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Práticas de gestão e monitorização hemodinâmica em unidades de cuidados intensivos em Portugal

Hemodynamic management and monitoring practices in intensive care units in Portugal

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RESUMO

Introdução: A gestão e monitorização hemodinâmica nas unidades de cuidados intensivos (UCI) em Portugal ainda não foi avaliada recentemente. Projetámos um questionário eletrónico para entender melhor a prática clínica e o alinhamento com as diretrizes internacionais mais recentes. **Métodos:** Um questionário de 24 questões, abordando a monitorização e gestão hemodinâmica na UCI, foi partilhado nas redes sociais e via email (e-blast®) pelos autores e pela Sociedade Portuguesa de Cuidados Intensivos de 11 de maio a 11 de setembro de 2023. Resultados: Dos 174 questionários válidos, 54% eram especialistas em medicina intensiva e os restantes eram médicos em formação em medicina intensiva. Ao abordar o paciente em choque séptico, o volume de bólus de fluído variou entre 500 mL (42%), 250 mL (30,5%) e 1.000 mL (19%), e o tipo de fluído mais utilizado foram soluções balanceadas (85,5% vs 14,4% de soro fisiológico). A norepinefrina foi universalmente a primeira escolha como vasopressor no

ABSTRACT

Introduction: The current hemodynamic management in intensive care units (ICU) in Portugal has not been assessed. We designed an electronic survey to better understand practice and alignment with the most recent guidelines. **Methods:** A short questionnaire of 24 questions, addressing hemodynamic monitoring and management in the ICU, was shared on social networks or via email (e-blast®) by the authors and the Portuguese Society of Critical Care from May 11th to September 11th, 2023. **Results:** Globally, 174 valid questionnaires were available for analysis. 54% were intensive care specialists, and the rest were physicians in training. When approaching the patient in septic shock, the volume of fluid challenge differed between 500 mL (42%), 250 mL (30.5%), and 1000 mL (19%), and the most used type of fluids were balanced solutions (85.5% vs 14.4% normal saline). Norepinephrine was universally the first choice for vasopressor in septic shock and most responders considered adding steroids (96%) and

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choque séptico e a maioria dos respondedores considerou adicionar complementarmente corticóides (em 96%) e vasopressina (em 66,1%). A ferramenta mais utilizada para avaliar a responsividade a fluídos e para monitorização hemodinâmica foi a ecocardiografia (97,1%), mas 31% dos respondedores consideraram que menos da metade da equipa médica tinha capacidade técnica para avaliação ecocardiográfica. **Conclusão:** A ecocardiografia é a ferramenta preferencial para avaliação hemodinâmica, mas parte dos respondedores considerou que a equipa não tinha proficiência na técnica, destacando assim a importância do treino e da padronização da mesma na UCI.

Palavras-chave: Monitorização Hemodinâmica. Ecocardiografia. Choque

vasopressin (in 66.1%). The most frequently used tool to assess fluid responsiveness and hemodynamic monitoring was echocardiography (97.1%), but 31% of responders considered that less than half of the medical staff was skilled in echocardiographic assessment. **Conclusion:** Our survey suggests that most patients in septic shock receive fluids, norepinephrine, vasopressin, and steroids, according to current international recommendations. Echocardiography is the preferential tool for hemodynamic assessment. Still, most responders considered that the team was not skilled enough to perform it, thus highlighting the importance of training and standardization in this technique in the ICU.

Key-words: Hemodynamic Monitoring. Echocardiography. Shock

INTRODUCTION

Adequate hemodynamic assessment and management are cornerstones in the care for the management of critically ill patients [1,2]. However, bedside hemodynamic monitoring faces many challenges. First, methods, devices, and parameters available for hemodynamic monitoring have evolved over the last 30 years, and this may be responsible for the significant heterogeneity in the types of techniques used by clinicians in various intensive care units (ICUs). Second, properly using these monitoring tools and interpreting the variables displayed is complex and requires a high level of knowledge and skill, resulting in heterogeneous interventions[3,4]. Third, advanced methods for hemodynamic monitoring, per se, have not been associated with improving patient survival [5,6] unless coupled with early and clinically relevant therapeutic strategies [2,7]. Considerable heterogeneity in the availability and practice of hemodynamic monitoring exists at the bedside across clinicians, ICUs, and countries, although studies investigating this issue are scarce [3,8,9].

