Correspondence

Risk factors associated with acute kidney injury in a cohort of 20,575 arthroplasty patients

Sir,—With interest we read the article of Jämsä et al. (Acta Orthop 2017; 88:3 70-6) assessing risk factors associated with postoperative acute kidney injury (AKI) in 20,575 arthroplasty patients. By multivariable logistic regression analysis, they show that preoperative estimated glomerular filtration rate, ASA classification, body mass index, and duration of operation are independent risk factors for AKI. Strengths of this study are a large sample and its use of appropriate statistical methods to identify risk factors of postoperative AKI. However, this study is a retrospective analysis, which potentially introduces a number of confounding variables. Other than the limitations described in the discussion, we note other issues of this study making interpretation of their results questionable.

First, the mean age of patients included in this study was 69 years, but perioperative albumin levels were not included in patients' data. The available evidence indicates that preoperative hypoalbuminemia is associated with AKI after noncardiac surgery (Kim et al. 2013). Furthermore, early postoperative albumin level < 3.0 g/dL is an independent risk factor for AKI in patients undergoing total knee arthroplasty (Kim et al. 2016).

Second, the readers were not provided with intraoperative risk factors affecting the occurrence of postoperative AKI. It has been shown that both vast blood loss and massive blood transfusions during surgery are independent risk factors of AKI after noncardiac surgery (Kheterpal et al. 2007). Furthermore, intraoperative hypotension, use of noradrenaline and low urine output are independently associated with increased risk of postoperative AKI (Sun et al. 2015). Actually, even short duration of an intraoperative mean arterial pressure < 55 mmHg can result in postoperative AKI, with an independent graded relationship between duration of intraoperative hypotension and postoperative AKI (Walsh et al. 2013a). Especially, combination of intraoperative anemia, transfusion and hypotension can synergistically act to increase the risk of postoperative AKI (Sun et al. 2015).

Third, other than preoperative anemia, postoperative anemia is also strongly associated with AKI after noncardiac surgery. Compared with patients who do not have a decrease in postoperative hemoglobin, a decrement of 1.1 to 2.0 g/dL is associated with an adjusted hazard ratio of 1.5 (95% CI, 1.2–2.0), and a decrement of > 4.0 g/dL with an hazard ratio of 4.7 (95% CI, 3.6–6.2) for AKI (Walsh et al. 2013b).

It must be emphasized that a limitation of multivariable logistic regression analysis is the assumption of a particular mathematical relation between intervention and measured outcome. To obtain the true inferences of multivariable logistic regression analysis for adjusted hazard ratios of measured outcome, all of known risk factors affecting measured outcome must be taken into account within the model. If an important risk factor is missed, the multivariate adjustment for hazard ratios of measured outcome can be biased and even a spurious association between intervention and outcome of interest may be obtained (Xue et al. 2017). Thus, we argue that not taking the above intraoperative and postoperative risk factors into account would have tampered with the inferences of multivariable logistic regression analysis for risk factors of postoperative AKI.

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Sir,—Yang et al. bring up some risk factors that have been shown to be associated with postoperative AKI in non-cardiac patients. They claim that not taking these factors into account would compromise our results. In their opinion, our multivariable model is biased, as we did not adjust it for preoperative hypoalbuminemia, blood loss, blood transfusions, intraoperative hypotension, use of noradrenaline, low urine output, and postoperative anemia. Due to the retrospective nature of our study, we did not report any of these in our article. Yang et al. suggest that our multivariable analysis should be performed adjusting with all known risk factors including the factors they introduced. However, we have used a different strategy to minimize bias and we think that lack of above-mentioned mainly intraoperative factors does not bias our results.

Our multivariable model was built with an aim to define, whether duration of the operation had any effect to incidence of AKI. We created a directed acyclic graph as a tool to pick correct variables to the multivariable model to minimize bias.

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It is known that the preferred strategy for multivariable modelling is not taking all possible factors causing outcome but rather avoiding conditional associations (Greenland et al. 1999, Shrier et al. 2008).

Concerning the specific factors that Yang et al. suggested should be included in our model, we would like to make the following remarks.

Preoperative hypoalbuminemia is not related to duration of the operation and therefore it should not be added to our model.

In our experience, most of the bleeding in hip or knee arthroplasty arises from the bone marrow and trabecular bone after bone resections, not from muscular or subcutaneous tissues. Subcutaneous or muscular tissue bleeding is rarely massive and hemostasis for this tissue is usually occurs quickly and therefore only small volume is lost. However, the bone resection bleeds more and most of this bleeding ceases when components are placed. While bleeding from the bone does not increase duration of the operation, however, prolonged operation can cause more bleeding and blood transfusions. Adjustment with a factor that is in the causal path would have biased our results (Schisterman et al. 2009).

In our opinion, intraoperative hypotension, which is an anesthesiological problem, does not increase the duration of arthroplasty (incision to closure time) and therefore it is unnecessary to make adjustments with hypotension or use of vasoactive agents in order to define if duration of the operation is a risk factor for AKI.

Low urine output does not cause AKI, but AKI itself, vice versa, causes low urine output and therefore it is not meaningful to adjust the model with consequence of our outcome (low urine output).

Postoperative anemia might be caused be prolonged operation (see above) but definitely postoperative anemia does not have effect on duration of the operation. Therefore it is unnecessary to make adjustments with it in our model.

In conclusion, although hypoalbuminemia, blood loss, blood transfusions, intraoperative hypotension, use of noradrenaline, low urine output, and postoperative anemia are risk factors for AKI, adding these to our multivariable model would have introduced more bias into our analysis. Thus, we think that we have used sound methods and provided the reader with valid results concerning the risk factors for AKI after hip and knee arthroplasty.

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