Original Article

Investigating the Possibility of Using Noninvasive Basic Monitoring in Patients with Acute Burns Undergoing General Anesthesia

Ali Akbar Jafarian, Ali Farhoodi[1], Zahra Jafarian[2], Azadeh Emami, Mohaddeseh Jafarian[3], Reza Salehi

Departments of Anesthesiology and Pain and [1]Plastic Surgery, Iran University of Medical Sciences and Motahari Hospital, Tehran, Iran, [3]Faculty of Biological Science, Tarbyat Modarres University, Tehran, Iran, [2]Faculty of Dentist, Qom Medical University, Qom, Iran

ORCID:

Ali Akbar Jafarian: https://orcid.org/0000-0002-4124-8315
Ali Farhoodi: https://orcid.org/0000-0003-0398-1484
Zahra Jafarian: https://orcid.org/0000-0002-6904-4007
Azadeh Emami: https://orcid.org/0000-0002-6107-0139
Mohaddeseh Jafarian: https://orcid.org/0000-0001-6208-2222
Reza Salehi: https://orcid.org/0000-0003-2952-1726

Abstract

Background: Basic noninvasive monitoring is considered as the standard procedure in patients with acute burns under general anesthesia. In such cases, noninvasive monitoring probes may often be ineffective on damaged skin due to the nature of burns pathology. Hence, the noninvasive monitoring is very challenging. Because of such limitations, we conducted this study to examine the practical difficulties or possibility of noninvasive monitoring utilization. **Methods:** Over the period of 2016–2017, 100 patients who were injured by acute burns with 20%–90% of TBS and undergoing general anesthesia at Motahari Burn Hospital were enrolled in this descriptive study. Basic monitoring techniques including noninvasive blood pressure (NIBP), cardiac monitoring, and pulse oximetry were applied throughout all surgeries as much as possible. **Results:** Evidence demonstrated that the application of NIBP monitoring in 23% of cases, cardiac monitoring in 63% of patients, and also even pulse oximetry in 7% of them were impossible. **Conclusion:** Limited usage of invasive monitoring due to vulnerability to sepsis leads to the noninvasive approach. Hence, technical innovations in noninvasive monitoring may help clinicians to monitor physiological indices, more safely.

Keywords: Basic noninvasive monitoring, burns, noninvasive blood pressure

Introduction

Monitoring of patients who undergo general anesthesia plays an important role in the intensive care (Emerson, 2003). Since 1956, the American Society of Anesthesiologists addressed standards for basic intraoperative monitoring through anesthesia procedure (Eichhorn, 1986). Accordingly, ventilation, oxygenation, hemodynamic function, and body temperature should be constantly monitored.[1-8]

According to the standard guidelines, patients' physiological parameters (blood pressure, cardiac status, blood oxygenation level, and body temperature) were monitored with special instruments during anesthesia. Depending on the clinical condition and the complexity of the surgery, other special monitoring tools may be needed (Practice Advisory for Intraoperative Awareness and Brain Function Monitoring. Task Force Report-Anesthesiology, 2006).

Access this article online

Quick Response Code:

Website: www.archtrauma.com

DOI: 10.4103/atr.atr_6_20

Address for correspondence: Dr. Reza Salehi, Department of Anesthesiology and Pain, Iran University of Medical Sciences, Ali Asghar Hospital, Tehran, Iran.
E-mail: rsalehi45@yahoo.com

How to cite this article: Jafarian AA, Farhoodi A, Jafarian Z, Emami A, Jafarian M, Salehi R. Investigating the possibility of using noninvasive basic monitoring in patients with acute burns undergoing general anesthesia. Arch Trauma Res 2020;9:173-5.

Received: 26-01-2020, **Revised:** 29-04-2020, **Accepted:** 27-09-2020, **Published:** 26-12-2020.

Challenges such as the extent and location of the burn wound, restrictions on disinfection, and sterilization make it impractical to properly use noninvasive monitoring in patients undergoing acute burn surgery. Electrocardiogram (ECG) electrodes, often due to the presence of the preparation solution, bleeding or other interfering factors, cannot stick properly. Obviously, with higher degrees of burns, the more monitoring problems emerge. A review of research literature shows that necessary considerations have not paid enough to this important issue (Stratos, 3013).

While the use of invasive monitoring techniques in burn patients may be associated with some risks, such as an increase in systemic infection rates, noninvasive methods have some limitations. The main purpose of this study was to evaluate the usefulness of three basic noninvasive monitoring in assessing blood pressure, heart status, and spo2 level in burn patients who undergone general anesthesia. Another purpose of the study was to draw the attention of physicians and even medical engineers to the limitations of noninvasive monitoring in patients with acute burns (Bernd, 2006).

Materials and Methods

One hundred participants with acute burns aged 20–90 years of both sexes who were candidates for surgery at Motahari Burn Center were included in this study to evaluate the possibility of using three basic noninvasive monitoring. The monitoring contains blood pressure measurement by the pneumatic cuff, continuous 12 ECG leads, and peripheral arterial oxygen saturation (SpO2) by pulse oximetry. The study was conducted from the second half of 2016 to the first half of 2017.

Man–Whitney and Chi-square tests were used to analyze qualitative/quantitative variables and were performed by the SPSS version. 26 software. The obtained data include values related to the mean standard deviation for quantitative and frequency (percentage) for qualitative variables. The significance level of all tests was considered with a probability of $P < 0.05$.

