Implementation of a Prehospital Whole Blood Program in the District of Columbia

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Abstract

The District of Columbia Fire and EMS Department implemented a low-titer type-O whole blood prehospital transfusion (LTOWB) program to enhance prehospital care. Modeled on best practices from the THOR-AABB recommendations, the program emphasizes safe blood storage, efficient transport, rigorous transfusion protocols, and comprehensive documentation. In collaboration with major trauma and pediatric centers, LTOWB protocols were defined to address both adult and pediatric trauma and medical needs. Geographic and demographic considerations, such as high call volumes and violent crime rates in socioeconomically disadvantaged wards, guided LTOWB unit placement with the twofold goals of prioritizing health equity and improving outcomes for patients suffering from hemorrhagic shock. With a focus on interdepartmental partnerships and streamlined hand-offs to hospital teams, DC Fire and EMS has set a precedent for integrating LTOWB into urban prehospital trauma care, supported by data-driven protocols and community partnerships.

Keywords: Prehospital, blood, cold storage, hemorrhagic shock, trauma care

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Department Background

DC Fire and EMS Department is the primary fire and emergency medical services response agency for the District of Columbia. Serving a geographic area of 68.3 square miles and an approximate population of 678,972, the Department responds to over 209,000 incidents annually (1). The Department has an operational workforce of 1,400 BLS and 350 ALS operational members, dispersed over four platoons that staff 33 Engine Companies, 16 Truck Companies, 26 BLS transport units, 17 ALS transport units, and 7 EMS Supervisor positions.

Program Overview

Program Pillars

The DC Fire and EMS program was designed to align with the four pillars outlined in the Yazer et al 2022 report "Trauma, Hemostasis, and Oxygenation Research – Association for the Advancement of Blood and Biotherapies (THOR)-AABB Working Party Recommendations for a Prehospital Blood Product Transfusion Program (2)".

The first pillar is addressed by establishing a clear rationale and defining the types of blood products appropriate for prehospital transfusion. The second pillar focuses on creating and implementing comprehensive policies for the secure storage of blood products outside the hospital blood bank and their safe transport to patients in prehospital settings. The third pillar outlines the need for rigorous policies, procedures, and certification requirements for prehospital transfusionists to ensure proper transfusion criteria and administration. The fourth pillar emphasizes standardized documentation of prehospital transfusion, including protocols for notification and handover to hospital teams.

The Whole Blood Coordinator and Department Medical Director have also taken on two additional pillars to strengthen the program. The first pillar addresses the imperative to safeguard LTOWB as a critical resource nationwide, with a focus on minimizing waste. The second pillar underscores the importance of transparency, not only in operational functions but also in data collection and information dissemination. Given the ongoing debate regarding prehospital LTOWB use and justification, the program is dedicated to building partnerships with other organizations to foster research and facilitate information-sharing collaborations.

Rationale for Low-Titer Type-O Whole Blood (LTOWB)

In comparing packed red blood cells (PRBC) to whole blood, whole blood demonstrates advantages over 1:1:1 component therapy. Recent studies have demonstrated that LTOWB is associated with improved early and late survival compared to component therapy. Compared to component therapy, LTOWB has also been associated with a lower total transfusion requirement (3). Studies have consistently demonstrated that transfusion of LTOWB is safe, with no evidence of increased risk of adverse events or clinically significant hemolysis, even in recipients with blood types A, B, and AB (4). LTOWB also offers the convenience of containing red blood cells, plasma, and cold-stored platelets all in one product and in the proper ratio.

The use of type-O RhD-positive whole blood for women of childbearing potential or those who are currently pregnant has been studied globally and was considered by the Department prior to implementation. Type-O RhD-negative blood donors make up only 6.9% of the blood donor population, and O-negative blood products are often in short supply (5). Transfusion of RhD-positive blood to RhD-negative patients is generally a safe practice (6,7,8,9). The risk of RhD alloimmunization in an RhD-negative patient after transfusion of RhD-positive blood is of greater concern in women of childbearing potential, due to the

possibility that a future pregnancy could be impacted by hemolytic disease of the fetus and newborn (HDFN). The probability of an RhD-negative female of childbearing potential receiving an RhD-positive transfusion that results in alloimmunization and subsequent fetal death from HDFN is estimated to be as low as 0.3%. Additionally, since most trauma patients are either male or female with no childbearing potential, the AABB recommends the provision of O-positive blood products for ground and air ambulances. Compared with conventional component therapy, a computer model found that the gains in maternal and child life years with transfusion of O-positive whole blood compared to component therapy offset the life years lost due to HDFN (10).

