

LETTER

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Indirect calorimetry is the gold standard to assess REE in ICU patients: some limitations to consider

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In their meta-analysis, Duan et al. address the role of indirect calorimetry (IC) in nutritional therapy in critically ill patients [1]. Their findings support using IC rather than predictive equations as the gold standard to assess resting energy expenditure (REE) [1]. Previous studies have demonstrated the low accuracy of various REE predictive equations based on weight, height, age, gender, etc. [1]. Despite adjustments according to patient population and other modifying factors, REE discrepancies remain, (with variations up to 60%) [1]. IC allows for the measurement of VO₂ and VCO₂ through the ventilator and is the gold standard method for measuring REE in ICU, when ideal test conditions are implemented [1]. Both the European (ESPEN) and American (ASPEN) clinical practice guidelines recommend the use of IC to measure REE [2]. While supporting the use of IC in some settings, we wish to point out a number of limitations, particularly when patients are undergoing continuous renal replacement therapy (CRRT) [3] and extracorporeal membrane oxygenation (ECMO) [4, 5]. Estimating REE using IC in CRRT patients is less reliable for several reasons [3]. First, CO₂ from bicarbonate-based dialysate can pass the filter and circulate in the form of dissolved CO₂, bicarbonate,

or carbamino compounds in red blood cells or plasma [3]. Though a quantity of CO₂ may be removed in the effluent [3], a recent study showed that CO₂ removal by CRRT led to a minimal change of 3% of measured EE [3]. Second, patients may experience heat loss up to 1000 kcal during CRRT, resulting in increased metabolism and REE [3]. Third, dialysate compositions and citrate also contribute to caloric uptake [3]. For all these reasons, IC remains less reliable during CRRT and more research should shed light [3]. This is also true for IC performed in patients on ECMO, unless a mathematical correction is applied [3]. It is important that clinicians are aware not only of the indications for IC, but also its limitations. [3]. Other technical limitations of IC in ICU are discussed in a comprehensive review to which readers should refer [5].

Response to the letter to the editor: "Using indirect calorimetry in place of fixed energy prescription was feasible and energy targets were more closely met: do not forget an important limitation"

Hui-Bin Huang, Jing-Yi Duan, Yuan Xu and Hua Zhou

We thank Professor Honore et al. for their interest in our meta-analysis [1]. Our study identified 8 RCTs and demonstrated that compared with predictive equations, indirect calorimetry (IC) guided energy delivery can significantly reduce short-term mortality in critically ill

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patients without affecting other important clinical outcomes such as hospital stay and mechanical ventilation.

We fully agree with what Professor Honore and colleagues pointed out that clinicians need to understand not only indications of IC but its limitations [6]. Especially, Professor Honore highlighted that the use of IC might be unreliable in patients undergoing continuous renal replacement therapy (CRRT) and extracorporeal membrane oxygenation (ECMO). Indeed, although all included RCTs in our meta-analysis provided detailed IC indications, only two trials had excluded patients receiving CRRT, and no trials reported having excluded patients with ECMO [1].

Cardiopulmonary bypass can remove part of VCO₂, which is considered the most important technical factor affecting the reliability of IC measurement [6]. However, this does not mean that patients who receive CRRT or ECMO are bystanders of the IC technique. In a monocentric, controlled, prospective, observational pilot study, Wollersheim, and colleagues proposed measuring the reliability of energy expenditure (EE) in extracorporeal lung support patients by calculating the O₂ uptake and the CO₂ elimination by the ECLS membrane, then using sum O₂ uptake and CO₂ elimination in the equation of Weir to calculate EE [7].

Although CRRT may be more complicated due to factors such as replacement fluid, Jonckheer et al. proposed a simple blood gas analysis based on the circuit to quantify CO₂ that was removal during continuous venovenous hemofiltration. In their study, the CO₂ content in ultrafiltration is available by blood gas analysis, and the CO₂ content is converted from mmol/L to mL with the help of the ideal gas law ($pV = nRT$). The authors performed IC in 4 different states (baseline, high dose, baseline with NaCl predilution and without CVVH) and found that CO₂ removal by CVVH led to a change in REE of only 3%, which makes a correction factor unnecessary in this setting [8]. Although the authors believed that citrate might be the only factor that significantly changes metabolism out of all the potential metabolic influences during CVVH, they also admitted that this required further research [8].

Abbreviations

IC: Indirect calorimetry; REE: Resting energy expenditure; ICU: Intensive care unit; ESPEN: European society for parenteral and enteral nutrition; ASPEN: American society for parenteral and enteral nutrition; CRRT: Continuous renal replacement therapy; ECMO: Extracorporeal membrane oxygenation; CRRT : Continuous renal replacement therapy; ECMO: Extracorporeal Membrane Oxygenation; IC: Indirect calorimetry; REE: Resting energy expenditure; RCTs: Randomized controlled trials.

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Competing interests

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