INFORMATION BRIEF (RAPID REVIEW)

RADIO FREQUENCY IDENTIFICATION (RFID) TECHNOLOGY IN BLOOD ESTABLISHMENT

Malaysian Health Technology Assessment Section (MaHTAS)
Medical Development Division
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Rapid Review
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PURPOSE

This review was conducted upon request by the Transfusion Medicine Consultant, National Blood Centre (PDN) to provide information on the effectiveness, safety and cost-effectiveness of radio frequency identification (RFID) technology following the interest to introduce this device in their blood transfusion services.

BACKGROUND

Blood transfusion is a vital medical procedure that demands rigorous tracking of blood products to ensure both safety and efficacy. In 2023, Malaysia reported a total of 575,403 blood donations.[1] The National Blood Centre estimates a monthly requirement of approximately 15,000 to 17,000 blood bags to meet the national blood supply needs.[2] Errors in blood management can lead to serious consequences, including transfusion reactions and the administration of incompatible blood products.

In alignment with the Pharmaceutical Inspection Cooperation Scheme (PIC/S) Good Practice Guidelines, a comprehensive linkage between the blood donor, blood, blood components, and blood samples must be established to ensure accurate donor identification and secure record-keeping.[3] For storage and distribution, these guidelines mandate a system for stock rotation to maintain the quality of blood and blood components and prevent potential mix-ups.[3,4] Historically, barcode systems have been utilised for blood product tracking. However, emerging technologies, such as Radio Frequency Identification (RFID), offer enhanced efficiency and safety.[5] Limitations of barcode systems include their reliance on active user interaction and the requirement for a line-of-sight scan, as well as potential errors from multiple barcodes on blood bags.[5,6]

Radio Frequency Identification (RFID) technology operates using radio frequency waves to transfer and collect data. Typically, an RFID system comprises a transponder, a tag reader, and an associated database or application software.[5,7] The RFID tag includes a microchip and an antenna coil, allowing data transmission over distances ranging from 10 meters for passive tags to up to 1,000 meters for active tags.[7] Compared to traditional barcode technology, RFID enables the simultaneous capture of multiple data points and does not require line-of-sight for data transmission.[7]

There are three types of RFID tags used, i.e. active tag which is powered by battery for sending and receiving information, semi-active tag operated with battery but do not communicate with RFID reader like active tag and passive tag obtains its power entirely from radio wave transmitted via a RFID reader.[6,8]

Phase Jitter Modulation (PJM) RFID systems can effectively identify RFID tags within stacked or closely positioned items, such as blood bags. This functionality is enabled by PJM StackTag™, which enhances RFID application in blood unit tracking.[9]

EVIDENCE SUMMARY

The systematic search found **two** relevant articles related to RFID technology for blood transfusion from the scientific databases such as Medline, EBM Reviews via OVID, PubMed and from general search engines up to November 2024 using the following search terms: *radio frequency identification device / phase jitter modulation / signal processing, computer-assisted / blood bank / blood management system / blood transfusion.*

EFFICACY/ EFFECTIVENESS

A retrospective review conducted by da Souza et al. (2024) assessed the influence of RFID on the management of red blood cell (RBC) unit inventory and staff workload in a transfusion service laboratory located in Washington, USA after its commencement in June 2021. The study involved 9337 RBC units where each RBC unit was encoded with RFID to capture information such as donor identification number, product code, blood type, expiration date, product volume and negative antigen(s). It was reported that there was significant difference in the percentage of RBC bag wasted that are presented by partial and full discard volumes RBC. There was a reduction in amount of RBC units expired on the shelves to be discarded from 4% to 0.63%. In comparison, only 69 RBC units (17,343 ml) expiring on the shelf were discarded in 2022 against 140 units (35,194 ml), 161 units (40,409 ml) and 180 units (45,160 ml) in 2021, 2020 and 2019, respectively. Meanwhile, the average time for manual counts and inspection of RBC units was decreased from the maximum of 25 minutes to less than a minute upon the implementation of RFID. This study concluded that the use of RFID technology has significantly decreased the loss of RBC units especially for Group O RBC units and improved the management of inventory.[10]

A validation study by Dusseljee-Peute et al. (2019) involving 243 tagged red blood cell (RBC) products, conducted as a part of a larger project called 'RFID in health care' in Amsterdam. The study evaluated the compliance of real-time data (i.e. location, time stamp, temperature) generated via active RFID to guidelines related to the management of RBC within hospital environment. The study focused on the compliance to the guideline. Firstly the preservation of RBC with a temperature between 2°C and 6°C, secondly the transfusion must be conducted within one hour after leaving a validated cooling system, thirdly there is no restorage or transfused within 24 hours for RBCs that reached more than 10°C, otherwise it will be discarded and finally the unused RBC are returned to the blood transfusion laboratory (BTL) within 24 hours after they left BTL. Only 16 RBCs out of 182 RBCs complied to the temperature preservation between 2°C and 6°C with temperature range between 3.0°C to 6.5°C. Mean minimum and maximum temperatures were reported highest to be 7.2°C to 15.1°C (RBCs transfused), followed by those returned from ICU (5.8°C to 11.1°C) and operating room (4.5°C to 9.0°C), respectively. Furthermore, on the second outcome, none of 49 RBCs monitored complied with requirement RBC to be transfused within one hour after leaving a validated cooling facility with mean of 3.74 hours (range: 1.11 to 7.56 hours). There were 39 out of 49 RBCs exceeded 10°C which all 49 RBCs were transfused within one hour after leaving BTL. Finally, 7.6% of 118 RBCs complied to the final outcome for unused RBCs to be returned to BTL within 24 hours after leaving the transfusion laboratory. This study concluded that RFID has the potential in ensuring the safety of the patients and improving work process efficiency.[5]

SAFETY

As of today, there was no health technology registered related to the PJM RFID with the Malaysian Medical Device Authority (MDA). There was one medical device listed under US Food and Drug Administration, i.e. iTrace for Blood Centers system that applied RFID in tracking and process automation in the blood transfusion services.[11]

There was concern related to the privacy and security implications of the technology which may be due to the unauthorised data detection/interception or counterfeiting sensitive unencrypted data contained within RFID tags.[7]

COST-EFFECTIVENESS

There was no retrievable evidence related to cost effectiveness on the use of RFID in blood transfusion service. There are elements of cost that need to be considered before acquiring RFID system, i.e. equipment, installation, tag, software, ongoing license and maintenance, as well as integrator cost.[12]

CONCLUSION

Based on the review, there was limited evidence retrieved regarding RFID technology used in blood centres. Evidence demonstrated RFID appeared beneficial in managing RBCs unit inventory by reducing number of expired RBCs, reducing time in manual count and inspection of the RBCs by the blood centres.

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