

Rationale of goal directed therapies in children

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Abstract

Editorial highlighting the rationale of goal directed therapies (GDT) in children.

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Editorial

A Thesis entitled ‘Do goal directed therapies improve post-operative outcome in children?’

(Perioperative Goal Directed Fluid and Hemodynamic Therapy; Transfusion goal directed therapy using viscoelastic methods and enhanced recovery after surgery and Post-operative outcome)’ is in preparation [1].

The objective of this Thesis is to demonstrate the impact of goal directed therapies on post-operative outcome in pediatric surgical patients. The hypothesis of this Thesis is by optimizing fluid and hemodynamic therapy, transfusion with viscoelastic methods and applying enhanced recovery after surgery protocols, post-operative outcome in terms of morbidity will be improved.

Goal Directed Therapies (GDT) englobe three entities [2,3]:

- 1) Goal Directed Fluid and Hemodynamic Therapy with echocardiographic parameters validated and to be validated in children.
- 2) Transfusion Goal Directed Protocols with viscoelastic methods in potential pediatric hemorrhagic surgery.

- 3) Enhanced recovery after surgery in children.

These Goal Directed Therapies share the same objective which is to improve post-operative morbidity in pediatric surgical patients. Post-operative morbidity includes post-operative complications which can occur post-operatively after surgery and which can be avoided, reduced and improved with optimal perioperative management.

There is a common rationale to these GDT [4]. This common rationale is the optimization of tissular oxygen consumption and oxygen delivery relationship. In this rationale, it is important to maintain an independent state between tissular oxygen consumption and oxygen delivery. When tissular oxygen consumption becomes dependent on oxygen delivery, organ dysfunction can occur [4]. Understanding the relationship between tissular oxygen consumption and oxygen delivery, the impact and importance of goal directed therapies on post-operative outcome become clear. Figure 1 illustrates the relationship between tissular oxygen consumption and oxygen delivery and the impact of sedation taken as exemple. The impact of GDT can have the same effect.

