Hiroyuki Kinoshita MD PhD
 Tetsuya Kakutani MD
 Kazuhiro Mizumoto MD PhD
 Yoshio Hatano MD PhD
 Wakayama Medical University, Wakayama, Japan
 E-mail: hkinoshi@pd5.so-net.ne.jp

References

- 1 Muraki K, Nakagawa H, Nagano N, et al. Effects of ONO-1101, a novel beta-antagonist, on action potential and membrane currents in cardiac muscle. *J Pharmacol Exp Ther* 1996; 278: 555–63.
- 2 Sasao J, Tarver SD, Kindscher JD, Taneyama C, Benson KT, Goto H. In rabbits, landiolol, a new ultra-short-acting beta-blocker, exerts a more potent negative chronotropic effect and less effect on blood pressure than esmolol. *Can J Anesth* 2001; 48: 985–9.
- 3 Yamazaki A, Kinoshita H, Shimogai M, et al. Landiolol attenuates tachycardia in response to endotracheal intubation without affecting blood pressure. *Can J Anesth* 2005; 52: 254–7.
- 4 Nishina K, Mikawa K, Yonemoto Y, Sugimoto Y. The efficacy of bolus administration of landiolol for attenuating tachycardia in pheochromocytoma. *Anesth Analg* 2004; 98: 876–8.

Mean arterial blood pressure estimation and its limitation

To the Editor:

Mean arterial blood pressure (MAP) has clinical and physiologic significance in both the representation of perfusion pressure and its utilization in the calculation of hemodynamic variables. The accurate MAP is defined as the zero frequency (direct current) component following Fourier analysis of the arterial waveform,¹ or as the time-weighted integral of the instantaneous pressures derived from the area under the curve of the pressure-time.² However, clinicians have yet to find an easier way that may be applied in clinical practice. Some researchers continue to investigate more accurate MAP estimation methods.^{2–4}

Even though we sometimes forget the limitations in using these equations,⁵ we should keep in mind that they will not have the same MAP if they have different arterial pressure waveform morphologies, no matter what are the causes of the differences.¹ The following is an example.

We analyzed a patient's direct arterial blood pressure data, which was continuously checked by an anesthesia monitor, sampled at 250 Hz, and stored in

FIGURE Different mean arterial pressures (MAP) of one patient. The X-axis is arbitrary time; the Y-axis is blood pressure in mmHg. Both readings have the same systolic and diastolic pressures, but have a 10 mmHg difference in MAP.

a computer through analogue output. The data length was about one hour. We divided the data in two-second intervals, so the total data sections numbered around 1,800. In each section, we calculated the mean using the Fourier transformations by a computer software program (Matlab®, Natick, MA, USA). The maximum difference of MAP within the same systolic arterial pressure and diastolic arterial pressure pairs was sought. We then compared the two waveforms with the maximum MAP difference. The MAP differences were originated mainly from, in my case, an early reflected wave (Figure). However, there may be other sources of waveform differences, for example, the existence of a dicrotic notch, high inotropic pressure pulse,⁶ and a double dicrotic notch.

As clinicians, we need an easily calculable determinant of MAP, but we should understand its limitations as applied to clinical practice, especially where the arterial waveform could be different from the one used to derive the simplified equation. Factors which may alter arterial waveform, and hence MAP determination include increasing age, atherosclerosis, and changes in blood volume status.

Wonsik Ahn MD
 Young Jin Lim MD
 Seoul National University Hospital, Seoul, South Korea
 E-mail: aws@snu.ac.kr

