Reply to: "The Balance of Risk Score for Allocation in Liver Transplantation"

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Reply to Letter: "The Balance of Risk Score for Allocation in Liver Transplantation"

***Reply*:**

We read with great interest the letter by Jochmans et al regarding the application of our recently developed balance of risk (BAR) score to predict outcome of individual patients after liver transplantation. The BAR score was developed with the availability of the large UNOS database after implementation of the model for end stage liver disease (MELD) system.[1] Our goal was to develop an easily applicable and reliable formula to balance the risks of transplantation combining specific graft characteristics with a particular recipient. We included 6 independent key factors, 2 for the donors and 4 for the recipients; all available at the time of organ allocation.

We are pleased that the Leuven's group could validate our results in their own population. Data from liver transplant centers in Leuven (Belgium), Zurich (Switzerland), and the United States[1] corroborate that a cutoff at the BAR score of 18 is highly discriminative for post–liver transplant survival (Table 1). Importantly, the recipient laboratory MELD score alone, at the time of transplantation, is not predictive (Table 1). These results are also consistent with a recent analysis using the European Liver Transplant Registry.[2]

The authors emphasize the relatively weak c-statistic of 0.7 for the BAR score targeting 3-month recipient survival. They speculate that the combination of only 6 variables results in moderate predictive accuracy for posttransplant survival. We would like to address these comments:

First, the limited accuracy of the BAR score of more than 18 is due to the low sensitivity despite an impressive specificity of 98%. Such high specific test is unlikely to give a false-positive result; in other words, any donor-recipient combination with a BAR score of more than 18 is exposed to a high likelihood for posttransplant mortality. On the contrary, the low sensitivity of BAR means that a negative result (BAR score $\leq$18) does not guarantee the absence of mortality. This drawback likewise relates to additional major confounders, such as the underlying disease, hepatitis C, or hepatocellular carcinoma.

Second, although the inclusion of more factors may intuitively seem advantageous, an appealing formula has not yet been identified. The inclusion of more variables, for example, with the SOFT model (18 factors included),[3] failed to improve c-statistics. Rather, the SOFT model is regarded as disadvantageous because of more heterogeneity of variables and less practicability.[4]

Third, other prediction models, such as the D-MELD,[5] or the donor risk index,[6] showed even inferior c-statistics as compared with the BAR.[1] Finally, additional graft risk factors, such as hepatic macrosteatosis of more than 30% or donor warm ischemia, may require a shift of the BAR score threshold from 18 to 9 to avoid wasteful transplantation.[2]

In summary, the BAR score is currently the most reliable and easiest applicable score to predict poor outcome after liver transplant. Future analysis will show whether respecting BAR cutoffs can improve collective survival benefit.

TABLE 1. Patient Outcome According to MELD and BAR

	Leuven, 2000–2010 (n = 552) (Jochmans et al)	Zurich, 2003–2012 (n = 324)	UNOS,[1] 2002–2010 (n = 37,255)	ELTR,[2] 2007–2010 (n = 11,942)
Median laboratory MELD score (IQR)	15 (11–22)	19 (10–29)	18 (14–27)	16 (11–23)
1-yr survival				
Laboratory MELD score <30	89%	84%	88%	86%
Laboratory MELD score ≥30	85%	79%	83%	73%
BAR score 0–18	90%	88%	88%	86%
BAR score >18	78%	48%	71%	67%
5-yr survival				
Laboratory MELD score <30	73%	75%	73%	75%
Laboratory MELD score ≥30	77%	67%	62%	60%
BAR score 0–18	75%	80%	72%	73%
BAR score >18	**47%**	**40%**	**42%**	**44%**

ELTR indicates European Liver Transplant Registry; IQR, interquartile range; MELD, model for end stage liver disease.

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