OBJECTIVES

This study aimed to investigate the Portuguese status and potential regional differences regarding shock assessment, namely focusing on hemodynamic management and monitoring practices, therapeutic options, and hemodynamic monitoring devices. Also, there are a few guidelines on circulatory compromise and hemodynamic management and monitoring, such as the Consensus on Circulatory Shock and Hemodynamic Monitoring: Task Force of the European Society of Intensive Care Medicine[10] and the Surviving Sepsis Campaign: international guidelines for management of sepsis and septic shock 2021[11]. Therefore, the second objective of this survey was to better understand current practices and alignment with these recent guidelines.

METHODS

A short questionnaire (see Appendix 1) was developed and posted online (Google Forms survey). Intensivists, both specialists and in training, working in Portuguese ICUs and involved in the care of critically ill patients, were invited to answer 24 questions about hemodynamic monitoring and management in the ICU.

From May 11, 2023, the survey was shared on social networks or via email (e-blast) by the authors and the Portuguese Society of Intensive Care (SPCI, spci.pt) and the association of Intensive care Medicine residents (AIMINT, ai

Questionnaires not filled by an intensivist (certified or trainee) or with more than three unanswered questions were considered invalid. Responses were monitored daily, and the database was locked in analysis after four months (September 11, 2023). Data are presented as numbers or percentages. Multiple answers were allowed for several questions (see Appendix 1). Therefore, cumulative percentages presented in the text may sometimes exceed 100%.

RESULTS

Globally, 174 valid questionnaires were available for analysis: 54% from intensive care specialists, 23.6% from intensive care residents, and 22.4% from other specialists in intensive care training. Regarding intensive care medicine practice experience, 46.6% had between 1 and 5 years, and 17.2% had more than 15 years (Figure 1). Most treated intensive care level III and II patients (94.3% and 86.8%, respectively), but only 14.3% treated level I patients.

Regarding the initial approach of the patient in septic shock, the volume of fluid challenge and type of fluid used differed between clinicians, as depicted in Figures 2 and 3,

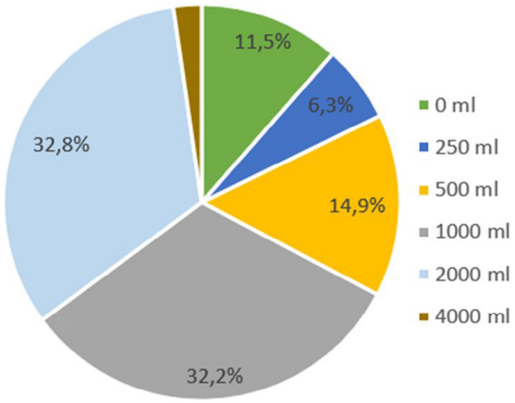

Figure 1. Distribution by volume of fluid given at day 5 of ICU stay in a patient in shock. ml - milliliters.

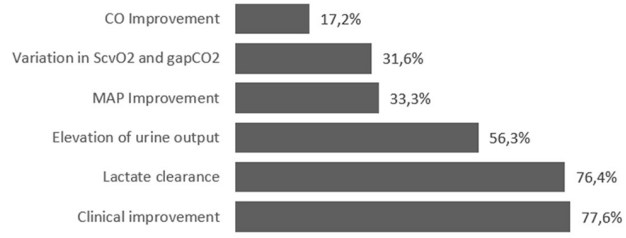

Figure 2. Distribution regarding the preferred therapeutic goals in shock, with the possibility of choosing a maximum of 3 options. CO - cardiac output; gapCO2 - gap between venous and arterial carbon dioxide; MAP - mean arterial pressure; ScvO2 - central venous oxygen saturation.