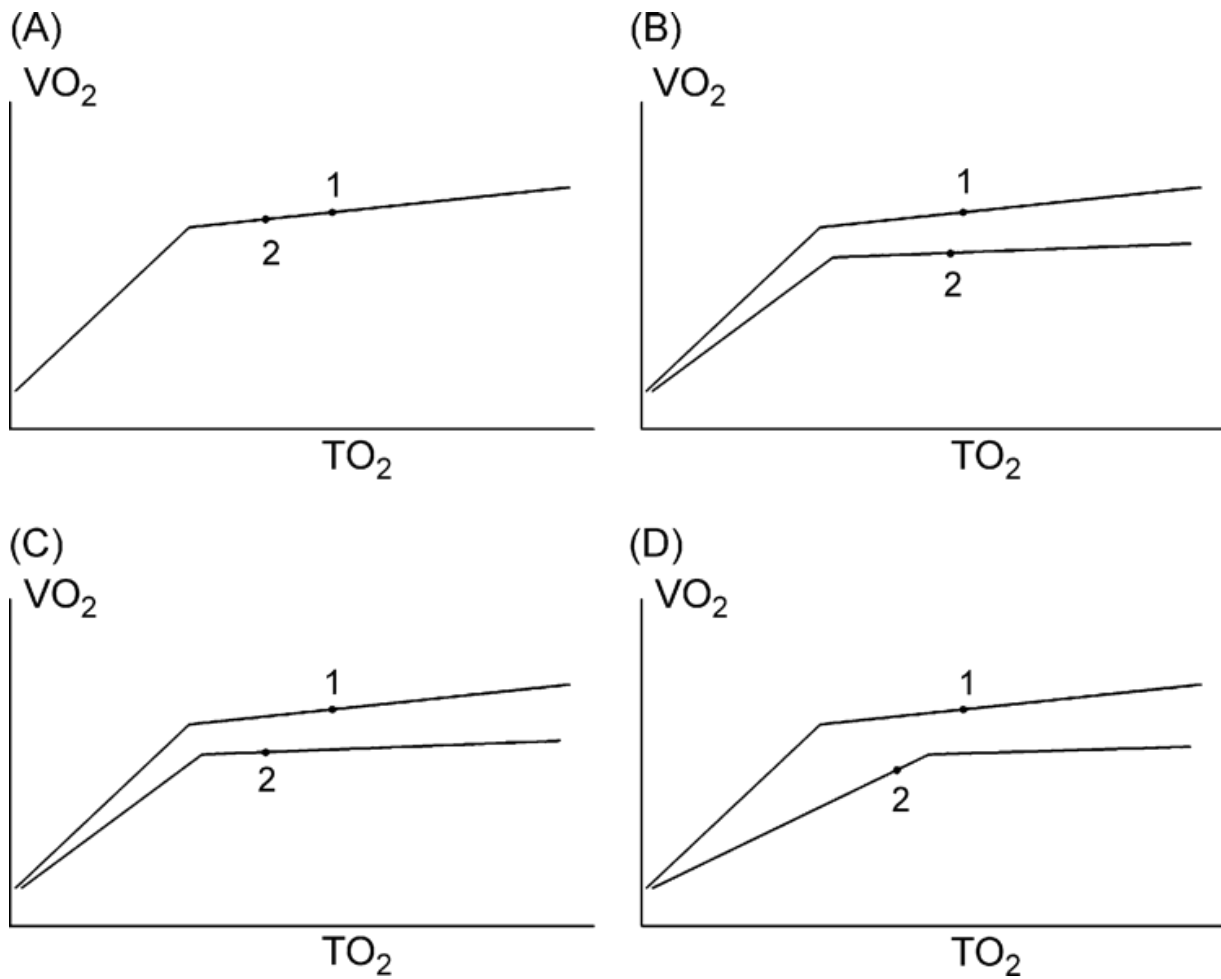


Figure 1. Illustration of possible effects of sedation on tissular oxygen balance. VO₂: Oxygen Consumption; TO₂:Oxygen Delivery. Point 1:Before sedation; point 2:After sedation. Panel A:decrease of TO₂ without effect on VO₂; potential deleterious effect if TO₂ decreases under critical TO₂. Panel B:Decrease of VO₂ without effect on TO₂; beneficial effect. Panel C: Decrease of VO₂ and TO₂; potential beneficial effect if the effect on VO₂ is higher than the effect on TO₂. Panel D:Decrease of VO₂ and TO₂; deleterious effect because the reduction of TO₂ induces a dependent state of VO₂ on TO₂. VO₂ is reduced below the metabolic demand and tissular hypoxia may occur with lactic acidosis. Illustration taken from ‘C. Kumba, P. Van der Linden Annales Françaises d’Anesthésie et de Réanimation 27(2008) 574–580)

The following formulas illustrate the rationale of GDT [4].

$$DO_2 = CO \times CaO_2 = CO \times (Hb \times 1.31 \times SaO_2 + 0.0031 \times PaO_2)$$

$$VO_2 = CO (CaO_2 - CvO_2)$$

$$CaO_2 = Hb \times 1.31 \times SaO_2 + 0.0031 \times PaO_2$$

$$CvO_2 = Hb \times 1.31 \times SvO_2 + 0.0031 \times PvO_2$$

$$O_2ER = \frac{CaO_2 - CvO_2}{CaO_2} = \frac{SaO_2 - SvO_2}{SaO_2}$$

$$SaO_2 = \frac{VO_2}{DO_2}$$

$$CO = SV \times HR = VTI \times D^2 \times \Pi / 4 \times HR$$

$$SV = \text{Aortic Velocity Time Integral} \times \text{area of the aortic valve} = VT \times D^2 \times \Pi / 4$$

$$PP = SVR \times CO$$

Where CO=Cardiac Output, SV=Stroke Volume, HR=Heart Rate, PP=Tissular Perfusion Pressure, SVR=Systemic Vascular Resistance, VTI=Aortic Velocity Time Integral, D=Diameter of the Aortic Valve, CaO₂=Arterial Oxygen Content, CvO₂=Venous Oxygen Content, Hb=Hemoglobin Levels, PaO₂=Arterial Oxygen Partial Pressure, PvO₂=Venous Oxygen Partial pressure, SaO₂=Arterial Oxygen Saturation, SvO₂= Venous

Oxygen Saturation, $O_2ER=Oxygen$ Extraction Ratio.

Table 1. Factors influencing determinants of DO_2 and VO_2 .

Determinants of DO_2	Determinants of VO_2	Influencing factors
CO	CO	Goal directed Fluid and hemodynamic therapy: Fluid therapy and or vasopressor-inotropic therapy
Hb	Hb	Transfusion Goal Directed Protocols
SaO_2	SaO_2	ERAS: Protective ventilation, oxygen therapy, physiotherapy, optimal pain therapy
PaO_2	PaO_2	ERAS: Protective ventilation, optimal oxygen therapy, physiotherapy, optimal pain therapy
	SvO_2	ERAS: Protective ventilation, optimal oxygen therapy, physiotherapy, optimal pain therapy, temperature, sepsis, stress
	PvO_2	ERAS: Protective ventilation, optimal oxygen therapy, physiotherapy, optimal pain therapy

In adults, GDT have shown their impact in terms of post-operative complications reduction [5-7]. In children the impact of goal directed fluid and hemodynamic therapy on post-operative outcome has not yet been demonstrated that is why it is important to conduct randomized controlled trials in the pediatric population for clarification [5]. Transfusion goal directed protocols with viscoelastic methods has shown reduction of fresh frozen plasma administration and length of hospital stay in pediatric hemorrhagic surgery [6]. A few retrospective and observational studies in pediatric surgery have demonstrated decrease in post-operative complications and length of hospital stay [7]. There are not yet randomized controlled trials to confirm these results in children. It is of great importance and interest to develop randomized controlled trials to confirm these data.

The first phase of the Thesis will focus on goal directed fluid and hemodynamic therapy [8], the second phase on transfusion guided protocols [9,10] and the third phase on enhanced recovery after surgery [11].

The first phase of the Thesis will concentrate on developing randomized controlled trials which will determine the impact of goal directed fluid and hemodynamic therapy on post-operative outcome in pediatric surgery [12-22]. The second and third phases will be completed later on because as

precised earlier these entire goal directed therapies share the same objectives and rationale. In order to determine the impact of each goal directed therapy on post-operative outcome each of them need to be evaluated separately. Having said this, goal directed fluid and hemodynamic therapy, transfusion goal directed protocols and enhanced recovery will have to be applied concomitantly in daily clinical practice to upgrade post-operative outcome in children. For obvious research and practical reasons, they need to be assessed separately in experimental protocols in order to determine the impact of each therapy on post-operative outcome.

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