2. Muller L, Toumi M, Bousquet PJ, Riu-Poulenc B, Louart G, Candela D, Zoric L, Suehs C, de La Coussaye JE, Molinari N, Lefrant JY; AzuRéa Group: An increase in aortic blood flow after an infusion of 100 ml colloid over 1 minute can predict fluid responsiveness: The mini-fluid challenge study. Anesthesiology 2011; 115:541–7
3. Mallat J, Meddour M, Durville E, Lemyze M, Pepy F, Temime J, Vangrunderbeeck N, Tronchon L, Thevenin D, Tavernier B: Decrease in pulse pressure and stroke volume variations after mini-fluid challenge accurately predicts fluid responsiveness. Br J Anaesth 2015; 115:449–56
4. Guinot PG, Bernard E, Defrancq F, Petiot S, Majoub Y, Dupont H, Lorne E: Mini-fluid challenge predicts fluid responsiveness during spontaneous breathing under spinal anaesthesia: An observational study. Eur J Anaesthesiol 2015; 32:645–9

(Accepted for publication January 26, 2018.)

In Reply:

We sincerely thank Drs. Vistisen and Scheeren for their insightful comments regarding our recent article.[1] The authors pinpointed that calculating predictor and outcome variables from the same baseline may induce theoretical methodologic misinterpretations. Even though we agree with their point of view, we are convinced that it has less impact on our results.

Vistisen and Scheeren claimed that Guinot *et al.*'s study[2] was the only work that addressed the mini-fluid approach with good methodology because it had a new baseline measurement five minutes after each mini-fluid challenge. Interestingly, the results from this study are very close to ours. The area under the receiver operating curve of that study was 0.93 (95% CI, 0.8 to 0.97) and 0.95 (95% CI, 0.90 to 0.99) in our study. The best cut-off value was 7% (6% in our study), gray zone ranged between 3 and 8% including 14% of patients (4 to 7% including 19% of patients in our study). This highlights similarity of the results observed whether we use the methodology recommended by Vistisen and Scheeren or ours. The potential "artificial boost of predictive power of the mini-fluid challenge," induced by our methodology, claimed by Vistisen and Scheeren, is clearly not obvious.

The concept of mini-fluid introduced by Muller *et al.*[3] is to infuse a small quantity of fluid to test whether stroke volume will increase. The major advantage of this concept is to stop fluid administration when stroke volume does not increase after a small fluid infusion, thereby reducing ineffective volume administration. The mini-fluid challenge helps the physician to predict fluid responsiveness and fluid unresponsiveness. We fully agree that standard strategies based on international recommendations and cited by Vistisen and Scheeren improve patient outcome. In two thirds of cases, however, these strategies lead to ineffective fluid administration.[4] A mini-fluid approach could decrease the rate of unnecessary fluid administration and consequently increase the benefit of fluid optimization. Further studies are warranted to investigate this issue.

To conclude, we agree that mathematical coupling exists between the effects of mini-fluid challenge and volume expansion. However, based on previous studies and ours, with all due respect, we completely disagree that mini-fluid challenge resembles a self-fulfilling prophecy design. A fluid challenge can be looked at as a bet; if we have to lose this bet, let's make sure to lose as little as possible!

Competing Interests

Dr. Biais received honoraria from Edwards Lifesciences (Irvine, California) and Pulsion Medical System (Feldkirchen, Germany) for lecturers. The other authors declare no competing interests.

Hugues de Courson, M.D., Musa Sesay, M.D., Karine Nouette-Gaulain, M.D., Ph.D., Matthieu Biais, M.D., Ph.D. Bordeaux University Hospital, Bordeaux, France (M.B.). matthieu.biais@chu-bordeaux.fr

References

1. Biais M, de Courson H, Lanchon R, Pereira B, Bardonneau G, Griton M, Sesay M, Nouette-Gaulain K: Mini-fluid challenge of 100 ml of crystalloid predicts fluid responsiveness in the operating room. Anesthesiology 2017; 127:450–6
2. Guinot PG, Bernard E, Defrancq F, Petiot S, Majoub Y, Dupont H, Lorne E: Mini-fluid challenge predicts fluid responsiveness during spontaneous breathing under spinal anaesthesia: An observational study. Eur J Anaesthesiol 2015; 32:645–9
3. Muller L, Toumi M, Bousquet PJ, Riu-Poulenc B, Louart G, Candela D, Zoric L, Suehs C, de La Coussaye JE, Molinari N, Lefrant JY; AzuRéa Group: An increase in aortic blood flow after an infusion of 100 ml colloid over 1 minute can predict fluid responsiveness: The mini-fluid challenge study. Anesthesiology 2011; 115:541–7
4. MacDonald N, Ahmad T, Mohr O, Kirk-Bayley J, Moppett I, Hinds CJ, Pearse RM: Dynamic preload markers to predict fluid responsiveness during and after major gastrointestinal surgery: An observational substudy of the OPTIMISE trial. Br J Anaesth 2015; 114:598–604

(Accepted for publication January 26, 2018.)

Assessing Glucose Meter Accuracy: The Details Matter!

