



RhD Alloimmunization Rates of RhD-negative Females Who Received O-positive Whole Blood on Medical Flights

Molly Schoephoerster, MMLS (ASCP)^{CM}, Tami Alpaugh, PhD, MLS (ASCP)^{CM}, Jed Gorlin, MD

Abstract

Whole blood transfusions during medical flights play a crucial role in saving lives, yet the selection of compatible blood poses a critical challenge. While O-negative whole blood is the most compatible choice, its supply is limited. To address this challenge, medical flight services have turned to using O-positive whole blood. This alternative introduces a potential risk for RhD-negative females of childbearing age, as it may lead to the development of antibodies, resulting in Hemolytic Disease of the Fetus and Newborn (HDFN) in future pregnancies. This study aims to provide valuable insights for hospitals, medical flight companies, and the military to make well-informed decisions regarding the selection of appropriate blood products and efficiently manage their inventory of whole blood. Data was collected for female patients who received O-positive whole blood from a prominent Midwest medical flight company since 2019. For patients identified as having RhD-negative phenotype, additional data was collected to determine their antibody status. The dataset comprised information from 99 patients, revealing that 14 (14%) were RhD-negative, 6 (43%) were women of childbearing age, and 1 (7.1%) RhD-negative patient was sensitized to RhD. Comparisons with similar studies indicated that approximately 22% of RhD-negative females in the United States become sensitized to RhD after receiving O-positive blood. With the low percentage of RhD-negative women receiving O-positive whole blood, coupled with the low rate of RhD sensitization, O-positive whole blood is a feasible choice for emergency use on medical flights.

Introduction

Efficiently managing blood supply is a delicate process for hospitals and emergency services, especially when considering the critical nature of hemorrhaging. Hemorrhaging ranks among the top causes of death in global traumatic injuries, with early blood transfusions significantly enhancing patient survival. Emergency medical services, particularly medical flights, have transitioned from a “scoop and run” to a “stay and play” approach, which includes essential interventions like blood transfusions. The availability of O-negative whole blood holds immense importance due to its universal donor status and benefits in minimizing donor exposure to foreign antibodies, making it crucial for helicopter emergency services. However, with only about 10% of global blood collections being O-negative, attaining this standard for all emergency blood transfusions is not feasible. Consequently, medical flight services have explored the adoption of low-titer O-positive whole blood (LTOWB). This poses risks for Rh-negative women of childbearing age with Hemolytic Disease of the Fetus and Newborn (HDFN), which is caused when maternal antibodies (e.g., RhD antibodies) cross the placenta and attack fetal red blood cells. Rh-negative women can create these antibodies when exposed to RhD antigens through a blood transfusion with Rh-positive blood. Additional challenges for medical flight services carrying O-negative whole blood include increased cost, wastage, and maintaining blood product quality in challenging air transport conditions. Therefore, it is crucial to explore the implications of adopting O-positive whole blood for emergency care.

Methods

This study involved a retrospective review of female recipients of O-positive whole blood during medical flights with an RhD-negative phenotype. The primary objective was to determine the presence or absence of anti-RhD antibodies. Patient data including names, transport dates, dates of birth, and the names of the receiving hospitals of all female patients, were obtained from Life Link III, a Midwest-based medical flight company that initiated the use of O-positive whole blood in 2019. Following this, the respective hospitals were contacted, requesting information regarding each patient's blood type. If the patient was identified as having an RhD-negative blood type, further information was requested about evidence of sensitization such as a positive antibody screen. All data retrieval and communication was conducted online under the approval of Hennepin County Medical Center's Institution Review Board. Upon completion of data collection, patient identifiers were appropriately disposed of to maintain confidentiality. Additionally, existing literature from 2018 to 2023 was used to support this study including research on low titer O-positive whole blood (LTOWB) programs, Hemolytic Disease of the Fetus and Newborn (HDFN), and RhD alloimmunization rates.

Results

Table 1: Patient blood types of all females who receive O-positive whole blood

Blood Types	Percent (n=99)
RhD negative	14%
RhD positive	86%
A positive	41%
A negative	5%
B positive	10%
B negative	0%
O positive	33%
O negative	7%
AB positive	1%
AB negative	2%

Table 2: RhD-negative females who received O-positive whole blood on medical flights

RhD-negative Female Patient Outcomes	Percent (n=14)
Childbearing age (12-51y)	43%
Died shortly after trauma	36%
Positive antibody screen (of childbearing age)	14%
Sensitized to RhD	7.1%

Discussion

The outcomes of the study affirm the viability of using O-positive whole blood as a practical choice for transfusion on medical flights. Table 1 reveals a low percentage (14%) of patients capable of creating the anti-RhD antibody. With the results from Table 2, it becomes evident that there is a low chance (7.1%) of RhD-negative women of childbearing age developing anti-D antibodies. Two RhD-negative patients had positive antibody screens. Both were due to passive anti-D from RhoGAM. One patient had another antibody screen about a year later which showed true anti-D. In comparison, existing studies conducted in the United States have found that the RhD alloimmunization rates are approximately 22%. These differing percentages may be attributed to demographic variations or varying population sizes. Despite the low alloimmunization rates and small presence of RhD-negative females of childbearing age, the persistent risk of developing HDFN remains a critical consideration.

The intensity and severity of HDFN varies widely. The most common symptoms are fetal and neonatal anemia. Numerous studies corroborate that roughly 31% of pregnancies complicated by anti-RhD antibodies manifest some degree of HDFN, with a 4% chance of fetal death. However, it is crucial to note that HDFN can be effectively treated through neonatal and intrauterine transfusions. There will always be some risk when administering O-positive whole blood to an RhD-negative female.

The limitations of this study include the sample size and inconsistencies in follow-up testing. Despite an initial population size of 119, data was only obtained from 99 patients. Some dispatching hospitals lacked information on patients if they were not admitted or if they died during transit. Small population size had the largest effect on the alloimmunization rate. Also, it is crucial to note that existing studies on RhD alloimmunization rates are from the late 2000's which could contribute to the variations in percentages. There have been no recent studies on RhD alloimmunization rates. Another limitation is that five out of the six RhD-negative patients did not undergo subsequent antibody tests beyond the initial or one-week post-transfusion tests. This project's time constraints restricted in-depth investigation. While these limitations may have altered the data to some degree, a review of existing literature affirms the reliability and accuracy of this study.

The advantages of choosing O-positive whole blood in emergency scenarios are substantial. In instances of hemorrhaging patients, the primary goals are to stop the bleeding, maintain vital organ function, and promote hemostasis. Additionally, in cases of massive bleeding, it is possible that the patient may naturally bleed out the RhD antigens and won't have the chance to become sensitized. The ultimate goal remains patient stability, and in emergencies, O-positive whole blood is not only a feasible but also a safe and practical choice for transfusions.

Conclusion

The demonstrated reliability of O-positive whole blood proves to be a valuable asset for optimizing blood supply management. This is especially crucial given the scarcity of RhD-negative blood and blood products. Looking ahead, a promising study for enhancing transfusion outcomes is exploring the potential efficacy of post-transfusion RhoGam administration for RhD-negative females receiving RhD-positive blood. This approach could further decrease RhD alloimmunization rates. Another expansion of this study would be to include other medical flight companies to increase the sample size. Transfusion medicine is a vital component of patient care and will continue evolving to address future challenges.

References

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