of multimodal analgesic approaches in many diagnoses. Some agents (opiates and acetaminophen) are commonly prescribed, whereas others are rarely so. They point out quite appropriately that deeper systematic study is necessary to uncover the principles that may one day help establish best practice. Reasons for drug selection may be important. Drug availability is an obvious factor but so might be ease of administration or side effects. As the authors indicate in their survey questions, there are other considerations. Care needs and dynamics of neurologic conditions might well be added to this list.

The term for the study of how experts at the sharp end actually do their job is "technical work." (9) Describing real work includes building representative models of the constraints and trade-offs clinicians face that shape their jobs (10). Understanding these factors is an iterative process. Zeiler et al (5) contribute an important first step toward building a better model.

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Raising Standards for Fluid Management: Keep It Up!*

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It is now well established that both insufficient and excessive fluid administration may lead to organ dysfunction (gut and myocardial ischemia, renal failure, anastomotic leak, and pulmonary edema), prolonged hospital length of stay, and increased costs (1). Recent publications have shown a large inter-operator variability in the volume of fluid administered (2) and have underlined the lack of rationale (3), when not the random chaos (4), behind clinical decisions of fluid administration. Over the past decades, several methods have been proposed to rationalize the way we administer fluid to surgical and critically ill patients. One of them is the prediction of fluid responsiveness by the assessment of stroke volume changes during passive leg raising (PLR). The principle is simple and elegant: PLR transiently increases venous return and mimics the hemodynamic effects of a real fluid challenge without the need and the risk to give fluid.

ADVANTAGES AND LIMITATIONS OF PLR

In this issue of *Critical Care Medicine*, Cherpanath et al (5) did a meta-analysis of 23 studies investigating the value of PLR to predict fluid responsiveness. In all studies analyzed, the response to a real fluid challenge was used as the reference method to classify patients as responders or nonresponders. The ability of PLR to correctly classify the same patients prior to fluid loading was investigated. Cherpanath et al (5) concluded that assessing stroke volume changes during PLR is a sensitive (86%) and specific (92%) method to predict fluid responsiveness. Of note, studies analyzed were done in different patient populations (medical or surgical), the volume and type of fluid infused was not always the same, the methods used to assess stroke volume were often different (esophageal Doppler, echocardiography, pulse contour, or bioreactance), as well as the PLR technique (starting position was either supine or semi-recumbent). As a result, heterogeneity was high, as confirmed by significant I^2 values. If this limitation does not invalidate the conclusion of Cherpanath et al (5), it is a plea for the harmonization of PLR maneuvers to guarantee their reproducibility and validity at the bedside. Such standardization could be achieved by following five simple steps nicely described by Monnet and Teboul (6) in a recent publication.

***See also p. 981.**

Key Words: fluid responsiveness; hemodynamic monitoring; fluid management; passive leg raising; pulse pressure variation

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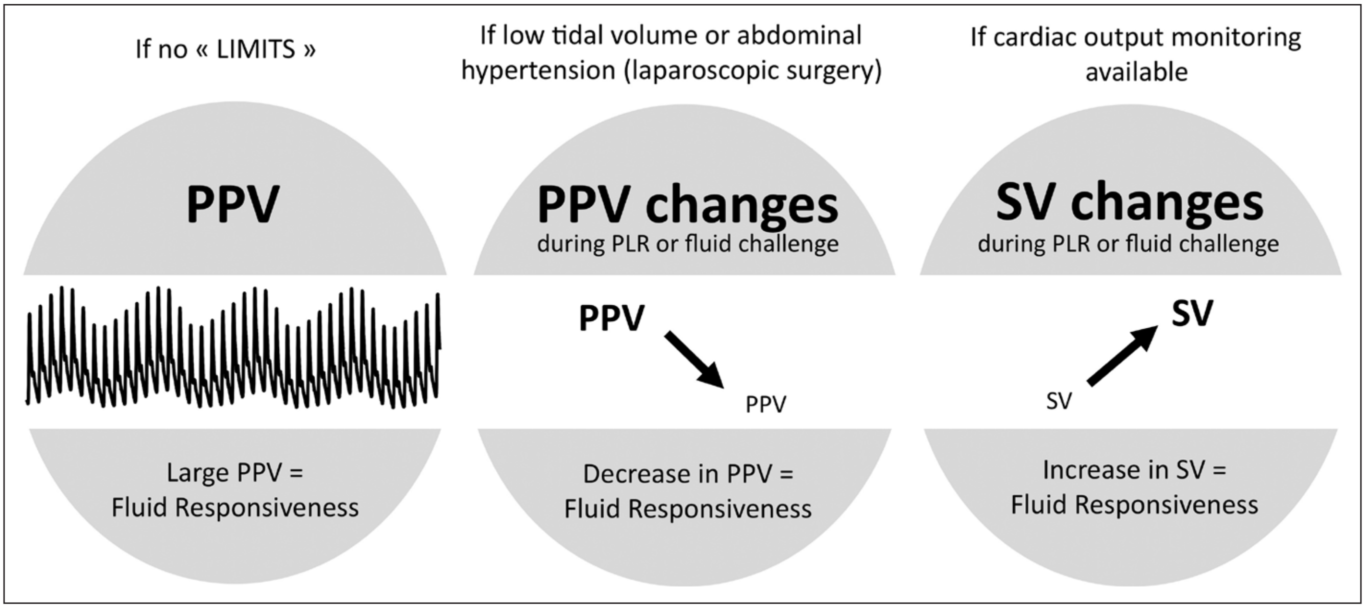

Figure 1. Several options to predict fluid responsiveness and rationalize fluid management. LIMITS = Low heart rate/respiratory rate ratio, Irregular heart beats, Mechanical ventilation with low tidal volume, Increased abdominal pressure, Thorax open, Spontaneous breathing, PLR = passive leg raising, PPV = pulse pressure variation, SV = stroke volume.

