



What is the quantity of Oxygen added to the perfusate in NMP?

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Introduction

NMP is one of the ex-situ perfusion protocols established for the recovery and the treatment of grafts for transplantation. In the current practice, NMP is performed recirculating a perfusate at 37°C from and towards the organ to be transplanted, providing the proper grafts' metabolic support by oxygen, nutrients and/or drugs administration. As NMP simulates the in-body environment the metabolic rate of the graft is the near-physiological one. This is the main reason why the NMP perfusate needs to be added with oxygen carriers such as packed red blood cells (RBCs). The aim of this report is to characterize the oxygen content [O₂] (mg/L; ml/L) in NMP perfusate.

Methods

We characterized: the state of art of perfusate compositions reported for NMP perfusions, focusing mainly on liver and kidney protocols; the relationship between [O₂] and the main components of the perfusate, the [O₂] associations with environment conditions (pO₂, Temperature (T)). We defined the [O₂] resulting in the most commonly used perfusate compositions.

Results

Overall NMP protocols report the use as RBCs as source of oxygen carriers (hemoglobin (Hb)). With this type of perfusate, considering the Hb-O₂-binding properties, 98% of O₂ is transported by Hb, while 2% is dissolved in the perfusate. Considering 2.2 L of NMP perfusate with Hb < 5 g/dL, resulting in total volume <133,2 mL O₂ when Hb is 98% saturated.

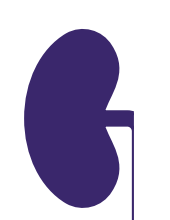
$$[O_2] = (Hb * 1,36) (SO_2/100) + PaO_2 * 0,0031$$

$$Mass_{O_2} = Q_{sol} * [O_2]$$

The amount of O₂ delivered to the organ

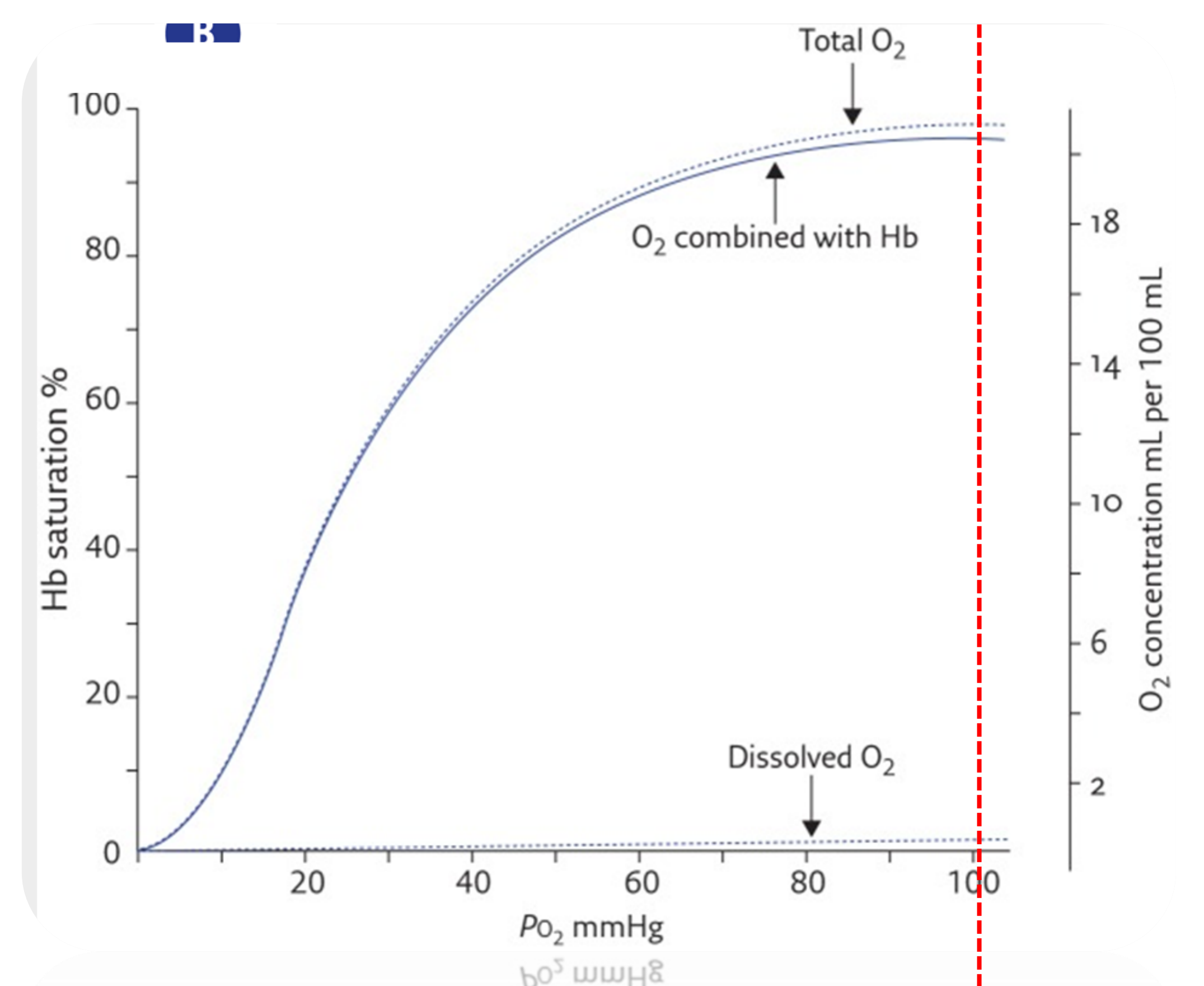
Perfusate Flow ml/min

O₂ content in the perfusate mlO₂/ml
98% Hb bonded
2% Dissolved

 10,2 mlO₂/min

 30,8 mlO₂/min

The amount of O₂ in NMP perfusate is mainly depending on the quantity O₂-carrier content in the liquid and on how much this carrier is saturated. Over-physiological pO₂ do not significantly contribute to increase O₂ as the Hb is fully saturated at pO₂ =100-110 mmHg.



At constant T=37°C, Hb results fully (>98%) saturated at pO₂=100-110 mmHg

Conclusions

pO₂ revealed not to be the crucial parameter for O₂ content regulation above 100-110 mmHg. The limiting factor is Hb content in the perfusate. We demonstrated that the highest O₂ delivered is by keeping pO₂ at 100-110 since below this threshold Hb is not saturated and above it reaches a plateau.