Results

According to the data analysis, 28% ($n = 28$) of patients were female and 72% ($n = 72$) of them were men. The mean age was 36.70 ± 1.36. The total body surface area average that was involved was assessed at about 41 ± 1.53.

The study showed that the possibility to use noninvasive blood pressure (NIBP) monitoring was generally 77%, and we were not able to measure BP monitoring from any limb by a pneumatic cuff in 23% of cases ($P = 0.00$). Limitations were included severe burning (17 cases), due to impracticality to place the pneumatic cuff on the surgical area (5 cases), and limb amputation (one case).

Continuous ECG monitoring from the chest and standard limb leads were impossible to perform simultaneously in 63% of cases ($P = 0.00$). ECG monitoring was performed in 41% of cases through the chest and in 37% of cases only through the limbs.

The impossibility to perform ECG monitoring simultaneously with the standard limb and chest leads occurred in 63% of cases due to the following restrictions: limb burns (53% of cases), problems related to prepping and draping of the surgical area in 4% of cases, unpreparedness of dressing site in 4% of cases, and in 2% of cases because of limb amputation.

Pulse oximetry monitoring was practicable in 93% of cases, whereas in 24% of cases ($n = 24$), pulse oximetry monitoring was performed in the upper and lower limbs at all. Simultaneous pulse oximetry monitoring was practicable in 7% of cases through the fingers, nose, and ears.

Data analysis showed that there is a direct relationship between the extent of burn injuries and the basic noninvasive monitoring impracticability ($P < 0.05$). However, there is no significant relationship between the practicability of pulse oximetry monitoring and the extent of burn injuries through relevant general anesthesia ($P > 0.05$) [Table 1].

Conclusion

Basic noninvasive monitoring is the tool to assess the physiological condition in patients with acute burns who undergoing general anesthesia. Since most of the surgical invasive procedures (fasciotomy, escharotomy, debridement, premature resection, and skin grafting) are performed in an emergency setting under general anesthesia, we must carefully monitor unstable vital conditions. On the other hand, because such patients are prone to various infections and sepsis, so minimally invasive monitoring is usually preferred (Liju, 2015).

Paradoxically, noninvasive monitoring is often challenged due to improper placement of probes at the surgical site, nonadhesive pads, bleeding, and use of ointments, presence of preparation solutions, and other annoying factors.

Discussion

In recent decades, some measures have been created to compensate the limitations, such as Ravindran Ram (1997) and Johanek LM *et al*. (2012) which have developed a new device (staple) for

Table 1: The relationship between the basic noninvasive monitoring practicability and the extent of burn injury

Monitoring methods	Head and neck	Trunk	Limbs	Possible (%)	Impossible (%)
NIBP monitoring	-	87	39	77	23
ECG monitoring	33	71	48	37	63
Pulse oximetry	19	-	25	93	7
Noninvasive basic monitoring	33	87	48	18	82
Extent of burns 41%±1.53 (%)	2.5	25	13.5	29	67

NIBP: Noninvasive blood pressure, ECG: Electrocardiogram

attaching ECG electrodes to damaged skin, securely (Ravidran, 1997). Alper Cömert and Jari Hyttinen also developed a new method to reduce the artifact of motion electrodes by stabilizing the skin deformations around the electrode.

Finally, the use of noninvasive monitoring during general anesthesia in patients with acute burns faces many major challenges. Specifically, the wet nature of the burn wound surface may cause problems with the placement of electrodes; probes and cuff unsecure and jeopardize the sterility. Thus, despite potential complications and high costs, burn clinicians should consider the invasive monitoring. Medical device engineers also should focus on the innovative development of noninvasive monitoring equipment that can be used in general anesthesia, recovery unit, and BICU.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Scheer BV, Perel A, Pfeiffer UJ. Clinical review: Complications and risk factors of peripheral arterial catheters used for hemodynamic monitoring in anesthesia and intensive care medicine. Critical Care 2002;6:198-204.
2. Cömert A, Hyttinen J. Investigating the possible effect of electrode support structure on motion artifact in wearable bioelectric signal monitoring. Biomed Eng Online 2015;14:44.
3. Emerson RG, Adams DC. Intraoperative monitoring. Current practice of clinical electroencephalography, 3rd ed.J. S. Ebersole and T. A. Pedley. Philadelphia, Lippincott Williams & Wilkins 2003. p. 936-954.
4. Eichhorn JH, Cooper JB, Cullen DJ, Maier WR, Philip JH, Seeman RG. Standards for patient monitoring during anesthesia at Harvard Medical School. JAMA 1986;256:1017-20.
5. Tao L, Zhou J, Gong Y, Liu W, Long T, Huang X, *et al.* Risk factors for central line-associated bloodstream infection in patients with major burns and the efficacy of the topical application of mupirocin at the central venous catheter exit site. Burns 2015;41:1831-8.
6. American Society of Anesthesiologists Task Force on Intraoperative Awareness. Practice advisory for intraoperative awareness and brain function monitoring: A report by the American society of anesthesiologists task force on intraoperative awareness. Anesthesiology 2006;104:847-64.
7. Ravidran Ram S, A solution to monitoring electrocardiograph in patients with extensive burn injury, American Society of anesthesiologists, 1997;87:711-2.
8. Sofos SS, Tehrani H, Shokrollahi K, James MI. Surgical staple as a transcutaneous transducer for ECG electrodes in burnt skin: safe surgical monitoring in major burns. Burns 2013;39:818-9.