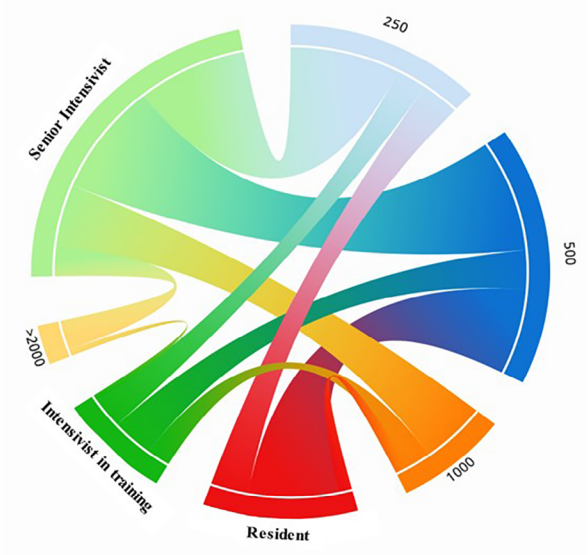

Figure 3. Chord diagram showing the connections between medical graduation level and the volume of fluid challenge. The volume of fluid is in millimeters.

respectively. Less than half of responders would perform a fluid responsiveness test before fluid administration on the initial approach (Figure 4).

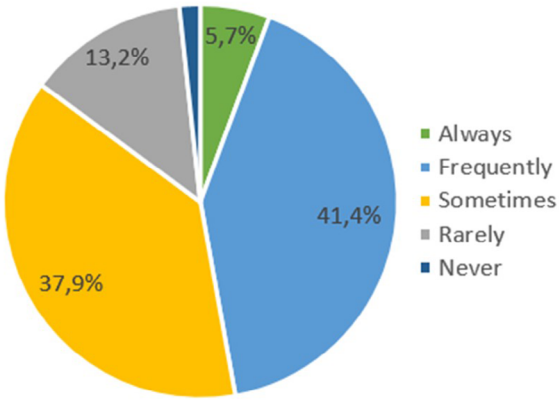

Figure 4. Distribution by frequency of performing a fluid responsiveness test before fluid administration on the initial approach.

When correlating the volume of fluid challenge administered on the initial approach with the medical graduation level, there was a significant association between the more differentiated intensive care specialist (senior intensivist) and less volume administered in the fluid challenge ($p = 0.01$) when compared to intensivists in training and residents of intensive care medicine, as shown on Diagram 1.

The most common criteria to start vasopressors was MAP 65 mmHg after 30 mL/kg of fluid loading and poor peripheral perfusion (77.6% both), with norepinephrine being the universal first choice. For the second vasopressor, 66.1% considered adding vasopressin, and 45.4% considered adding epinephrine. Regarding adjuvant therapies for septic shock, we highlight the choice of steroids (96%) and albumin (63.8%). Radial insertion was the commonest site for invasive blood pressure continuous monitoring (75.3%). Most respondents (71.8%) considered decreasing the patient's sedation to improve hemodynamic status if the patient was sedated with a RASS -5.

The most used therapeutic targets in shock were clinical improvement (77.6%) and lactate clearance (76.4%), according to Figure 5 (clinical improvement was defined as improvement in one or more organ hypoperfusion signs on the physical examination).

Volume status was evaluated routinely in 41.4% and sporadically in 37.9% of the cases. The most common assessment strategies were echocardiography-derived cardiac output combined with lung ultrasound evaluation (92.5%), physical examination (55.2%), and thermodilution

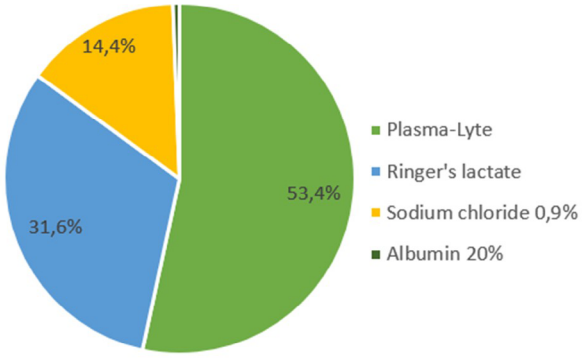

Figure 5. Distribution regarding the type of fluid preferred in the initial approach of a septic shock.

techniques derived cardiac output and volume parameters (50.6%). Less frequently, clinicians used cardiac output measured by pulse contour analysis, bioreactance, PPV, CVP, or urinary output. The most frequently used tools to assess fluid responsiveness varied among responders but predominated the dynamic evaluation of IVC (52.3%), cardiac output measured by echocardiography (45.4%), and PPV calculation (44.8%).