References

- 1 Poullis M. New formula to calculate mean aortic pressure? (Letter). *Lancet* 1999; 353: 2075.
- 2 Meaney E, Alva F, Moguel R, Meaney A, Alva J, Webel R. Formula and nomogram for the sphygmomanometric calculation of the mean arterial pressure. *Heart* 2000; 84: 64.
- 3 Chemla D, Hebert JL, Zamani K, Coirault C, Lecarpentier Y. A new formula for estimating mean aortic pressure. *Lancet* 1999; 353: 1069–70.
- 4 Razminia M, Trivedi A, Molnar J, et al. Validation of a new formula for mean arterial pressure calculation: the new formula is superior to the standard formula. *Catheter Cardiovasc Interv* 2004; 63: 419–25.
- 5 Chemla D, Hebert JL, Zamani K, Coirault C, Lecarpentier Y. Estimation of mean aortic pressure (Letter). *Lancet* 1999; 354: 596.
- 6 Murray, WB, Gorven, AM. Invasive v. non-invasive blood pressure measurements -- the influence of the pressure contour. *S Afr Med J* 1991; 79: 134–9.

Continuous renal replacement therapy

To the Editor:

We read the article by Jacka *et al.*¹ with interest. This manuscript is provocative and novel but raises potentially significant methodological questions.

First, the issue of crossovers between treatment groups makes it difficult to conclude which modality was responsible for favourable or adverse outcomes. Was continuous renal replacement therapy (CRRT) still associated with better renal recovery if only patients treated with a single modality were included?

Second, comparing renal recovery in survivors is of questionable validity as the sole renal outcome. Specifically, the “advantage” of CRRT was observed only after excluding those who died – and as Jacka *et al.* note, death in the intensive care unit (ICU) was significantly more frequent in the CRRT group. Since death and dialysis-dependence are competing risks, the composite of both outcomes would seem more appropriate. This outcome does not appear to significantly differ between the two modalities, which is unsurprising. Although the largest randomized study to date actually showed significantly increased in-hospital mortality due to CRRT use,² this may not have resulted from the effect of treatment per se. As noted by Jacka *et al.* in their article, the underlying illness probably influences prognosis to a far greater extent than the dialytic modality.

Third, impaired kidney function at baseline is strongly associated with the need for chronic dialysis in

people with acute renal failure.³ In the study by Jacka *et al.*, patients who received intermittent hemodialysis (IHD) had significantly higher serum creatinine at ICU admission, suggesting that they were more likely to have pre-morbid chronic renal insufficiency. Unfortunately, analyses evaluating renal recovery by treatment modality did not control for this difference, which may have influenced the findings.

Finally, a pooled analysis of four randomized studies including more than 400 patients showed no renal benefit of CRRT (and a slight trend towards harm).⁴ Although meta-analysis has its limitations, none of the four included studies showed a renal benefit of CRRT. Jacka *et al.* do not discuss why their retrospective study might differ from the available randomized trials. We speculate that the discrepancy is due to bias resulting from the non-randomized design.

Multiple non-randomized studies over the last 20 years have been used to support the theoretical benefits of CRRT, and to justify its higher costs. However, randomized studies have not demonstrated that CRRT is superior. Even for surrogate outcomes such as intradialytic hypotension, no good quality data support the use of this indisputably more expensive treatment.

We agree with Jacka *et al.* that larger randomized trials should be performed, but respectfully disagree that their article helps to inform debate in the interim. Since the best available data do not indicate that dialytic modality influences outcome in critically ill patients, we suggest that the least costly therapy should be used until new randomized trials demonstrate otherwise.

Marcello Tonelli MD SM*

Braden Manns MD MSc†

Neesh Pannu MD*

Scott Klarenbach MD MSc*

Kailash Jindal MD*

University of Alberta,* Edmonton, Canada

University of Calgary, Calgary,† Canada

E-mail: marcello.tonelli@ualberta.ca

References

- 1 Jacka MJ, Ivancinova X, Gibney RT. Continuous renal replacement therapy improves renal recovery from acute renal failure. *Can J Anesth* 2005; 52: 327–32.
- 2 Mehta RL, McDonald BR, Babbai FB, et al. A randomized clinical trial of continuous versus intermittent dialysis for acute renal failure. *Kidney Int* 2001; 60: 1154–63.
- 3 Silvester W, Bellomo R, Cole L. Epidemiology, management, and outcome of severe acute renal failure of