Justification for Use

Retrospective Study

To assess the need for a whole blood program within the District, a retrospective study was conducted on trauma patients from January 1 to May 30, 2023. Using ePCR records from DC Fire and EMS, patients were identified based on systolic blood pressure < 90 mmHg and/or heart rate > 110 beats per minute. A total of 222 patients were classified into central (153 cases) and non-central (69 cases) trauma categories. Special Operations incidents were excluded from the study. The data collected also included scene time, transport time, administration of tranexamic acid (TXA) and calcium, and the responding EMS Supervisor.

Geographical Considerations

The District is divided into four quadrants and eight distinct wards, each with overlapping EMS Supervisor coverage. Historically, Wards 7 and 8, situated east of the Anacostia River, experience the highest EMS call volumes and report some of the city's highest rates of homicide and assault with a deadly weapon. These wards are served by a single general hospital, United

Medical Center, which does not offer trauma services. Trauma care facilities are located in the city's Northwest quadrant, necessitating considerable drive time for access and care (Appendix A Figure A1).

Homicide Rate

Homicide trend data from the Metropolitan Police Department (MPD) indicated a 161% increase from 2014 to 2023 (11). Notably, there was a 36% rise in homicide rates from 2022 to 2023 alone. According to 2023 data from CrimeData DC, Ward 8 recorded 98 homicides; Ward 7 had 56, and Ward 5 reported 35, with the remaining homicides dispersed across other areas of the city (12). From 2021 to 2023, the District consistently ranked among the top five cities nationwide for homicide rates.

Consideration for LTOWB Placement

The placement of LTOWB within the District followed a comprehensive approach, prioritizing health equity for all residents, including those most vulnerable and at risk of violent crime. EMS (supervisor) units 2 and 3, covering all of Wards 7 and 8, were designated as priority units for LTOWB integration. EMS 4 covers Wards 1, 4, and part of 5, while EMS 7 was strategically selected for its Special Operations designation, Surgical Strike Team involvement, and capacity for rapid citywide deployment. An additional unit was assigned to the EMS Battalion Chief to facilitate prompt response to critical or expanding incidents. Using 2023 hot-mapping data on violent crime, the system ensures LTOWB and an EMS transfusionist are accessible within a 10-minute drive time in 99.7% of cases (Appendix A Figure A2).

Program Partnerships

American Red Cross

Sourcing LTOWB presented challenges, as extensive regulatory requirements, such as confirmatory ABO typing, are cost-prohibitive to singular departments and agencies. Partnering with hospital blood banks that have expertise in testing, storing, and transfusing blood products safely and within regulatory requirements offers an opportunity to streamline the process and to minimize blood product wastage. Multiple hospitals were approached to act as an intermediary between the Department and the American Red Cross (ARC). The American Red Cross supported sending LTOWB to the established hospital partner for secondary testing, establishing par levels, access to BloodHub, and training for the Whole Blood Coordinator (WBC).

Trauma Surgeons and Coordinators

The program design and protocol were submitted to the District's Chief Trauma Surgeons and Emergency Department Leaders to ensure a thorough evaluation was completed prior to implementation. Along with an invitation for open commentary, the LTOWB initiative was featured as a critical agenda item during the Department sponsored monthly ED Leaders meetings, allowing all hospital-based stakeholders to provide input and uphold a culture of safety during patient transfers and hand-offs. This open communication approach fostered a high level of trust between the Department and hospital partners, strengthening overall program support.

An open dialogue was established between the Whole Blood Coordinator and Trauma Coordinators from the primary trauma centers. The Chief Trauma Surgeons and Trauma Coordinators contributed their expertise to develop a comprehensive data set for the LTOWB program. This data set is populated with information extracted from electronic health records generated by prehospital providers, ESO Health Data Exchange (HDE) Interface agreements, and the trauma registry. The agreed-upon data set includes 142 data points on each patient administered LTOWB by the Department.

In-Person Hospital Based Training

The Department's LTOWB protocol extends beyond trauma cases to include medical cases with diverse symptomatology. To ensure a robust culture of safety, the Medical Director and Whole Blood Coordinator conducted in-service training sessions for emergency departments across the city. These sessions included a comprehensive overview of the LTOWB program, an information package containing the protocols, a discussion regarding the program's rationale, and direct contact information for the Whole Blood Coordinator and Medical Director. Nurses and physicians received hands-on demonstrations of the transfusion equipment, detailed guidance on documentation requirements for both transfusionists and receiving hospitals and participated in question-and-answer sessions to address any concerns.