According to the responders, most patients received between 1000 and 2000 mL/day after five days in the ICU (Figure 6).

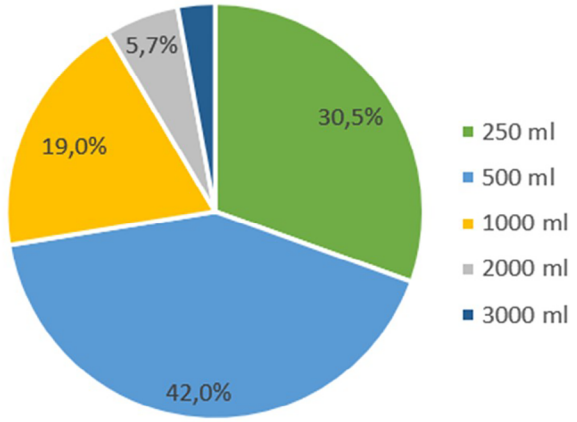

Figure 6. Distribution regarding the volume of fluid challenge on the initial approach of a patient with septic shock.
ml - milliliters.

When questioned about how many patients received an echocardiographic evaluation at least once during their ICU stay, 60.3% of responders considered between 75-100%, 23% between 50-75%, and 9.8% between 25-50% of the patients. Regarding echocardiography competency to assess patients, 57.5% considered that more than half of the medical staff was skilled, 31% considered less than half of the medical staff, and 7.5% considered all the medical staff could do it (Figure 7).

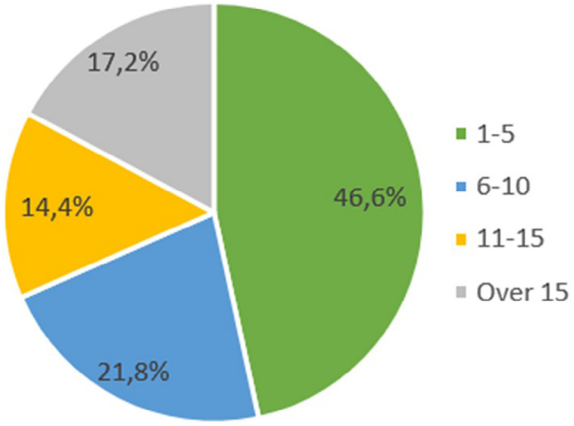

Figure 7. Distribution by number of years of experience in Intensive Care Medicine. Distribution by number of years of experience in Intensive Care Medicine.

When inquired about implementing measures to improve the utilization of hemodynamic monitoring tools and devices, more than half of the responders valued education, algorithm implementation, and participation in hemodynamic projects. Overall, there were no regional differences between hemodynamic management and monitoring practices.

DISCUSSION

The main findings of our survey could be summarized as follows: 1) most septic shock patients in Portuguese ICUs receive fluids, norepinephrine, vasopressin, and steroids; 2) echocardiography was the primary tool to assess cardiac output, volume status, fluid responsiveness, and hemodynamic monitoring; 3) almost a third of responders considered that more than half of the team was not skilled enough to perform echocardiography.

Initial management of patients with hemodynamic instability in Portuguese ICUs included fluid administration. However, the volume chosen for the fluid challenge varied between 250 (30.5%), 500 (42%), and 1000 mL (19%). The current literature recommends 4 mL/kg of volume in 10-15 minutes for the fluid challenge (280 mL for a 70 kg adult) [12,13]. We could speculate that this mismatch could be partly explained by confusion between fluid concepts, such as "fluid challenge" vs. "fluid bolus" vs. "fluid resuscitation". According to SSC [11], at least 30 mL/kg of fluid is suggested in the first 3 hours, which would be more in line with the 1000

mL option of the responders. It is important to remember that the fluid challenge technique is first of all a test of the cardiocirculatory system. It allows the clinician to test whether the patient has a preload reserve that can be used to increase the SV with further fluids. These further fluids can be given after a positive response to a fluid challenge, or they can be given in a controlled way by repeating the fluid challenge as long as there is a positive response [14]. This is very different from fluid bolus, in which fluids are given without real-time monitoring of the response. The only 'excess' fluid that may be given with the fluid challenge technique is the amount of fluid used when the patient fails to respond. Also, the volume of fluid challenge differed among the clinicians, with less volume being administered by the more graduated intensivists when compared to residents or non-intensivists. This highlights the importance of education programs in hemodynamic management, especially in shock and fluid challenges, in the intensive care department, and in specialty graduation programs.

