



**Fluid Resuscitation in the ICU:  
Choice of Fluids, Volume and  
Targets**

Jeff Hawley, BSc, BScN, RN, CNCC(c)  
Barbara Fagan, BScN, MEd, RN, CCNE, CCCI, CNCC(c)



Registered Nurses  
Professional Development Centre

**Declarations**



**About RNPDC**

We have moved to one regulator for all nurses in the province - LPN, RN, NP (One regulator, one nursing body)

RNPDC receive our funding from NS Department of Health and Wellness to meet the needs for specialty training in the province

IEN entry - Maritime assessment center

Interprofessional faculty and offer interprofessional programming

We now fall under IPPL umbrella in NSHA

REBRANDING is coming

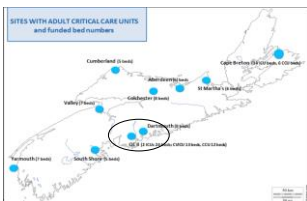


Registered Nurses  
Professional Development Centre

**Little bit about NS/NSHA**



**Adult ICUs in NSHA**



**Objectives**

Describe the differences between balanced crystalloid solutions and saline

Compare and contrast the composition of commonly used IV fluids in the critical care area.

Apply current evidence to select/recommend fluid types & volumes and suggest target fluid resuscitation goals using case study approach.



### History of IVF

1832 – Cholera epidemic in London  
 1880's – Hamburger discovered that erythrocytes in a solution of 0.9% saline maintained their shape  
 1902 – standard use of saline  
 Sydney Ringer (1835-1910)  
 Alexis Hartmann (1898-1964)



### Why Fluid Resuscitate?

2007:  
 #1 impaired tissue perfusion or low cardiac output (44%)  
 #2 'abnormal' vital signs (35%)  
 (Finfer et al, 2010)

2014:  
 #1 impaired tissue perfusion or low cardiac output (61%)  
 #2 'abnormal' vital signs (25%)  
 (Hammond et al, 2017)



### Normal Saline

0.9% sodium chloride  
 154 mmol/L Na<sup>+</sup>  
 154 mmol/L Cl<sup>-</sup>  
 Often cited as the most commonly used IVF  
 Slightly hyperosmolar  
 Terms such as "physiologic" or "normal" often used to describe and may have aided its rise to common use



### Balanced Crystalloids

Chemical composition more closely associated with human plasma  
 Slightly hyposmolar  
 Lactated Ringer's/Hartmann's  
 Plasmalyte/Plasmalyte A  
 Normosol



	Blood Plasma	0.9% Saline	Lactated Ringer's	Plasmalyte/ Normosol	0.45% Saline
Na <sup>+</sup> (mmol/L)	136-145	154	130	140	77
K <sup>+</sup> (mmol/L)	3.4-5.0	0	4	5	0
Ca <sup>2+</sup> (mmol/L)	2.2-2.6	0	3	0	0
Mg <sup>2+</sup> (mmol/L)	0.66-1.07	0	0	1.5	0
Cl <sup>-</sup> (mmol/L)	100-110	154	115	98	77
Lactate (mmol/L)	0.5-1.7	0	28	0	0
Osmolality (mOsm/kg)	283-292	308	274	295	154

Blood plasma levels based on NSHA (Central Zone) Laboratory Reference Test Ranges (2017).



### Significance of Composition

Yet to discover the 'perfect' IVF  
 NS:  
 Compatible with blood  
 Used as a base solution for many IV medications  
 Higher than physiologic Cl<sup>-</sup>  
 Hyperchloremic metabolic acidosis  
 AKI  
 Death  
**Balanced Crystalloids:**  
 Closer to physiological concentrations of E<sup>-</sup>  
 Not all are compatible with blood  
 Not often compatible with IV medications  
 May not be suitable for TBI patients





The results

“...intravenous administration of balanced crystalloids rather than saline had a favorable effect on the composite outcome of death, new renal replacement therapy, or persistent renal dysfunction”

(Semler et al, 2018)



Types of Fluids

Summary Statements:

High renal tubular [Cl<sup>-</sup>] induce renal afferent constriction with a resultant decrease in renal blood flow.

The availability and cost of saline and balanced crystalloids are not significantly different, saline should probably no longer be used for intravascular volume expansion.



Balanced Crystalloids vs 0.9% Saline

Summary Statements:

If a large volume of fluid is likely to be required for resuscitation, especially in septic patients, balanced fluid solutions should be selected as these may reduce the likelihood of AKI.

Balanced solutions for fluid resuscitation can be favoured even in small amounts of fluid as they may reduce the incidence of persistent renal dysfunction and the use of RRT

0.9% saline remains useful for patients with hypochloremic alkalosis





Case #1

68 year-old male with sepsis. He is intubated and on a mechanical ventilator. HR - 114, BP - 80/54 (63), urine output 15ml/hr, JVP not measurable. Lactate 3.8 mmol/L, Cr - 163µmol/L. 85kg.

