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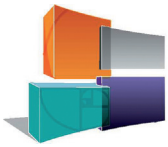

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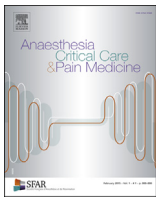

Original article

Evaluation of the knowledge base of French intensivists and anaesthesiologists as concerns the interpretation of respiratory arterial pulse pressure variation

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ABSTRACT

Objective: The aims of the study were to assess the knowledge of intensivists and/or anaesthesiologists concerning respiratory arterial pulse pressure variation (PPV) and to define the criteria used to indicate a fluid challenge.
Study design: A prospective observational study.
Patients and methods: Intensivists and anaesthesiologists from one region of France were evaluated for their knowledge about the prerequisites (continuous arterial pressure monitoring, regular sinus rhythm, mechanical ventilation without spontaneous breathing) and confounding factors shifting the threshold value of PPV (low tidal volume, decreased pulmonary compliance, low heart rate/respiratory rate ratio, right ventricular dysfunction, and/or intra-abdominal hypertension) using clinical vignettes. Criteria used by physicians to indicate a fluid challenge were also collected.
Results: One hundred and forty-five physicians were included in the study. Among them, 87 (60%) knew prerequisites but none of them had full knowledge of all confounding factors. Criteria used to perform a fluid challenge were mainly PPV and the passive leg-raising test for the residents and PPV, blood pressure, oliguria and hydric balance for the qualified physicians.
Conclusions: PPV was widely employed to indicate a fluid challenge and 60% of the physicians knew the prerequisites. However, the physicians did not correctly interpret all confounding factors.

1. Introduction

Fluid optimization is often used as a first-line therapy in patients with hemodynamic instability and represents a daily challenge for physicians managing critically ill patients in the intensive care unit (ICU) or high-risk surgical patients in the operating room [1,2]. The respiratory arterial pulse pressure variation (PPV) has been described as a simple, continuous and reliable means to predict fluid responsiveness [3], which could help optimize volemia and conduct early goal-directed therapy [4]. The ability to monitor PPV in a non-invasive manner has been recently reported [5] and could further promote a wider use of PPV. However, three prerequisites are mandatory in order to use PPV reliably at the bedside:

- a continuous beat-to-beat arterial pressure monitoring;
- a regular sinus rhythm;
- controlled positive-pressure ventilation without spontaneous respiratory effort [3].

Furthermore, various hemodynamic, respiratory and abdominal confounding factors could limit the interpretation of the threshold value of PPV indicating fluid responsiveness. For example, the threshold value could be decreased in case of low tidal volume (Vt) [6], low pulmonary compliance [7] or low heart rate/respiratory rate ratio (HR/RR) [8]. In contrast, the threshold value could be increased when right ventricular dysfunction (RVD) [9] or intra-abdominal hypertension occur [10]. Although less described, other additional factors may also be involved, such as a

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decreased left ventricular ejection fraction (LVEF) [11] or a decreased value of perfusion index [12]. Finally, taking into account the gray zone approach at the bedside could further decrease the proportion of patients for which PPV was usable [13]. One issue not yet assessed is whether or not PPV is fully understood and correctly interpreted by physicians involved in the management of critically ill and high-risk surgical patients on a daily basis.

Therefore, we performed a prospective study in which residents and qualified intensivists and anaesthesiologists answered questions derived from two clinical vignettes. The aim of the study was to assess the proportion of physicians who interpreted PPV correctly regarding both prerequisites and confounding factors. Additionally, we studied the parameters used by clinicians to guide the decision for fluid loading.

2. Material and methods

2.1. Ethics

Institutional approval was obtained from the local, independent Ethics Committee (*Comité de Protection des Personnes Nord Ouest III: A11-D32-VOL.11*) and written consent was obtained from all included physicians. Registered anaesthesiologists and intensivists of the *Conseil de l'Ordre des Médecins de Basse-Normandie* (a northwest region of France) were initially contacted by phone to participate in an individual scheduled meeting. There was no *a priori* exclusion criteria. The study period went from January 2012 to November 2012.