To the Editor:

We read with great interest the recent article by Dr. Karon *et al.* titled "Accuracy of Capillary and Arterial Whole Blood Glucose Measurements Using a Glucose Meter in Patients under General Anesthesia in the Operating Room."[1] We congratulate the authors on identifying a glucose meter potentially safe for insulin dosing in the perioperative environment using both capillary and arterial samples, given that no glucose meter is currently approved by the U.S. Food and Drug Administration for use with capillary (fingerstick) samples in critically ill patients.[2] Using this meter may offer

an important step toward improved blood glucose control in these patients. The authors attributed the improved accuracy of glucose measurement, at least partially, to the fact that the newer generation glucose meters can "correct for hematocrit or other interferences." We have three comments.

First, the authors used blood gas analyzers as the reference method. Even though blood gas analyzers generally are considered more accurate than meters, they have never been established as a reference method in the literature. In clinical practice, the central laboratory device has been used as a reference method when assessing glucose meters because of its high accuracy.[3,4] We are wondering why the authors used blood gas analyzers rather than central laboratory devices as the reference method, and how we can interpret the accuracy of glucose meters in this article if the reference method used is not the commonly used "clinical reference method."

Second, the authors assessed the accuracy of glucose meters in a narrow range of values, which were between 70 and 250 mg/dl, with no hypoglycemic values studied. Multiple previous studies have shown that measurements by glucose meters are more accurate in the "normal physiologic" range rather than hypoglycemic or hyperglycemic values.[5–7] Thus, we are wondering how the accuracy data of this meter in a range of relatively "physiologic" glucose values could be generalized to its accuracy in a wider range of glucose values that we are concerned about in the clinical practice.

Third, we agree with the authors that patients in the operating room share similarities with patients in the intensive care units. These two populations, however, also could be vastly different. For example, one of the biggest concerns with using glucose meters with capillary samples in "critically ill patients" was impaired peripheral perfusion.[2] Although the majority of patients in this study received vasopressor treatment during their care, the dose of vasopressor was rather small and most likely just counteracted the vasodilatory effect of the anesthetics. It is difficult to determine if these patients had impaired or actually improved peripheral perfusion. These patients are very different from patients in the intensive care unit who are receiving high-dose vasopressors with other evidence of poor peripheral perfusion, such as lactatemia, acidosis, or peripheral edema. Therefore, we need to be cautious in extrapolating these results from the perioperative population to the intensive care unit population.

No doubt glucose management is an important part of standard patient care, but with the enormous amount of literature published every year regarding glucose measurement accuracy with various devices, readers should be very cautious about interpreting the results and careful before incorporating those results into their clinical practice. Many factors need to be considered when it comes to assessing device accuracy, including the reference method, range of glucose values tested, sample sources, assessment methodology, and patient populations. The details matter!

Competing Interests

The authors declare no competing interests.

Yafen Liang, M.D., Mark J. Rice, M.D. Vanderbilt University Medical Center, Nashville, Tennessee (Y.L.). yafen.liang@vanderbilt.edu

References

1. Karon BS, Donato LJ, Larsen CM, Siebenaler LK, Wells AE, Wood-Wentz CM, Shirk-Marienau ME, Curry TB: Accuracy of capillary and arterial whole blood glucose measurements using a glucose meter in patients under general anesthesia in the operating room. Anesthesiology 2017; 127:466–74
2. U.S. Food and Drug Administration: Blood glucose monitoring test system for prescription point-of-care use: Draft guidance for industry and food and drug administration staff. Draft guidance issued on January 7, 2014. Available at: http://www.fda.gov/downloads/medicaldevices/deviceregulationandguidance/guidancedocuments/ucm380325.pdf. Accessed May 7, 2016
3. Rebel A, Rice MA, Fahy BG: Accuracy of point-of-care glucose measurements. J Diabetes Sci Technol 2012; 6:396–411
4. Burtis CA, Ashwood ER, Bruns DE, eds.: Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. 4th ed. St. Louis, Missouri, Elsevier-Saunders, 2006, pp 868–71
5. Pereira AJ, Corrêa TD, de Almeida FP, Deliberato RO, Lobato Mdos S, Akamine N, Silva E, Cavalcanti AB: Inaccuracy of venous point-of-care glucose measurements in critically ill patients: A cross-sectional study. PLoS One 2015; 10:e0129568
6. Kanji S, Buffie J, Hutton B, Bunting PS, Singh A, McDonald K, Fergusson D, McIntyre LA, Hebert PC: Reliability of point-of-care testing for glucose measurement in critically ill adults. Crit Care Med 2005; 33:2778–85
7. Schifman RB, Nguyen TT, Page ST: Reliability of point-of-care capillary blood glucose measurements in the critical value range. Arch Pathol Lab Med 2014; 138:962–6

(Accepted for publication January 31, 2018.)

In Reply:

We thank Drs. Liang and Rice for their insightful comments on our study.[1] There is no widely used or accepted reference method for blood glucose; therefore, the reference method used is a potentially confounding variable in studies of glucose meter accuracy. Perhaps the best choice for any study would be the predicate method for the device being studied, which for the Nova StatStrip (Nova Biomedical Corporation, USA) would be the plasma hexokinase method. The choice of reference method, however, needs to be weighed against other logistical aspects of study design. Specifically, cellular glycolysis occurring in the reference sample increases glucose meter bias as a function of time between sample draw and analysis.[2] We chose a study design that allowed us to analyze reference samples within 10 min of blood draw (a practice used in studies intended for U.S. Food and Drug Administration review). However, this required using the whole blood glucose oxidase method on a Radiometer ABL90 (Radiometer America Incorporated, USA) in a laboratory located adjacent to the operating room as the