



Intravenous fluids in hot pre-hospital environments: Thermal and physical stability of normal saline after exposure to simulated stress conditions

Ousama Rachid^{1,2,*}, Mohammed Akkbi¹, Ahmed Makhlof³, Ayad Moslih⁴, Loua Al Shaikh³, Guillaume Alinier^{3,5,6,7}

ABSTRACT

Background: Normal saline 0.9 % (NS) is the most widespread crystalloid used as a life-saving intravenous (IV) fluid.¹ NS contains sodium and chloride in equal concentrations and is subject to thermal stress conditions while stored and transported by clinicians in the pre-hospital environment.² This study aimed to investigate the effect of high-temperature exposure on NS bags used by the Hamad Medical Corporation Ambulance Service in Qatar.

Methods: Five-hundred mL polyolefin NS soft bags (Qatar-Pharma, BN:1929013008) were divided into 4 groups of 24 each and stored at constant temperature (22, 50, or 70°C), or subjected to a temperature of 70°C for 8 hours followed by 22°C for 16 hours repeatedly over 28 days. Inspection and chromatographic analysis of the bags was performed at 0, 12, 24, 48, and 72 hours in the 72-hour study, and at 1, 2, 3, and 4 weeks in the 28-day study.

Results: NS bags slightly bulged at 50°C and significantly bulged at 70°C or in the long experiment with temperature variation (Figure 1). During the exposure period, there was no discoloration, turbidity, or leaching of plastic components observed in the NS fluid. The pH readings were 5.59 ± 0.08 (22°C-Control sample), 5.73 ± 0.04 (50°C), 5.86 ± 0.02 (70°C), and 5.79 ± 0.03 following prolonged temperature variation. The sodium and chloride levels for the short-term study ranged from 100.2 ± 0.26% to 107.9 ± 0.75% and from 99.04 ± 0.76 to 102.11 ± 1.71%, and for the long-term study they ranged from 101.93 ± 0.90% to 111.27 ± 2.61 and from 99.05 ± 0.94% to 110.95 ± 1.63%; respectively (Figure 2) in comparison to manufacturer stated concentrations.

Conclusion: There was no evidence to suggest that the NS fluid inside the PO bags is physically and chemically different when exposed up to 28 days to 50°C, 70°C, and prolonged temperature variations compared to 22°C. These simulated conditions are subject to further testing under real-life pre-hospital care emergency conditions in a hot country.

Keywords: Normal Saline, Thermal and physical stability, Pre-hospital, Sodium chloride, Ambulance Service

¹College of Pharmacy, QU Health, Qatar University, Doha, Qatar

²Biomedical and Pharmaceutical Research Unit, QU Health, Qatar University, Doha, Qatar

³Hamad Medical Corporation Ambulance Service, Doha, Qatar

⁴College of Medicine, QU Health, Qatar University, Doha, Qatar

⁵School of Health and Social Work, University of Hertfordshire, Hatfield, UK

⁶Weill Cornell Medicine-Qatar, Doha, Qatar

⁷Faculty of Health and Life Sciences, Northumbria University, Newcastle upon Tyne, UK

*Email: orachid@qu.edu.qa

<http://dx.doi.org/10.5339/jemtac.2022.qhc.60>

Submitted: 27 July 2021

Accepted: 6 October 2021

Publication date: 15 January 2022

© 2022 Rachid, Akkbi, Makhlof, Moslih, Al Shaikh, Alinier, licensee HBKU Press. This is an open access article distributed under the terms of the Creative Commons

Attribution license CC BY-4.0, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.



Figure 1. Influence of temperature on bulging of PO bags of normal saline after 28 days.

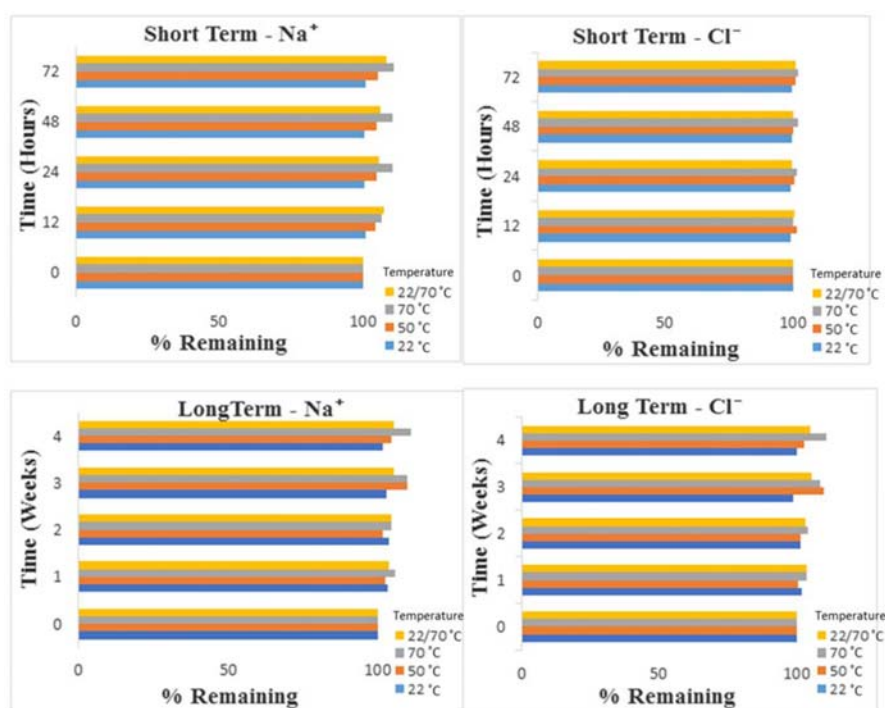


Figure 2. Remaining percentages of sodium and chloride ($n = 9$) in both short- and long-term stability studies relative to manufacturer's stated concentrations.

Disclosures and acknowledgments: Special thanks to Professor Mohamed Izhah Mohamed Ibrahim for facilitating the initial collaboration between Qatar University and Hamad Medical Corporation Ambulance Service (HMCAS). The researchers acknowledge HMCAS for funding the study by providing the required 0.9% sodium chloride research samples. This work was made possible by the Qatar National Research Fund [UREP25-069-3-021] and Qatar University Student Grants [QUST-1-CPH-2020-11, QUST-2-CPH-2019-23, QUST-1-CPH-2019-7, QUST-2-CPH-2018-6]. The contents herein are solely the responsibility of the authors.

REFERENCES

- [1] Langer T, Santini A, Scotti E, Van Regenmortel N, Malbrain M L NG, Caironi P. Intravenous balanced solutions: From physiology to clinical evidence. *Anaesthesiology Intensive Therapy*. 2015 Mar 7;47(1):78–88.
- [2] Rachid O, Obasi J, Ibrahim MM, Diab M, Al-Moslih A, Makhlof A, Alinier G. A systematic review of stability of medicines used in emergency medical service settings. *Journal of Emergency Medicine, Trauma and Acute Care*, Volume 2020, Issue 3-Qatar Health 2020 Conference abstracts. <http://dx.doi.org/10.5339/jemtac.2020.qhc.8>