Community Engagement

Recognizing the importance of community engagement in the District's diverse population, the Medical Director and Whole Blood Coordinator proactively met with Advisory Neighborhood Commissions and City Council members to address anticipated questions regarding transfusion consent and program structure. Informative question-and-answer sessions were held to ensure community members fully understood the program's benefits and considerations. The Department launched a dedicated website section for the LTOWB program, specifically designed to engage the community and enhance public understanding of its purpose and benefits. In January, the Department officially announced the program through a press conference featuring key stakeholders, including the Mayor and the American Red Cross.

Budgetary and Equipment Considerations

Budgetary Considerations

An actuarial study was conducted to estimate the LTOWB program's overall costs, including start-up expenses, fiscal-year projections, and per-patient administration costs. The start-up cost estimate for equipping five EMS Supervisors with cold chain storage capabilities, disposable and fixed equipment and the initial LTOWB inventory was $53,700. Annual recurring costs based on projected use of 350 LTOWB units per year, along with disposable supplies, totaled $379,242.50.

Each LTOWB unit has an established price with the American Red Cross. Additional disposable supplies and medications were budgeted including normal saline, LifeFlow Infusion devices, Qinflow CDUs, IV and IO supplies, TXA and calcium chloride. The estimated per-patient cost for IV blood administration was $1,000.83, while intraosseous (IO) blood administration was $1,166.27. Excluding additional supplies (IV and IO access supplies, ancillary medications), the cost for blood administration alone was $943.89 per patient. Until January 1, 2025, there was no reimbursement mechanism in place for prehospital agencies administering LTOWB.

Blood Storage

Effective temperature management of LTOWB products is essential to ensure the safety and longevity of the prehospital program. In selecting a validated cold chain storage solution, the objective was to maintain precise temperature control over a 24-hour operational period. LTOWB is stored in a Credo Cooler®, a reusable, military-grade portable cooler equipped with daily rotating inserts (boxes) to maintain a temperature range of 1.5-5.5°C, in accordance with AABB and our local GWUH blood bank standards. Credo Boxes are rotated on a 24-hour basis,

cycling from the Credo Cooler® to the freezer, from the freezer to the refrigerator, and from the refrigerator to the Credo Cooler®. This ensures that each Credo Box® is appropriately primed to align with manufacturer recommendations. Additional units for immediate restocking are stored in a secure medical-grade refrigerator located in the office of the EMS Battalion Chief, also calibrated to maintain a temperature of 1.5-5.5°C.

Continuous temperature monitoring is facilitated by SensorPush HTP.xw Extreme Accuracy Sensors positioned in each Credo Cooler®, refrigerator, and freezer. The assigned sensors capture data every minute, transmitting it via the SensorPush G1 WiFi Gateway to both mobile and desktop applications. The SensorPush device was selected for its independent data storage capability, even when offline, with the ability to store up to 30 days of data. This data automatically syncs with the mobile application when within range of any gateway. Alerts are issued if the temperature deviates from the prescribed range through our unique ArcGIS whole blood program dashboard and ActiveAlert programs linked to the SensorPush dashboard. The on-duty EMS Supervisors, EMS Battalion Chief, Fire Operations Center, and the Whole Blood Coordinator continuously monitor alerts.

Blood Administration

New Orleans Emergency Medical Services demonstrated significant improvements after implementing an Advanced Resuscitative Care (ARC) bundle for patients suffering from severe hemorrhage. Patients who were treated with the ARC bundle demonstrated a lower median heart rate, shock index (SI), and a decrease in both twenty-four-hour and in-hospital mortality rates (13,14). Applying this concept to our program ensured that best practices were followed.

In conjunction with the Credo Cooler®, a specialized bag (ARC bag) was created for the transfusionists containing the equipment required to administer LTOWB to a critically ill or

injured patient. The bag includes the administration equipment to warm and infuse LTOWB via the LifeFlow Plus® Volume Infuser (410 Medical; Durham, North Carolina USA) and the Qin Flow Warrior Lite® Fluid Warmer (Quality in Flow; New Prague, Minnesota USA). Collocated in the bag are calcium chloride, TXA, ETCO2 monitoring equipment, and IO supplies (Appendix B Figure B1).

