Non-invasive hemoglobin measurement by Masimo Radical-7™ pulse co-oximeter in patient undergoing orthotopic liver transplantation

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Background

Due to large fluid volume shift or blood loss may occur during liver transplantation surgery, rapid and accurate monitoring hemoglobin level and making decision of blood transfusion is important for anesthesiologist.

Masimo Radical-7™(Rad-7™) pulse co-oximeter is a noninvasive continuous hemoglobin(Hb_{Ni}) monitoring device, which has been reported accurate in health adults, but might be less accurate in patient with shock, hypothermia or vasoconstriction. Current data of its application in liver transplantation surgery are still limited. **This study is to evaluate the accuracy of hemoglobin measurement by Masimo Rad-7™ in patient undergoing orthotopic liver transplantation.**

Methods and Materials

From 2013/12 to 2017/01, Thirty-five patients undergoing orthotopic liver transplantation were enrolled. Noninvasive Hb (Hb_{Ni}), gas analyzer Hb (Hb_{Gas}) and central laboratory Hb (Hb_{Lab}) were measured every hour during the whole period of surgery.

The relationship between Hb_{Gas} , Hb_{Ni} and Hb_{Lab} was assessed using a 4-quadrant plot, linear regression, and modified Bland-Altman analyses.

Figure 1. Bland-Altman plots for Hb_{Ni}/Hb_{Lab} and Hb_{Gas}/Hb_{Lab} LoA, Limits of agreement

Results

232 and 284 paired measurements of Hb_{Ni}/Hb_{Lab} and Hb_{Gas}/Hb_{Lab} were obtained. The correlation coefficient between Hb_{Ni} and Hb_{Lab} was 0.616 ($p < 0.0001$), and between Hb_{Gas} and Hb_{Lab} was 0.847 ($p < 0.0001$).

Bland-Altman plots for Hb_{Ni} and Hb_{Gas} compared to Hb_{Lab} are depicted in Figure 1. Compared to Hb_{Lab} , **the mean bias $\pm$ SD and 95% limits of agreement was 1.97 ± 1.59 g/dL and -1.1 to 5.1 for the noninvasive Hb, 0.39 ± 0.89 g/dL and -1.4 to 2.1 for the gas analyzer Hb.**

Four-quadrant plots are depicted in Figure 2. **The concordance rate (a measure of the number of data points in 1 of the 2 quadrants of agreement) of Hb_{Ni}/Hb_{Lab} and Hb_{Gas}/Hb_{Lab} was 75% and 83.4% with a central exclusion zone of 0.5 g/dL.**

Figure 2. The concordant rate between Hb_{Lab} and Hb_{Ni} was 75%. The value of ΔHb_{Lab} and ΔHb_{Gas} means the difference between each measurement.

Conclusions

We found that hemoglobin noninvasively obtained by the Masimo Radical-7™ system overestimated the standard value by the central laboratory in patients undergoing orthotopic liver transplantation.

Hemoglobin level obtained from gas analyzer has less bias and better concordance rate than from Masimo Radical-7™ system. It is not clinically acceptable to make a decision of transfusion based on the noninvasive hemoglobin measurement. However, there is an acceptable reliability in tracking changes in intraoperative hemoglobin levels. Because the liver transplantation is a time-consuming procedure, the Masimo Radical-7™ system could still provide potential clinical values in continuous monitoring intraoperative changes of serum hemoglobin levels.

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