Despite consistent recommendations on using fluid responsiveness tests before fluid administration by SSC 2021 guidelines [11] and the ESICM 2014 guidelines [10], less than half of the responders used it frequently, which is in accordance with a previous study [13]. Nevertheless, when used, responders always used dynamic instead of static parameters, such as the evaluation of IVC variation (52.3%), cardiac output variation measured by echocardiography (45.4%), and PPV calculation (44.8%). The prediction of fluid responsiveness with TTE requires the evaluation of the inferior vena cava (IVC) respiratory variations [15] or of the velocity time integral (VTI) respiratory variations recorded at the level of the left ventricular outflow tract [16]. It is worth noticing that these variables have limited sensitivity in patients ventilated with a low tidal volume for protective mechanical ventilation. Indeed, in this context, if large IVC or VTI respiratory variations are highly suggestive of fluid responsiveness, small variations cannot exclude it (false negative). The same limitation applies to pulse pressure variation (PPV) and stroke volume variation (SVV), which were also popular methods among our respondents[17]. The passive leg raising maneuver (PLR) [18] and the end-expiratory occlusion test (EEOt) [19] are interesting alternatives to TTE-derived variables, PPV and SVV during protective mechanical ventilation [20] were less often used (PLR 38.5% and EEOt 21.8%).

The fluid challenge test [14], PLR test, and EEOt usually require the simultaneous use of a fast response cardiac output monitoring system (typically a pulse contour technique) to capture transient changes in stroke volume or cardiac output during the maneuver [18]. Of note, although in clinical practice, an increase in mean arterial pressure following the elevation of a patient's legs is often used as a "passive leg raising test," a passive leg raising test in a narrow sense should follow a strict protocol. It should include the continuous assessment of CO [18]. Also, it has been demonstrated that dynamic cardiac preload parameters (pulse pressure variation, stroke volume variation) cannot be used in a relevant proportion of critically ill ICU patients because mandatory criteria for their use (i.e., controlled ventilation, sinus rhythm) are not fulfilled [21]. These limitations and technical aspects could account for the low compliance with fluid responsiveness tests before fluid administration.

Most respondents (71.8%) considered decreasing the patient's sedation to improve hemodynamic status if the patient was sedated with a RASS -5, which may reflect the arousal of the vasoplegic effects of most of the sedatives used in septic shock patients. This has to be counterbalanced by the benefits of decreasing overall metabolic demands on an already mismatched delivery-consumption state, a characteristic of sepsis. For critically ill patients, as with any other medical procedure they undergo in the ICU, such as hemodynamic monitoring or ventilation, the personalization of sedoanalgesia is the only way to obtain the best patient outcomes. Indeed, we must go beyond simply avoiding the use of certain group of drugs towards the concept of "objective-guided sedation", taking full advantage of the therapeutic arsenal currently available to us, as recently reviewed by Marcos-Vidal et al.[22].

A hemodynamic monitoring device was considered in 59.2% for cardiac output measurement, mainly in the context of refractory shock (79.9%), undifferentiated shock (57.7%), or inconclusive echocardiographic evaluation (54.6%), which matches the ESICM 2014 [10] and SSC 2021 guidelines ([11]) recommendations. The most used devices by the responders were echocardiography (97.1%), transpulmonary thermodilution system (82.2%), and pulmonary artery catheter (45.4%), like previous surveys done in Brazil, Germany, Switzerland, and worldwide [23–27].

