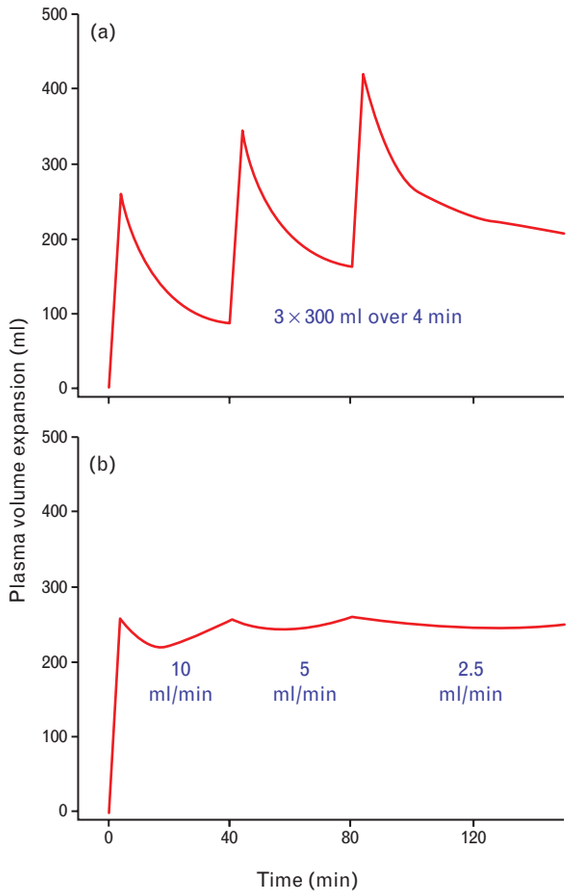
Fig. 1



Plasma volume expansion following three boluses of Ringer's solution infused with an interval of 40 min (a). The expansion resulting from the first bolus is maintained with a gradual step-down infusion (b). Computer simulation-based kinetic data from infusions of larger amounts of fluid during thyroid surgery.[3]

cast doubts over the relative potency of these fluids in several intensive care studies.[4]

When administering crystalloid as a bolus, clinicians must continue the infusion at a lower step-down rate to maintain the plasma volume expansion that has just been achieved (Fig. 1b). If not, the bolus infusion needs to be repeated much more frequently than with a colloid, since the latter lacks a redistribution phase and better remains in the circulation.

Clinicians apparently handle this issue by accepting a lower overall CI and giving bolus infusions more frequently, which was the also case in the László *et al.*'s study.[1] However, their bolus infusions were administered over a maximum of 15 min, which somewhat reduces the distribution effect. A shorter infusion time, which is more common, aggravates the problems associated with the redistribution phase.

I give those who advocate crystalloids the possibility that I am wrong in my scepticism. When urinary excretion is very prompt, as in well hydrated conscious volunteers, the infusion of a small amount of fluid does not always hydrate the interstitial fluid space because excretion may occur faster than the distribution.[5] This is unlikely during ongoing anaesthesia and surgery because urinary excretion is strongly inhibited in that setting (−90%).[2] Moreover, the results of László *et al.* indicate that their infusions were subject to distribution in the way I suspect.

My kinetic considerations are not unique for infusion fluids but pertain to all drugs with exponential distribution and elimination. Hence, a crystalloid fluid should be continued at a lower rate after a bolus infusion to achieve a stable plasma volume expansion profile similar to that of a colloid. Such a step-down is quite possible to perform, but never practiced as far as I know. This is the rationale behind my opinion that crystalloid fluids should be a second-choice for goal-directed therapy during surgery.

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Reply to: crystalloids should be second choice for goal-directed fluid therapy

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Editor,

We would like to thank Hahn[1] for his comments concerning our recently published trial on the effects

of goal-directed fluid therapy on microcirculation during free flap surgery.[2] We assume that most clinicians are using crystalloids, while some, like Dr Hahn, prefer colloids for their better volume : replacement ratio.

Basically, both crystalloids and colloids are suitable for fluid resuscitation. According to Starling's '3-compartment model', crystalloids are distributed in the extracellular space, while colloids should remain intravascularly due to their large molecular weight. However, clinical trials seem to disprove this principle as we do not see this large difference in the required volume of crystalloids versus colloids to stabilise patients. Published data have shown a strong association between acute kidney injury, an increased use of renal replacement therapy and the use of hydroxyethyl starch solution, which was also accompanied with unfavourable patient outcome.[3–5] However, in these trials, the ratios of the administered volume of crystalloids and colloids were completely different to what should have been expected according to the Starling principle. Theoretically, colloids have better volume expansion effects, therefore they restore the circulating blood volume and hence DO_2 faster than crystalloids do. A fluid challenge study shows that fluid responsiveness is time-dependent and that the issue of optimal timing needs to be addressed. Roger *et al.*[6] aimed to evaluate whether echocardiographic assessment of the response to fluid challenge could affect the results by crystalloid solutions. In this study, 51.3% of initial responders had a persistent response to fluid 30 min after the beginning of fluid infusion and only 41.3% had a transient response.[5] However, fluid therapy, a main component of resuscitation, may cause substantial endothelial injury.[7] Preclinical studies show that fluid resuscitation degrades the endothelial glycocalyx structure. The volume of intravenous fluids during resuscitation is associated with the degree of glycocalyx degradation. These findings suggest a potential mechanism which may induce iatrogenic endothelial injury.

In our moderate bleeding-resuscitation animal model, the volume: replacement ratio for crystalloids and colloids followed similar patterns as predicted by Starling's principle, and the glycocalyx remained intact.[7]

Our study's main finding is that when fluid management is guided by detailed haemodynamic assessment, more crystalloid than colloid is needed to maintain haemodynamic stability. We did not find any difference between the effects of crystalloids and colloids on the microcirculation. Crystalloids actually have a worse volume : replacement ratio than colloids, therefore complex monitoring is essential for decision-making. Our results raise a point that personalised therapy may be superior to guidelines/bundles- driven management, which assumes the 'one size fits all' paradigm, and leaves the question on the crystalloid-colloid debate open.[8]

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Ipsilateral hemidiaphragmatic paresis after a supraclavicular and costoclavicular brachial plexus block

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Editor,

We read with great interest the recently published article by Sivashanmugam *et al.*[1] With regard to a lower incidence of hemidiaphragmatic paresis, the costoclavicular brachial plexus block seems to be a promising alternative to the supraclavicular brachial plexus block. We appreciate the authors' great work, but we have several concerns.

First, patients with impaired pulmonary function (i.e. obstructive or restrictive pulmonary disease) should have been excluded from the study. In these patients, hemidiaphragmatic paralysis may result in severe consequences. This was not mentioned among the exclusion criteria.