VIA MEDICA

LETTER TO THE EDITOR

Jakub Kobiałka[1], Ugo Giordano[2]

[1]Department of Rheumatology and Internal Medicine, J. Mikulicz-Radecki University Clinical Hospital in Wrocław, Poland
[2]Department of Nephrology and Transplant Medicine, J. Mikulicz-Radecki University Clinical Hospital in Wrocław, Poland

Artificial oxygen carriers in emergency medicine

To the Editor

We read with great interest the article by Mohanto et al. concerning reports on the medical use of artificial oxygen carriers (AOS) [1]. We fully agree with the thesis that they may have important applications in emergencies typical of disaster and emergency medicine.

Artificial oxygen carriers allow to sustain oxygen transport to tissues in the event of a significant reduction in circulating blood volume, or a decrease in the concentration of its constituents. In case of massive blood loss, they can play a key role when blood transfusion is not possible [1–4]. Sudden trauma associated with major haemorrhage often requires immediate medical intervention. Under the conditions encountered by emergency medical teams, therapeutic options are often limited. It is then the task of the emergency team to adequately secure the patient for transport to a hospital facility [3–6]. Due to the need for testing and cross-matching, allogeneic emergency transfusion is generally not possible directly at the scene of the accident [1]. Even when the patient reaches the hospital quickly, the procedures involved in transferring the patient take valuable time. In case of massive blood loss, every second can be critical for the patient. Delayed compensation of hypoxia can lead to damage to the central nervous system and internal organs consequently even leading to death of the patient [1, 3].

Artificial oxygen carriers partially solve this problem. As synthetic preparations, they do not have blood group-specific antigens, which makes them a universal product. By solving the issue of blood groups, the same preparation can theoretically apply to any patient [7, 8]. Furthermore, they are characterised by high microbiological purity and long shelf life. AOS also reduce the risks associated with allogeneic transfusion regarding the possibility of acute post-transfusion reactions or transmission of infectious agents [8, 9]. They may also be an important therapeutic option for patients who refuse blood transfusion for various personal reasons (e.g. Jehovah's Witnesses due to religious beliefs) [1, 4].

Artificial oxygen carriers have the potential to reduce the mortality rate of victims injured in collective accidents characterised by large numbers of injured people. In incidents requiring simultaneous assistance to multiple patients, AOS provide the time needed to segregate and transport them to appropriate medical facilities. The authors note the potential for the use of AOS in areas remote from medical facilities and war battlefields [1, 7, 8]. Due to the independence of some AOS from blood donations, they may provide therapeutic options in areas with underdeveloped blood supply systems, or where demand for blood exceeds the stocks held in blood banks [1, 7].

Among the AOS, we mainly distinguish between haemoglobin-based artificial oxygen carriers (HBOCs) and fully synthetic preparations based on various chemical compounds such as perfluorocarbons (PFOCs) [2, 7, 9]. Currently, the routine use of AOS still faces many difficulties due to potential adverse effects [9]. Perfluorocarbons are compounds with excellent respiratory gas solubility. However, they are not suitable for direct injection into the circulatory system and must undergo the process of emulsification or encapsulation to droplets of 100–300 nm in size. However, due to the limited stability of the colloid and the need for frozen storage, their potential for practical application is limited [1, 5, 10]. In the case of haemoglobin-based AOS, current efforts are to obtain the haemoglobin required

Corresponding author:

Jakub Kobiałka, Department of Rheumatology and Internal Medicine, J. Mikulicz-Radecki University Clinical Hospital, Borowska 213 St., 50–556 Wrocław, Poland; e-mail: jakub-kobialka@wp.pl

Medical Research Journal 2023; Volume 8, Number 4, 320–321, 10.5603/mrj.96727, Copyright © 2023 Via Medica, ISSN 2451-2591, e-ISSN 2451-4101

for their production from sources other than human or bovine blood, allowing production to be independent of blood donations. The process of obtaining recombinant haemoglobin from the Nicotiana benthamiana plant is in the research phase. Another limitation of HBOCs is their short half-life of up to 18–23 hours with an erythrocyte life span of about 120 days. This necessitates multiple infusions of the preparation, with the need for prolonged use [5]. However, the short half-life does not reduce the advantages of HBOCs in emergencies, as they allow preserved respiratory gases transport in the severely injured patient before highly specialised hospital care [3, 5].

In our opinion, AOS are a significant topic, and increasing the availability of their practical application has great potential to improve survival rates of trauma patients with significant blood loss. The issue of AOS is certainly a topic with great research potential, requiring further development and refinement.

Article information

Acknowledgements: *The authors would like to thank all the academics who contributed to the knowledge they gained in the educational process.*

Conflict of interest: *None.*

Funding: *None.*

References

1. Mohanto N, Park YJ, Jee JP. Current perspectives of artificial oxygen carriers as red blood cell substitutes: a review of old to cutting-edge technologies using in vitro and in vivo assessments. J Pharm Investig. 2023; 53(1): 153–190, doi: 10.1007/s40005-022-00590-y, indexed in Pubmed: 35935469.
2. Jayaraman MS, Graham K, Unger EC. Injectable oxygenation therapeutics: evaluating the oxygen delivery efficacy of artificial oxygen carriers and kosmotropes . Artif Cells Nanomed Biotechnol. 2021; 49(1): 317–324, doi: 10.1080/21691401.2021.1879103, indexed in Pubmed: 33739901.
3. Spahn DR. Artificial oxygen carriers: a new future? Crit Care. 2018; 22(1): 46, doi: 10.1186/s13054-018-1949-5, indexed in Pubmed: 29471841.
4. Haldar R, Gupta D, Chitranshi S, et al. Artificial blood: a futuristic dimension of modern day transfusion sciences. Cardiovasc Hematol Agents Med Chem. 2019; 17(1): 11–16, doi: 10.2174/1871525717666190617120045, indexed in Pubmed: 31204626.
5. Ferenz KB, Steinbicker AU. Artificial oxygen carriers — past, present, and future-a review of the most innovative and clinically relevant concepts. J Pharmacol Exp Ther. 2019; 369(2): 300–310, doi: 10.1124/jpet.118.254664, indexed in Pubmed: 30837280.
6. Szarpak A. Organization of trauma centres in Poland. Disaster Emerg Med J. 2019; 4(2): 55–59, doi: 10.5603/demj.2019.0011.
7. Chen L, Yang Z, Liu H. Hemoglobin-based oxygen carriers: where are we now in 2023? Medicina (Kaunas). 2023; 59(2), doi: 10.3390/medicina59020396, indexed in Pubmed: 36837597.
8. Malchesky P. Artificial Oxygen Carriers. Artif Organs. 2017; 41(4): 311, doi: 10.1111/aor.12946, indexed in Pubmed: 28397404.
9. Jahr JS, Guinn NR, Lowery DR, et al. Blood substitutes and oxygen therapeutics: a review. Anesth Analg. 2021; 132(1): 119–129, doi: 10.1213/ANE.0000000000003957, indexed in Pubmed: 30925560.
10. Jägers J, Wrobeln A, Ferenz KB. Perfluorocarbon-based oxygen carriers: from physics to physiology. Pflugers Arch. 2021; 473(2): 139–150, doi: 10.1007/s00424-020-02482-2, indexed in Pubmed: 33141239.