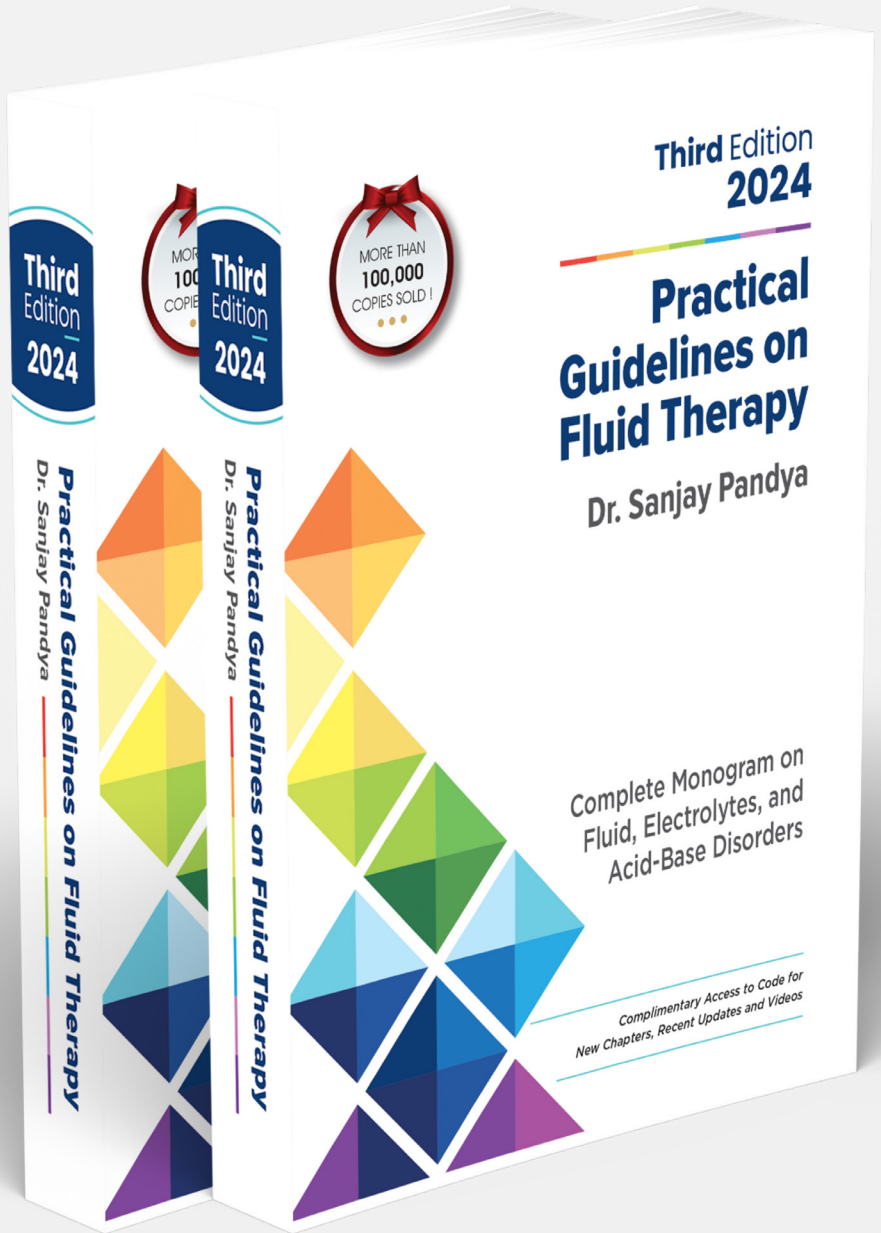
fluid therapy.org

Chapter 7:

Maintenance Fluid Therapy



To get a copy of the book, visit: **www.fluidtherapy.org**

7 Maintenance Fluid Therapy

Patients who are euvolemic, hemodynamically stable but unable to take adequate fluid by oral or enteral route need maintenance intravenous (IV) fluids to replace anticipated insensible (such as respiration, perspiration, and stools) and sensible (such as urine) losses [1].

PHYSIOLOGICAL BASIS

The goal of maintenance IV fluid is to replace the ongoing daily physiologic losses such as urine, feces, and sweat, maintain normal water and electrolyte balance and provide adequate calories to avoid starvation ketosis [1, 2].

