoly, Some Observations, and Suggestions. Biomed Instrument Technol. 2005; 39: 237-41.
4. Arcuri E. From Riva Rocci, Recklinghaunsen and Korotkoff to nowadays: the challenge of blood pressure measurement accuracy. Online Brazilian Journal of Nursing. 2005; 4:(3)----
5. Carter BL. Blood pressure as a surrogate end point for hypertension. Annals of Pharmacoterapy. 2002; 36: 87-92.
6. Evans D, HodgKinson B, Berry J. Vital signs: a systematic review. Joanna Briggs Institute for Evidence Based Nursing and Midwifery. 1999: 1-106.
7. Plavnik FL. Revisão/ Atualização em Hipertensão Arterial: Avaliação do sistema vascular na hipertensão arterial essencial através da metodologia não-invasiva. J Bras Nefrol. 1998; 20(2): 191-7.
8. Abassade P, Baudouy PY, Gobet L, Lhosmot JP. Comparison of two indices of arterial distensibility: temporal apparittions of Korotkoff sounds and pulse wave velocy. A Dopller echocardiography and ambulatory blood pressure monitoring study. Arch Mal Coeur Vaiss. 2001; 94(1): 23-30.
9. Imbelloni LE, Beato L, Tolentino AP, Souza DD, Cordeiro JA. Automatic Blood Pressure Monitors. Evaluation of Tree Models in Volunteers. Rev Bras Anestesiol. 2004; 54(1): 43-52.
10. Saul L, Smith J, Mook W. The safety of automatic versus manual blood pressure cuffs for patients receiving thrombolytic therapy. 1998; 7(3): 192-6.
11. Cavalcanti S, Marchesi G, Ghidini C. Validation of automatic oscillometric sphygmomanometer (HDBPM) for arterial pressure measurement during haemodialysis. Med & Biol Eng & Comput. 2000; 38(1): 98-101.
12. Devbhandari Mohan P, Shariff Z Duncan AJ. Skin necrosis in a critically ill patient due to a blood pressure cuff. JPGM; 2006; 52(2): 136-8.
13. Lin CC, Jawan B, de Villa MV, Chen FC, Liu PP. Blood pressure cuff compression injury of the radial nerve. J Clin Anesth 2001; 13:306-8.
14. Norderhaug PI. Ambulatory blood pressure measurement. A review of internacional studies. The Norwegian Knowlewdge Centre for the Health Services (NOKC) 2000.
15. Sims AJ, Menes JA, Bousfield DR, Reay CA, Murray A. Automated non-invasive blood pressure devices: are they suitable for use? Blood Press Monit 2005; 10(5): 275-81.
16. Dannevig I, Dale HC, Liestol K, Lindemann R. Blood pressure in the neonate: three non-invasive oscillometric pressure monitors compared with invasively measured blood pressure. Acta Paediatrica 2005; 94(2): 191-6.
17. Mc Cann ME, Hill D, Thomas KC, Zurakowski D, Laussen PC. A comparison of radial artery blood pressure determination between the Vasotrac device and invasive arterial blood pressure monitoring in adolescent undergoing scoliosis surgery. Anesth Analg 2005; 101(4): 978-85.

18. Polito MD, Farinatti PTV. Considerations on blood pressure assessment during resistive exercise. Rev Bras Med Esporte 2003; 9(1): 25-33.
19. Imholz BP, Settels JJ, van der Meiracker AH, Wesseling KH, Wielling W. Non-invasive continuous finger blood pressure measurement during orthostatic stress compared to intra-arterial pressure. Cardiovasc Res 1990; 24(3): 214-21.
20. Bogert LW, van Lieshout JJ. Non-invasive pulsatile arterial pressure and stroke volume changes from the human finger. Exp Physiol 2005; 90(4): 437-46.
Beales D. How accurate are automated blood pressure monitors? Br J Community Nurs 2005; 10(7): 421-4.

*****

Ethical Implications of Errors in ICU Nursing Practice

Katia Grillo Padilha, BSN, PhD
Faculty member, Department of Medical Surgical Nursing. School of Nursing University of São Paulo, Brazil
kgpadilh@usp.br

Abstract
This article discusses general considerations on ethical nursing practice relating to errors in ICUs, according to the bioethical principles of beneficence and nonmaleficence. In the health care context, the need for error analysis under a systemic focus in a safe non-punitive culture is highlighted, so that effective preventive measures are adopted in such services. It is a mandatory ethical commitment for nurses working in ICU that they provide care to assign a priority to patient dignity in a system that ensures more protection and less risks and failures.

Introduction

The ethical implication of errors in intensive care nursing practice requires some consideration of the general ethical aspects of the profession.

The first relates to nurses' competence whose main basis is "know how to behave", a mandatory ethical component in nursing practice, which complements scientific knowledge. This involves 'know-how' skills, including knowing how to interact with each other.

The second, according to Anne Davis[1], refers to the fact that nursing has never considered ethics an unimportant issue or a kind of fashion. Nursing history has shown a growing literature, as well as a number of ethical activities in professional associations, in codes of ethics and health care standards and protocols. According to Davis[1], "nothing has been irrelevant to the permanent and intentional commitment with ethics for the nursing profession".

The third aspect concerns the technology that has been developed in recent decades. It has brought new and complex challenges to the health care professional and has become a core focus of ethical discussions.

In this sense, in the face of the diagnostic and therapeutic tools available for health care and the appeal for technological innovations for consumers, the problems these professionals will face tend to be more and more of an ethical nature than technical.[2] Therefore, this reality reinforces the great number of ethical problems present in the daily life of the nurse, especially in the intensive care area. It is within this perspective that actual and potential errors take place in ICU practice.