2.2. Clinical vignettes and progression of the individual interviews

We arranged a meeting with each included resident and qualified intensivist or anaesthesiologist. Interviews took place in an office, away from any noise or other disturbance or clinical activity. Demographic, professional and continuous medical education characteristics for all participants were collected. The criteria used to decide a fluid challenge, the availability of PPV monitoring and the clinical use of PPV by physicians were then assessed. Two critical care (Appendices 1 and 2) and two anaesthesia (Appendices 3 and 4) clinical vignettes were written by the investigators (FD and MOF) and validated by two independent hemodynamic experts (JLF and JLH). Cases consisted in histories based on realistic clinical scenarios and they were submitted as critical care or anaesthesia cases, at the convenience of each participant. The clinical vignettes had an open-ended response format, as previously described [14]. The physicians conducting the interview (MOF for the residents and FD for the qualified physicians) did not take any notes and did not help the physicians with their answers. Clinical vignettes included questions regarding the PPV formula, the PPV physiological concept, the threshold value of PPV, the gray zone approach, and the knowledge of participants about both prerequisites and confounding factors.

2.3. Assessment of the answers to clinical vignettes

All individual interviews were recorded and listened to immediately after the meeting by MOF or FD in order to complete the evaluation checklist. The expected answers are presented in Table 1. They were similar for critical care and anaesthesia clinical vignettes. If an ambiguous response was noted, the two independent hemodynamic experts listened to the audio band again to definitely classify the answer as exact or inexact. The record was destroyed 7 days following the individual interview.

Table 1
Expected answers to clinical cases.

Item	Expected answer
PPV formula	$100 \times [(PPmax-PPmin)/((PPmax+PPmin)/2)]$
PPV physiological support	Respiratory variability of arterial pulse pressure
PPV threshold value	$>13\%$
Gray zone approach	Area of uncertainty without clinical application
PPV prerequisites	Sinus rhythm, controlled ventilation without spontaneous breathing and continuous arterial pressure monitoring
PPV confounding factors	
Respiratory conditions	$Vt \geq 8$ mL/kg, HR/RR >3.6, low respiratory system compliance (<30 mL/cmH_2O) due to low pulmonary compliance
Cardiac conditions	Absence of RVD (TAPSE >15 mm)
Abdominal conditions	Absence of intra-abdominal hypertension (<16 mmHg)

HR/RR: heart rate/respiratory rate ratio; LVEF: left ventricular ejection fraction; PPmax: maximal pulse pressure; PPmin: minimal pulse pressure; PPV: arterial pulse pressure variation; RVD: right ventricular dysfunction; TAPSE: tricuspid annular plane systolic excursion; Vt: tidal volume.

2.4. Definitions

2.4.1. Prerequisites

The prerequisites were defined as follows: patients having a continuous beat-to-beat arterial pressure monitoring, a regular sinus rhythm, and controlled positive-pressure ventilation without spontaneous respiratory efforts.

2.4.2. Confounding factors

The confounding factors were defined as follows: clinical situations decreasing the threshold value of PPV that predicts fluid responsiveness (low Vt, low respiratory system compliance due to low pulmonary compliance, and low HR/RR ratio) or increasing the threshold value of PPV (RVD and intra-abdominal hypertension).

Physicians included both residents in anaesthesiology and critical care, and qualified intensivists and anaesthesiologists.

2.5. Endpoints

The primary endpoint was the proportion of physicians who correctly interpreted PPV as regards both prerequisites and confounding factors. The secondary endpoint was the criteria used by physicians to administer a fluid challenge.

2.6. Statistical analysis

Data are expressed as means ± standard deviations (SD) for normally distributed variables, medians [25th–75th percentiles] for non-normally distributed variables (Kolmogorov-Smirnov test) or numbers (%), as appropriate. Continuous variables were analysed with the unpaired Mann-Whitney *U* test. Categorical variables were analysed with the Fisher exact test. A P value < 0.05 was considered to be statistically significant and all P values were two-tailed. Statistical analyses were performed using MedCalc® Software bvba version 12.5.0. (Ostend, Belgium).

3. Results

One hundred and one (55%) qualified intensivists and anaesthesiologists and 44 (92%) residents participated in the