Ideal maintenance IV fluid should provide adequate water and electrolytes to preserve the extracellular volume and ensure proper tissue perfusion without causing volume depletion, fluid overload, or electrolyte disturbances, along with supplementation for optimal calories [1].

Sodium concentration of maintenance fluids

Sodium concentration of maintenance IV fluids is a crucial but debatable issue discussed in many studies, which needs special consideration because of its two common and potentially harmful effects, hyponatremia [3, 4] and volume overload [5, 6].

How much sodium concentration is appropriate for the maintenance IV fluids in adult patients?

The concepts of appropriate sodium concentration of maintenance IV fluids in adults are changing like a pendulum shift.

REFERENCES

1. Moritz ML, Ayus JC. Maintenance intravenous fluids in acutely ill patients. N Engl J Med. 2015;373(14):1350–1360.
2. National Institute for Health and Care Excellence Guideline for Intravenous fluid therapy in adults in hospital (CG174), 2013-Updated May 2017 (https://www.nice.org.uk/guidance/cg174).
3. Foster BA, Tom D, Hill V. Hypotonic versus isotonic fluids in hospitalized children: A systematic review and meta-analysis. J Pediatr. 2014;165(1):163–169.
4. McNab S, Duke T, South M, et al. 140 mmol/L of sodium versus 77 mmol/L of sodium in maintenance intravenous fluid therapy for children in hospital (PIMS): a randomised controlled double-blind trial. Lancet. 2015;385(9974):1190–7.
5. Mitchell KH, Carlbom D, Caldwell E, et al. Volume overload: prevalence, risk factors, and functional outcome in survivors of septic shock. Ann Am Thorac Soc. 2015;12(12):1837–1844.
6. Van Regenmortel N, Verbrugghe W, Roelant E, et al. Maintenance fluid therapy and fluid creep impose more significant fluid, sodium, and chloride burdens than resuscitation fluids in critically ill patients: a retrospective study in a tertiary mixed ICU population. Intensive Care Med. 2018;44(4):409–417.
7. Holliday Ma, Segar We. The maintenance need for water in parenteral fluid therapy. Pediatrics 1957;19(5):823–32.
8. Shafiee MA, Bohn D, Hoorn EJ, et al. How to select optimal maintenance intravenous fluid therapy. QJM 2003;96(8):601–10.
9. Koczmara C, Wade AW, Skippen P, et al. Hospital-acquired acute hyponatremia and reports of pediatric deaths. Dynamics 2010;21(1):21–6.
10. Padua AP, Macaraya JR, Dans LF, et al. Isotonic versus Hypotonic saline solution for maintenance intravenous fluid therapy in children: a systematic review. Pediatr Nephrol 2015;30(7):1163–72.
11. Robles CMF, García CAC. A prospective trial comparing isotonic with hypotonic maintenance fluids for prevention of hospital-acquired hyponatraemia. Paediatr Int Child Health. 2016;36(3):168–174.
12. Hall AM, Ayus JC, Moritz ML. Things we do for no Reason: the default use of hypotonic maintenance intravenous fluids in pediatrics. J. Hosp. Med 2018;13(9):637–640.
13. National Institute for Health and Care Excellence. Intravenous fluid therapy in children and young people in hospital. NICE guideline [NG29]. December 2015. Available from: https://www.nice.org.uk/guidance/ng29.
14. Feld LG, Neuspiel DR, Foster BA, et al. Clinical practice guideline: maintenance intravenous fluids in children. Pediatrics 2018;142:e20183083.
15. Aronson D, Dragu RE, Nakhoul F, et al. Hyponatremia as a complication of cardiac catheterization: a prospective study. Am J Kidney Dis 2002;40(5):940–6.
16. Moritz ML, Ayus JC. Hospital-Acquired Hyponatremia – Why are hypotonic parenteral fluids still being used? Nat Clin Pract Nephrol 2007;3(7):374–82.
17. Nair V, Niederman MS, Masani N, et al. Hyponatremia in community acquired pneumonia. Am J Nephrol 2007;27(2):184–90.
18. Bihari S, Peake SL, Seppelt I, et al. George Institute for Global Health; Australian and New Zealand Intensive Care Society Clinical Trials Group. Sodium administration in critically ill patients in Australia and New Zealand: a multicentre point prevalence study. Crit Care Resusc. 2013;15(4):294–300.
19. Bihari S, Watts NR, Seppelt I, et al. George Institute for Global Health and the Australian and New Zealand Intensive Care Society Clinical Trials Group. Maintenance fluid practices in intensive care units in Australia and New Zealand. Crit Care Resusc. 2016;18(2):89–94.
20. Van Regenmortel N, De Weerdt T, Van Craenenbroeck AH, et al. Effect of isotonic versus hypotonic maintenance fluid therapy on urine output, fluid balance, and electrolyte homeostasis: a crossover study in fasting adult volunteers. Br J Anaesth. 2017;118(6):892–900.
21. Van Regenmortel N, Moers L, Langer T, et al. Fluid-induced harm in the hospital: look beyond volume and start considering sodium. From physiology towards recommendations for daily practice in hospitalized adults. Ann Intensive Care. 2021;11(1):79.
22. Van Regenmortel N, Langer T, De Weerdt T, et al. Effect of sodium administration on fluid balance