Although very informative when well executed, PLR requires clinician's intervention and is not always technically possible (e.g., during surgery). There are clinical situations, such as abdominal hypertension, pain-induced sympathetic activation, or the use of compression stockings, where the interpretation of PLR-induced stroke volume changes is not unequivocal. Because arterial pulse pressure depends on arterial compliance, PLR-induced pulse pressure changes cannot be used as a surrogate for stroke volume changes. In this respect, Cherpanath et al (5) showed that the sensitivity of pulse pressure changes during PLR was only 58%. In other words, predicting fluid responsiveness with PLR requires the use of a cardiac output monitor, which may not always be readily available.

PULSE PRESSURE VARIATION INDUCED BY MECHANICAL VENTILATION

A simpler and operator-free method to predict fluid responsiveness consists in using the mechanical ventilator to test the sensitivity of the cardiovascular system to a change in preload. Because each mechanical breath induces a transient decrease in venous return, the pulse pressure variation (PPV) induced by mechanical ventilation can be used as a marker of the position on the Frank-Starling curve and hence to predict fluid responsiveness (7). Multiple studies and meta-analysis have confirmed the high predictive value of PPV, and outcome studies have demonstrated that using it (or a surrogate such as stroke volume variation) to guide intraoperative fluid management is useful to decrease postoperative complications and length of stay (8). However, the use of PPV has limitations, which have been described in details elsewhere (7) and were recently summarized (9) by the mnemonic "LIMITS," which stands for Low heart rate/respiratory rate ratio, Irregular heart beats, Mechanical ventilation with low tidal volume, Increased abdominal pressure, Thorax open, and Spontaneous breathing (**Fig. 1**).

PPV CHANGES DURING PLR

In patients with sepsis, Michard et al (10) showed a strong correlation between changes in PPV and changes in cardiac output: the greater the decrease in PPV, the greater was the increase in cardiac output during fluid loading. The ability to predict changes in blood flow from changes in PPV was later confirmed by Le Manach et al (11) in surgical patients, a fluid loading–induced decrease in PPV indicating a rise in cardiac output with excellent sensitivity and specificity. Recently, Mallat et al (12) investigated the value of changes in PPV during a mini-fluid challenge (100 mL in 1 min) in critically ill patients ventilated with a low tidal volume (< 8 mL/kg). First, they confirmed that PPV is not a good predictor of fluid responsiveness when tidal volume is low. Second, they showed that changes in PPV were in contrast very informative: an absolute decrease of more than 2% during the minifluid challenge was predicting the positive response to a 500-mL fluid challenge with a sensitivity of 86% and a specificity of 85%. Therefore, when cardiac output monitors are not available, and PPV values are difficult to interpret because of a low tidal volume (false-negative), or an increase in abdominal pressure (false-positive typically observed during laparoscopic surgery), one may use changes in PPV to track changes in blood flow during PLR or fluid challenges (Fig. 1).

DON'T GUESS, MEASURE!

Given the clinical and economic burden of postsurgical complications, acute renal failure and prolonged mechanical ventilation, there is an urgent need to rationalize the way we administer fluid. Several recent consensus statements and guidelines, as well as the Centers for Medicare and Medicaid Services (management bundle NQF 0500), called for individualized fluid titration, based on the assessment of fluid responsiveness, to ensure patients receive the right amount of fluid at the right time (13, 14). Several methods are now available to easily and quickly predict fluid responsiveness at the bedside: the assessment of PPV (or surrogate parameters) and the assessment of changes in stroke volume or of changes in PPV during PLR or a fluid challenge (Fig. 1). These methods have limitations (6, 7) but are complementary. They offer clinicians the opportunity to raise standards for fluid management, improve quality of care, and decrease healthcare costs at the same time (15).

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Earplugs, Sleep Improvement, and Delirium: A Noisy Relationship*

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Delirium occurs frequently during critical illness and is associated with negative outcomes both during the ICU admission and after ICU discharge; prevention efforts during the period of critical illness are therefore essential (1). The occurrence of delirium is dependent on a complex interplay between predisposing and precipitating risk factors (2). Efforts to reduce the burden of delirium should be focused on risk factor reduction and proven nonpharmacologic interventions such as early mobilization (3).

Sleep disruption is common in the ICU and has been hypothesized to be a risk factor for delirium (4). Cognitive dysfunction, alterations of cerebral perfusion and cortical metabolism, and circadian rhythm disturbances are common to both delirium and sleep deprivation (4, 5). Critically ill patients frequently report poor sleep as one of their worst memories and an important source of stress and anxiety (6). Thus, sleep promotion has been identified as a potential strategy for reducing the prevalence of ICU delirium and improving patients' ICU quality of life (7).

One such strategy for sleep promotion has been noise reduction. Noise levels in modern ICUs far exceed World Health Organization requirements and may be associated with sleep disturbances (8). In this issue of *Critical Care Medicine*, Litton et al (9) report the result of a systematic review of studies that evaluated the efficacy of nocturnal ear plug placement as a strategy to reduce delirium in the ICU. Across five studies

*See also p. 992.

Key Words: delirium; ear protective devices; intensive care; noise; prevention; sleep

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