Urine Oxygen Monitoring in Cardiac Surgery: Comment

To the Editor:

Silverton *et al.*[1] nicely described their work with a prototype monitor that measures oxygen partial pressure in the urine at the exit from the urinary catheter. I commend the authors for further emphasizing the association between oxygen partial pressure in the urine and postoperative acute kidney injury (AKI) and stressing the potential benefit of real-time continuous kidney monitoring. There are, however, some important points of concern.

First, the authors found that mean urinary oxygen partial pressure threshold of 25 mmHg was associated with severe AKI. But the relationship between urinary oxygen partial pressure and the subsequent development of AKI might be more of a cumulative exposure response than a single threshold. A threshold of mean urinary oxygen partial pressure could not be used to elucidate the association between oxygen partial pressure in the urine and AKI. Maybe characterizing the hypo-urinary oxygen partial pressure exposure by time under the 25 mmHg threshold would be preferable.

Second, some variables that might affect the monitor accuracy of urine oximeter were not mentioned in the study. For example, loop diuretic of Henle can cause oxygen partial pressure in the urine to rise, but vasopressin (*i.e.*, norepinephrine) can result in a reduction of urinary oxygen partial pressure.[2]

In short, I appreciate Silverton and colleagues for their great contributions to this important topic.

Competing Interests

The author declares no competing interests.

Dong Xu Chen, Ph.D. West China Hospital, Sichuan University, Chengdu, China. scucdx@foxmail.com

DOI: 10.1097/ALN.0000000000004113

References

1. Silverton NA, Lofgren LR, Hall IE, Stoddard GJ, Melendez NP, Van Tienderen M, Shumway S, Stringer BJ, Kang WS, Lybbert C, Kuck K: Noninvasive urine oxygen monitoring and the risk of acute kidney injury in cardiac surgery. Anesthesiology 2021; 135:406–18
2. Lankadeva YR, Kosaka J, Evans RG, Bailey SR, Bellomo R, May CN: Intrarenal and urinary oxygenation during norepinephrine resuscitation in ovine septic acute kidney injury. Kidney Int 2016; 90:100–8

(Accepted for publication December 10, 2021. Published online first on January 20, 2022.)

Urine Oxygen Monitoring in Cardiac Surgery: Reply

In Reply:

We thank Dr. Chen[1] for his interest in our pilot study determining the feasibility of real-time noninvasive urine oxygen measurements in cardiac surgery patients.[2] The device we investigated was a brand-new technology measuring urine oxygen outside of the body at the distal end of the urinary catheter. We chose to describe a measure of central tendency (mean urine oxygen values) because there were no previous studies to suggest an optimal threshold of urine oxygen measurements using this novel device. The threshold of 25 mmHg reported in our study was exploratory and should be validated in future work. One excellent way to do this, as suggested by Dr. Chen, would be to test the hypothesis that cumulative exposure to urinary hypoxia below this threshold is associated with increased risk of postoperative acute kidney injury.

For comments regarding variables that might affect the accuracy of urine oxygen monitoring, we agree that loop diuretics may affect urine oxygen measurements. We stated in our Methods that no diuretics other than mannitol were administered during surgery.[3] We did investigate the effect of mannitol on urine oxygen measurements and found that there was no significant difference in urine oxygen between patients who did receive mannitol and those who did not. This may be because mannitol is an osmotic diuretic and therefore does not directly affect energy-consuming ion

transport in the renal tubule. Alternatively, it might be because the doses of mannitol we used were relatively low (12.5 to 25 g). Larger studies and animal models may help elucidate the effects of various types of diuretics as well as vasoactive agents on real-time urine oxygen monitoring.

Research Support

This work was supported in part by the University of Utah Department of Anesthesiology Research Council (Salt Lake City, Utah); a University Technology Acceleration Grant from the Utah Science, Technology, and Research Initiative (USTAR; Salt Lake City, Utah); and a career development award from the National Center for Advancing Translational Sciences of the National Institutes of Health (Bethesda, Maryland) under Award Number UL1TR002538 and KL2TR002539. These organizations were not involved in study design, analysis, interpretation, or manuscript creation.

Competing Interests

Drs. Silverton and Kuck are inventors on a patent application for the urine oxygen and flow sensing technology. This prototype is under development for commercial consideration but as of yet no commercial activity has occurred. This work was performed under a conflict of interest management plan approved by the University of Utah Conflict of Interest Office (Salt Lake City, Utah). This included disclosure of conflict of interest to patients and collaborators and an independent peer review of the data analysis. Dr. Hall declares no competing interests.

Natalie A. Silverton, M.D., F.R.C.P.C., F.A.S.E., Isaac E. Hall, M.D., M.S., Kai Kuck, Ph.D. University of Utah, Salt Lake City, Utah (N.A.S.). natalie.silverton@hsc.utah.edu

DOI: 10.1097/ALN.0000000000004114

References

1. Chen DX: Urine oxygen monitoring in cardiac surgery: Comment. Anesthesiology 2022; 136:662
2. Silverton NA, Lofgren LR, Hall IE, Stoddard GJ, Melendez NP, Van Tienderen M, Shumway S, Stringer BJ, Kang WS, Lybbert C, Kuck K: Noninvasive urine oxygen monitoring and the risk of acute kidney injury in cardiac surgery. Anesthesiology 2021; 135:406–18
3. Tolley PM, Purcell A, Bolsin SN: Effect of i.v. furosemide on pelvic urinary oxygen tension in humans. Br J Anaesth 1999; 83:328–9

(Accepted for publication December 9, 2021. Published online first on January 20, 2022.)

One Thousand Words...

To the Editor:

Thank you for the vivid cover art from Maria Koijck and Eva Glasbeek[1] that accompanied the pair of environmental pieces from McGain *et al.*[2] and Struys and Eckleman[3] in the December 2021 issue. While the discussion in the article[2] and editorial[3] of the carbon footprint of anesthesia help contextualize this issue, this cover art drives home the message in a striking fashion. Work such as McGain's needs to be done to assess and document the impact of our current healthcare practices. Further work in this area must follow, expanding to consider better practices. Naturally, this must be done in partnership with our surgery and nursing colleagues. Hospital administrators, too, have an interest due to the cost and local regulations regarding recycling and waste management. McGain's work is a phenomenal first step. Without actual knowledge, we will not know how to improve care for patients and the environment. However, if the world's response to viruses and vaccines are any proof, many people struggle to comprehend scientific information. Thus, images like that on the December cover, which quickly conveys the heart of both McGain's and Struys' writing, are more than just welcomed: they are crucial. Visual media have been powerful agents of change in the past: recall the crying American Indian advertisement of the 1970s or the egg-and-skillet antidrug campaign of the 1980s. Koijck, laying in the epicenter of a circle of waste products, communicates our dilemma: the amount of waste from this single operation is staggering. It's hard to imagine the amount of daily waste our operating rooms create. This image transitions from the personal to the wider situation. Images work quickly and can elicit emotive responses. For better or for worse, our world often responds more to images than to nuanced writing. Thus, while research and articles are paramount, a cover like this is a wonderful adjunct for promoting the message. Please continue to utilize art in the Journal!

Research Support

Support was provided solely from institutional and/or departmental sources.

Competing Interests

Dr. Hester reviews some submissions to the *Mind to Mind* section of Anesthesiology. The author declares no competing interests.

Douglas L. Hester, M.D., M.F.A. Vanderbilt University Medical Center, Nashville, Tennessee. doug.hester@vumc.org

DOI: 10.1097/ALN.0000000000004131