What type of fluid?  
How much fluid?  
Target?



Case #2

54 year old female with Acute Decompensated Heart Failure. HR 130, BP 74/48 (57), urine output 5ml/hr (over past 3 hours), JVP 6cm.

Labs: Na<sup>+</sup> 132 mmol/L, K<sup>+</sup> 5.4 mmol/L, Cr 108 µmol/L

What type of fluid?  
How much fluid?  
Target?



Case #3

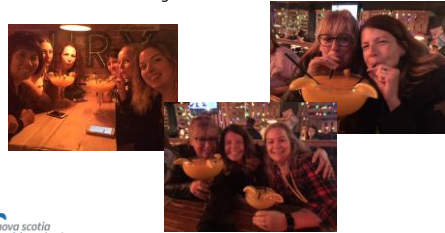
22 year old male post MVC. GCS 5T, ICP 20 mm Hg, HR 100, BP 110/65 (80), urine output 45 mL/hr.

What type of fluid?  
How much fluid?  
Target?



Case #4

A group of ICU nurses go on a pub crawl...should they purchase the little one or da big one????



The Real Case #4

55 yo female patient who weighs 100kg admitted with acute pancreatitis. Patient has been feeling unwell for days. T 38.6 C, HR 128, BP 70/42, intubated on controlled mechanical ventilation, given 3L Ringers Lactate.

What type of fluid?  
How much fluid?  
Target?



Case #5

72 year old chronic dialysis patient (dry wt 84kg) with peritonitis secondary to peritoneal dialysis catheter. Patient has been cultured (Blood, urine, sputum, PD catheter before removal), on broad spectrum antibiotics. Given 500 cc of NS. T 40.2 C, HR 136, BP 85/40. On FiO2 .60.

What type of fluid?  
How much fluid?  
Target?



## References

- Awad, S., Allison, S., & Lobo, D. (2008). The history of 0.9% saline. *Clinical Nutrition*, 27, 179-188. DOI: 10.1016/j.clnu.2008.01.008.
- Canadian Institute for Health Information (2016). *Care in Canadian ICUs*. Retrieved from: [https://secure.cihi.ca/free\\_products/ICU\\_Report\\_EN.pdf](https://secure.cihi.ca/free_products/ICU_Report_EN.pdf)
- Dellinger, R.P., Schorr, C.A., & Levy, M.M. (2017). A users' guide to the 2016 surviving sepsis guidelines. *Critical Care Medicine*, 45(3), 381-385.
- Finfer, S., Liu, B., Taylor, C., Bellomo, R., Billot, L., Cook, D., Du, B., McArthur, C., Myburgh, J., & SAFE TRIPS Investigators (2010). Resuscitation fluid use in critically ill adults: an international cross-sectional study in 391 intensive care units. *Critical Care*, 14, e185. DOI: 10.1186/cc9295.
- Finfer, S., Myburgh, J., & Bellomo, R. (2018). Intravenous fluid therapy in critically ill adults. *Nature Reviews Nephrology*, 14, 541-557. DOI:10.1038/s41581-018-0044-0.
- Hammond, N., Taylor, C., Finfer, S., Machado, F., An, Y., Billot, L., Myburgh, J. (2017). Patterns of intravenous fluid resuscitation use in adult intensive care patients between 2007 and 2014: an international cross-sectional study. *PLoS ONE*, 12 (5). <https://doi.org/10.1371/journal.pone.0176292>



## References

- Lee, J. (1981). Sydney Ringer (1834-1910) and Alexis Hartmann (1898-1964). *Anaesthesia*, 36, 1115-1121.
- Martin, C., Cortegiani, A., Gregoretti, C., Martin-Loeches, I., Ichi, C., Leone, M., Marx, G., & Einav, S. (2018). Choice of fluids in critically ill patients. *BMC Anesthesiology*, 18:200. <https://doi.org/10.1186/s12871-018-0669-3>.
- Self, W., Selmer, M., Wanderer, J., Wang, L., Byrne, D., Collins, S., Rice, T. (2018). Balanced crystalloids versus saline in noncritically ill adults. *The New England Journal of Medicine*, 378 (9), 819-828. DOI:10.1056/NEJMoa1711586.
- Semler, M., Self, W., Wanderer, J., Ehrenfeld, J., Wang, L., Byrne, D., Rice, T. (2018). Balanced crystalloids versus saline in critically ill adults. *The New England Journal of Medicine*, 378 (9), 829-39. DOI: 10.1056/NEJMoa1711584.