and sodium balance in health and the perioperative setting. Extended summary with additional insights from the MIHMoSA and TOPMAST studies. J Crit Care. 2022;67:157–165.

23. Hawkins WA, Smith SE, Newsome AS, et al. Fluid Stewardship during Critical Illness: A Call to Action. J Pharm Pract. 2020;33(6):863–873.
24. Boyd JH, Forbes J, Nakada TA, et al. Fluid resuscitation in septic shock: a positive fluid balance and elevated central venous pressure are associated with increased mortality. Crit Care Med. 2011;39(2):259–265.
25. Claure-Del Granado R, Mehta RL. Fluid overload in the ICU: evaluation and management. BMC Nephrol. 2016;17(1):109.
26. Neyra JA, Li X, Canepa-Escaro F, et al. Cumulative fluid balance and mortality in septic patients with or without acute kidney injury and chronic kidney disease. Crit Care Med. 2016;44(10):1891–1900.
27. Perez Nieto OR, Wong A, Lopez Fermin J, et al. Aiming for zero fluid accumulation: First, do no harm. Anaesthesiol Intensive Ther. 2021;53(2):162–178.
28. Barhight MF, Nelson D, Chong G, et al. Non-resuscitation fluid in excess of hydration requirements is associated with higher mortality in critically ill children. Pediatr Res. 2022;91(1):235–240.
29. Van Regenmortel N, Hendrickx S, Roelant E et al. 154 compared to 54 mmol per liter of sodium in intravenous maintenance fluid therapy for adult patients undergoing major thoracic surgery (TOPMAST): a single-center randomized controlled double-blind trial. Intensive Care Med 2019;45(10):1422–1432.
30. Giordano M, Ciarambino T, Castellino P, et al. Diseases associated with electrolyte imbalance in the ED: age-related differences. Am J Emerg Med 2016;34(10):1923–1926.
31. Bihari S, Prakash S, Potts S, et al. Addressing the inadvertent sodium and chloride burden in critically ill patients: a prospective before-and-after study in a tertiary mixed intensive care unit population. Crit Care Resusc. 2018;20(4):285–93.
32. Choo WP, Groeneveld AB, Driessen RH, et al. Normal saline to dilute parenteral drugs and to keep catheters open is a major and preventable source of hypernatremia acquired in the intensive care unit. J Crit Care. 2014;29(3):390–4.
33. Bihari S, Peake SL, Prakash S, et al. Sodium balance, not fluid balance, is associated with respiratory dysfunction in mechanically ventilated patients: a prospective, multicentre study. Crit Care Resusc. 2015;17(1):23–8.
34. Langer T, D'Oria V, Spolidoro G, et al. Fluid therapy in mechanically ventilated critically ill children: the sodium, chloride and water burden of fluid creep. BMC Pediatr 2020;20(1):424.
35. Gamble KC, Smith SE, Bland CM, et al. Hidden Fluids in Plain Sight: Identifying Intravenous Medication Classes as Contributors to Intensive Care Unit Fluid Intake. Hospital Pharmacy 2021.
36. Padhi S, Bullock I, Li L, et al. Intravenous fluid therapy for adults in hospital: summary of NICE guidance. BMJ 2013;347:f7073.
37. Sterns RH, Emmett M, Forman JP. Maintenance and replacement fluid therapy in adults. UptoDate 2019.
38. Meyers RS. Pediatric fluid and electrolyte therapy. J Pediatr Pharmacol Ther 2009;14(4):204–211.