

Laura Cappuyns<sup>1,2</sup>, Ascanio Tridente<sup>1</sup>, Yvonne Stubbington<sup>1</sup>, Nina C Dempsey<sup>2</sup>,

Kayvan Shokrollahi<sup>1</sup>

1. Mersey Burns Centre, Whiston Hospital, Warrington Road, Prescott, Merseyside, L35 5DR

2. Manchester Metropolitan University

## Introduction

Fluid resuscitation remains the basis of early burn management. Both the type and volume of fluids can impact the outcome of burn patients. Appropriate fluid resuscitation is at the core of hemodynamic management and has long been identified as a key factor for patients with major burns (1).



Ringer's lactate (RL) has been the most widely used fluid for burn resuscitation for decades (2). Plasmalyte®, a newer balanced crystalloid, is gaining popularity for use in critically ill patients including those with burns. This popularity is partly due to the fact that Plasmalyte® theoretically offers a favourable metabolic profile(3), but may also be attributed to its relatively lower cost. Patients with large burns receive very large volumes of fluids, especially during the resuscitation period and these high volumes may have metabolic consequences.

**AIM:** Following a trust-wide formulary change from RL to Plasmalyte®, we decided to explore existing evidence and rationale supporting the use of Plasmalyte® as an alternative to the standard RL solution for resuscitation in burns.

## Method

- We comprehensively searched Medline, Embase, Google scholar and the Cochrane library for articles on the use of Plasmalyte® Vs RL for burn resuscitation in adults.
- Keywords used for search:

ACETIC ACID PLUS GLUCONATE SODIUM PLUS MAGNESIUM CHLORIDE PLUS POTASSIUM CHLORIDE PLUS SODIUM CHLORIDE] OR [PLASMALYTE] OR [PLASMA-LYTE] OR [PL148] OR [PL 148]

AND

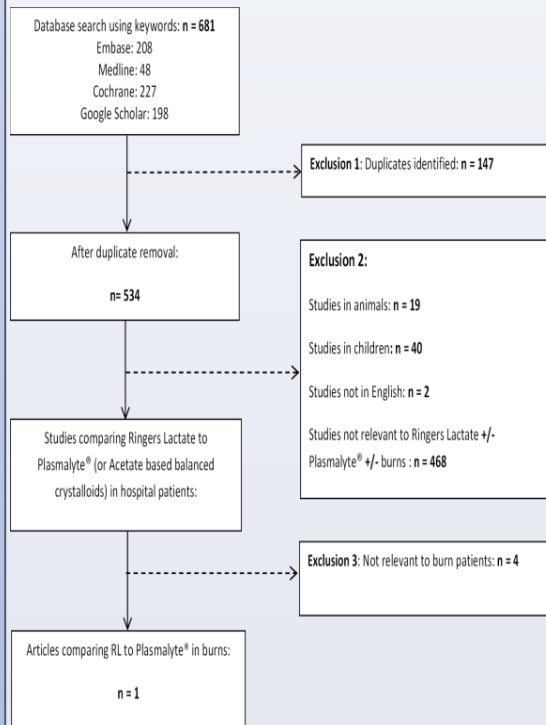
[BURNS] OR [BURN UNIT] OR [BURN PATIENT] OR [BURN] OR [INTENSIVE CARE] OR [INTENSIVE CARE UNIT] OR [CRITICAL CARE] OR [CRITICAL ILLNESS] OR [EMERGENCY MEDICINE] OR [EMERGENCY DEPARTMENT] OR [EMERGENCY SERVICE, HOSPITAL] OR [TRAUMA CENTRES] OR [ICU], OR [CCU] OR [ITU] OR [ACCIDENT AND EMERGENCY] OR [TRAUMA CARE] OR [TRAUMA MEDICINE] OR [TRAUMA PATIENT].

- Titles and abstracts were reviewed and irrelevant papers were excluded.

## Results

Only one study was identified directly comparing Plasmalyte® and RL for resuscitation of burn patients.