Our survey shows a clear predominance in the use of echocardiography as a diagnostic and monitoring tool. Still, when questioned about how many patients received an echocardiographic evaluation at least once during their ICU stay, only 60.3% of responders considered between 75-100%, and 31% considered that less than half of the medical staff was skilled for an echocardiographic assessment. This perspective of the responders can be biased, first, by the prevalence of 46% of intensivists in training and less experienced (between 1 and 5 years), second, by the lack of specification on the level of training in echocardiography in this question. This gap in echocardiography experience and training could be improved by a national educational program including more ultrasound courses stratified by levels of expertise, more training time in the Cardiology echocardiography

laboratory, more comprehensive and frequent simulator training, implementation of echocardiography internships in the ICU environment (with certificated mentors, such as European Diploma of Advanced Critical Care Echocardiography – EDEC – or European Association of Cardiovascular Imaging (EACVI) Certification in Adult Transthoracic Echocardiography (TTE)).

Recently, the ESICM released an expert-based consensus regarding the basic skills for head-to-toe ultrasonography in the intensive care setting [28], where it recommends that the evaluation of LV outflow tract velocity time integral as an estimation of stroke volume should be a basic skill. Also, some previous studies have demonstrated that critical care echocardiography performed at the bedside by intensivists with basic critical care echocardiography training is an accurate and reproducible technique to measure cardiac output in critically ill patients[29,30]. Nevertheless, there is growing evidence demonstrating that machine learning automatic tools in ultrasound machines can accurately help inexperienced clinicians acquire essential measurements for hemodynamic management, such as left ventricle outflow tract VTI [31] and left ventricle ejection fraction [32,33].

The traditional approach to the shocked patient has been administering fluids until the patient is no longer fluid-responsive. However, this strategy may lead to fluid overload [20]. Although fluid overload is associated with increased morbidity and mortality, no clear parameters guide the physician on when to stop fluid administration. Clinical and imaging variables suggest the presence of interstitial edema occurs late. In 1984, Shippy [34] analyzed fluid therapy and its relationship to variables such as central venous pressure (CVP), concluding that they do not adequately reflect the volume status of critically ill patients. Therefore, they are not currently recommended for guiding fluid removal [35,36]. It has been observed that the normal maximum diameter of the IVC ranges from 1.9 to 2.1 cm; patients presenting with an IVC diameter close to this, with minimal or no variation during the respiratory cycle, do not benefit from IV fluids[37]. The use of the IVC collapsibility index does have some limitations, including inter-observer differences, high rates of false positives, and mild-to-moderate positive predictive value, as discussed in the review paper by Via et al. [38]. The use of VExUS relies on the measurement of the inferior vena cava's size in conjunction with Doppler flow interrogation at the level of the hepatic, portal, and intra-renal veins. It may be useful in assessing systemic venous congestion and directing fluid management [39], helping clinical decision-making regarding fluid tolerance. Also, LUS has been confirmed to be a rapid, non-invasive, and reproducible bedside tool to estimate the extra-vascular lung water [40], and it is turning into a key component for determining the presence of pulmonary edema and estimating its severity in different clinical contexts [41,42]; hence, it could help to understand whether there is a clinically relevant impact of increased LA pressure.

Our study has limitations. In addition to emails that are clearly targeted, we used social networks (LinkedIn, Twitter, WhatsApp) to invite clinicians to answer the survey and share the link. Therefore, we could not control the number of clinicians who received the survey and hence determine the percentage of respondents. Furthermore, we can have a bias phenomenon in which clinicians who are more interested and skilled in the subject are more motivated to answer. However, regarding the Portuguese population and the ratio of intensivists, our survey had fewer participants than previous surveys in other bigger countries [23–26]. All the questions on this survey had close-ended answers, which conditions the respondents' options and perspectives and sometimes could lead to misinterpretations. Finally, this is a survey, not an audit or an observational study. Therefore, the clinician's feedback reflects their perception of what is done in their unit, which may sometimes differ from reality.

CONCLUSION

Resuscitation practices in Portuguese ICUs regarding fluid administration, norepinephrine, and steroid usage are following current international recommendations. Echocardiography is a preferential tool for hemodynamic monitoring, assessing volume status and fluid responsiveness. Nevertheless, according to about a third of the surveyed physicians, there are gaps in skill and qualifications to adequately perform advanced echocardiography in more than half of the medical team. These results highlight the importance of training and standardization in this technique.

DECLARATION OF AUTHORS' CONTRIBUTION

All authors contributed equally from the project design, data collection and analysis, to the writing and reviewing.

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