Searching for safer red blood cell bags for pediatric recipients

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What is this research about?

Over 50 years ago, plastic replaced glass as the container of choice for collection and storage of blood and blood products. This greatly improved the safety of blood for transfusion by reducing the risk of contamination and containers breaking. Polyvinylchloride, better known as PVC, is the most popular plastic for blood bags because it is durable, strong and can resist temperature changes. However, PVC is inflexible and brittle. To make flexible bags suitable for blood storage, PVC must be combined with a chemical called a “plasticizer”, which softens the plastic.

The most widely used plasticizer in blood bags is called DEHP. DEHP is also found in toys, medical tubing, water bottles, rainwear and many other goods. Despite DEHP’s extensive use, there are concerns about its toxicity. There is no clear evidence that DEHP has harmful effects in humans following transfusion or exposure to other medical devices, but animal studies have shown that it may affect the development of the reproductive system, particularly in males. Due to the possibility of harm, a Health Canada Expert Advisory Panel recently concluded that alternatives to DEHP-containing medical devices should be sought, especially when foetuses, newborns, infants and young children are concerned. Several alternative plasticizers are available but it is not clear how well blood products will store in bags made with these other plasticizers. This is a concern for red blood cells, as an unexpected effect of using DEHP blood bags was the finding that red blood cells store very well and have better quality in these bags than in others. To explore alternative plasticizers, these studies compared the quality of red blood cells stored in bags specifically designed for pediatric patients plasticized either with DEHP or two less toxic plasticizers called DINCH and BTHC.

What did the researchers do?

Red blood cells were prepared and stored in each of the three bag types: PVC/DEHP, PVC/DINCH and PVC/BTHC. Samples were taken several times during storage and the quality of the red blood cells in each of the three bag types was compared. The researchers looked at many measures of red blood cell quality. In particular, the effect of the three bag types on the stability and function of the red blood cell membrane was assessed.

What did the researchers find?

- Metabolism of the red blood cells was affected by the bag they were stored in. Metabolism was best maintained in DINCH bags, and worst in BTHC bags.
- Red blood cells in BTHC bags had more signs of damage: they had the greatest release of potassium and the highest levels of hemolysis (rupture or bursting of red blood cells). By the end of the storage period, hemolysis levels in BTHC bags were higher than the 0.8 per cent limit set by Canadian Standards Association guidelines.
- Arrangement of phospholipids, an important structural part of red blood cell membranes, was not different among the bags.
- Red blood cells stored in BTHC bags were larger, more rigid and more sensitive to hemolysis than red blood cells stored in the other containers. This indicates that the red blood cell membrane was less damaged and better preserved in DEHP and DINCH bags than in BTHC bags.
- Overall, red blood cells in DEHP and DINCH bags showed good quality, while red blood cells in BTHC bags stored poorly.
How can you use this research?

The use of DEHP in medical devices, toys and other goods is controversial, and there are moves in several jurisdictions, including the European Union, to ban its use. Unfortunately, no plasticizers are completely without potential health concerns. Of the alternative plasticizers proposed so far for use in blood bags, DINCH has the lowest toxicity levels, making it an attractive option. These studies show that DINCH bags are effective at maintaining red blood cell quality during storage. For energy balance and maintenance, red blood cells stored in DINCH bags actually did better than those in DEHP bags. Therefore, bags plasticized with DINCH could be a suitable, less toxic alternative to DEHP bags. In contrast, storing red blood cells in BTHC bags was damaging to the cells indicating BTHC may not be a viable alternative to DEHP. Other studies have seen different results with BTHC, suggesting this finding may be specific to the BTHC preparation used in the bags in this study.

Overall, the findings strongly suggest the plasticizer DINCH is a superior alternative to DEHP than BTHC. This research to understand which plasticizers might be a good alternative to DEHP is the first step in making safer blood bags for pediatric transfusions. All of the bags in this study were manufactured by one company, and these results will help the manufacturer determine which bag to develop further. While more research is needed — for example, to understand how the plasticizers affect red blood cells stored in different storage solutions — these results support a potentially promising future for DEHP-free blood storage.

About the research team: This research was conducted in the laboratories of Dr. Dana Devine, Canadian Blood Services chief medical and scientific officer and a professor in the department of pathology and laboratory medicine at the University of British Columbia, Vancouver, B.C. and Dr. Jason Acker, a centre for innovation senior development scientist and a professor in the department of laboratory medicine and pathology at the University of Alberta, Edmonton, Alta. In Dr. Devine’s laboratory, the research was led by Dr. Katherine Serrano, a research associate with the centre for innovation and a clinical assistant professor at the department of pathology and laboratory medicine at the University of British Columbia. In Dr. Acker’s laboratory, the research was led by Dr. Beatriz Bicalho, a postdoctoral fellow at the centre for innovation, Edmonton, Alta. The work was conducted in collaboration with Fresenius-Kabi Deutschland GmbH, Bad Homberg, Germany.

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