### Literature search result



### Literature on Plasmalyte Vs RL for burn resuscitation

Study	Title	Participants	Conclusions
RCT by Chaussard et al, 2020 (4)	Physiological response to fluid resuscitation with Plasmalyte® Vs RL	28 patients with burn TBSA >30%	No significant differences in acid-base status (i.e. pH, base excess) between patients receiving Plasmalyte® & RL  Alkalinizing effect of Plasmalyte® was less significant than expected due to gluconate accumulation  Plasmalyte® led to significantly lower ionized calcium levels

### Comparison of properties of Plasmalyte to other Crystalloids

	Mmo/L							Mosmo/L	pH
	Cations				Anions				
	Na <sup>+</sup>	K <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Cl <sup>-</sup>	Acetate (CH <sub>3</sub> COO <sup>-</sup> )	Lactate (C <sub>3</sub> H <sub>5</sub> O <sub>3</sub> <sup>-</sup> )		
Saline (0.9%)	154 ↑	-	-	-	154 ↑	-	-	308 ↑	5.5
Ringer's Lactate	131 ↓	5 ↔	2 ↓	-	111 ↑	-	29 ↔	278 ↓	6.5
Plasmalyte®	140 ↔	5 ↔	-	1.5 ↑	98 ↔	27 ↔	-	23 ↔	295 ↔ (range: 6.5-8.0)
Plasma	136-145	3.5-5.0	2.2-2.6	0.8-1.2	98-106	-	Bicarbonate 21-30	280-300	7.35-7.45

Red arrows = higher than Plasma levels; Blue arrows = lower than Plasma levels; Green arrows = within range of Plasma levels

### Properties of Plasmalyte

- More closely resembles plasma than other balanced solutions
- Lactate-free to reduce the risk of hyperlactataemia compared to RL.
- Physiological concentrations of Na and Cl ions maintain water and electrolyte balance of intravascular, interstitial, and intracellular fluids

- Calcium-free for compatibility with blood transfusions.
- Does not contribute to exacerbation of metabolic acidosis
  - indicated in mild and moderate acidosis
- Magnesium may help in the balance of magnesium levels
  - low magnesium concentrations often follow surgery

IV fluids	Cost (£)
0.9% saline 500 ml	£1.66
Ringers Lactate /Hartmann's 500 ml	£2.53
Plasmalyte® 500ml	£1.46
Gelofusine 4% 500ml	£4.97
Human albumin solution 4.5% 500 ml (MW 68,000 Da)	£55.02

Prices according to UK Baxter Healthcare Limited Hospital List Price (£ ex VAT) 2019 and British National Formulary (National Institute for Health and Care Excellence).

## Discussion

Plasmalyte® is more physiologically similar to blood plasma and has metabolic properties that make it theoretically suitable for large volume resuscitation in critically ill patients. Plasmalyte® costs less than most of the other intravenous fluids in current practice and its wholesale use is projected to bring significant cost saving.

There is however a paucity of level-one evidence to suggest that use of Plasmalyte® for burn resuscitation is safe or is recommended practice. The study by Chaussard et al (4) was limited by the small number of patients and did not report patient outcomes. Most studies done comparing lactate- versus and acetate-based solutions were performed in elective surgical settings and there is limited data on high-risk critically ill patients which include severe burns.(ref)

The use of Plasmalyte in burns will have physiological implications for burn patients the nature and extent to which will require formal research in the form of multicentre randomised controlled trials. Until further research has been published, the mainstay of evidence for crystalloid burn fluid resuscitation in the world literature is centred on Ringer's Lactate.

## Conclusions

Based on the limited literature on the use of Plasmalyte® in burns, it is difficult to draw firm conclusions. However, the evidence that currently exists does not suggest that Plasmalyte® is unsafe for burn resuscitation. Furthermore there are potential cost savings of the order of 42%.

We advise against formulary changes that remove access to RL. RL should continue to be available for use in burn patients until such time that research has established the safety profile of large volume resuscitation with Plasmalyte® more conclusively.

## References

- Klein MB, et al, The association between fluid administration and outcome following major burn: a multicenter study. *Ann Surg*, 2007. 245(4): p. 622-8.
- Baker RH, et al, Resuscitation of thermal injuries in the United Kingdom and Ireland. *J Plast Reconstr Aesthet Surg*, 2007. 60(6): p. 682-5
- Baxter, *Plasma-Lyte 148 (pH 7.4) UK SmPC*. 2018
- Chaussard M, et al., *Physiological response to fluid resuscitation with Ringer lactate versus Plasmalyte in critically ill burn patients*. *J Appl Physiol* (1985), 2020. 128(3): p. 709-714
- Ellekjaer KL, Perner A, Jensen MM et al: Lactate <em>-</em>versus</em> acetate buffered intravenous crystalloid solutions: a scoping review. *British Journal of Anaesthesia* 2020, 125(5):693-703