Administration Documentation

Transfusion Record

When a patient is transported and transfused LTOWB, the receiving hospital is promptly notified via radio transmission. The transfusionist provides a detailed hand-off report through direct, face-to-face communication with the hospital team. The transfusionist and a registered nurse from the receiving team complete a Transfusion Record. This triplicate form includes a barcode sticker with the patient's medical record number (MRN) assigned by the hospital, the Department-issued incident number, the patient name (if available), the ISBT number for the transfused unit(s), and a field to indicate whether or not a transfusion reaction was observed. The LTOWB bag and two copies of the triplicate form remain at the hospital: one copy accompanies the patient's chart, and the second is retained with the LTOWB bag sent to the receiving hospital's blood bank. The third copy is retained by the Department as a back-up to our electronic transfusion record (Appendix B Figure B2).

Electronic Health Record

Following each LTOWB administration, documentation for the patient encounter is completed in the prehospital electronic health record (EHR) system (Digitech Computer LLC, Chappaqua, New York, USA). The EMS Supervisor (transfusionist) is required to document using mandatory fields that align with and exceed THOR-AABB standards. A pre-generated

narrative platform has been implemented to ensure consistency in documentation, efficient capture of specific data points, and ease of use for the EMS Supervisor. Upon completion of the EHR, an email notification with the associated incident narrative is sent to the EMS Battalion Chief, Whole Blood Coordinator, and Medical Director, alerting all parties that a prehospital blood transfusion event has occurred (Appendix B Figure B3 and B4).

Provider Training

Transfusionist Designation

To maintain a reasonable span of control over the LTOWB field operation, the Department designated a select group of ALS Officers to receive transfusionist training. Recognized as a high-acuity, low-frequency skill, this training was initially offered to ALS Officers currently serving as EMS Supervisors. ALS Officers expected to assume EMS Supervisor roles within three months were also trained, along with former EMS Supervisors, following an initial 180-day period. The Department currently has no plans to extend transfusion training to all ALS Officers.

Initial Training Program

EMS Supervisors were assigned two preliminary online modules provided by 410 Medical and Quality in Flow Ltd (QinFlow). These assignments covered foundational knowledge, device setup, and troubleshooting for LTOWB administration. Each course included a 30-minute video followed by a quiz requiring an 80% passing grade. Completion certificates were submitted to the Whole Blood Coordinator before the in-person training.

The Medical Director and Whole Blood Coordinator developed an eight-hour in-person course in partnership with 410 Medical and Quality in Flow Clinical Specialists. The program included a four-hour lecture covering the recognition and management of hemorrhagic shock,

focused instruction surrounding the “Diamond of Death” with attention to avoidance of hypothermia and proactive treatment of hypocalcemia, as well as instruction on protocols for administration, documentation, and recognition of transfusion reactions. The remaining four hours were dedicated to hands-on, practical training guided by clinical specialists, focusing on device setup, administration, and troubleshooting.

Following the online modules and in-person training, EMS Supervisors completed a written and practical examination. The practical component emphasized correct setup and transfusion reaction assessment, while the written test focused on clinical and administrative decision-making. An 80% score on both examinations was required to earn the Department’s Transfusionist designation.

Transfusionist Re-Certification

To maintain proficiency in LTOWB transfusion, ALS Officers with the Transfusionist designation must undergo reevaluation every 90 days. If a Transfusionist has not performed or assisted with an LTOWB transfusion within this period, they are required to meet with the EMS Battalion Chief. During this evaluation, the EMS Battalion Chief ensures the ALS Officer can demonstrate the requisite knowledge, skills, and competencies, including adherence to administration protocols, proper setup for transfusion, and recognition of transfusion reactions. If an EMS Supervisor has successfully administered and documented a LTOWB transfusion within the prior 90-day period, they are marked as ‘complete’ for the mandatory reevaluation cycle.

Department-Wide Training

Before the LTOWB program’s launch, the Department implemented a comprehensive training strategy. A department-wide module was shared through the online learning management system, where the Medical Director outlined the purpose of prehospital transfusions

and procedures for requesting EMS Supervisors with LTOWB. EMS Supervisors conducted battalion-based follow-up sessions to address individual questions, and paramedics attended in-depth training, equipment demonstrations, and Q&A sessions led by the Medical Director and Whole Blood Coordinator during our Department's quarterly Paramedic Grand Rounds.

Operational Mapping and Management

Survey123

An ArcGIS Survey123 (Esri, Redlands CA, USA) smart form is completed at each EMS Supervisor shift change, serving as the official chain of custody documentation for each blood unit. Chain of custody entries can be recorded by scanning the blood unit labels or manually entering the details. Using activity drop-downs, the EMS Supervisor selects the appropriate activity and then verifies and confirms their Unit ID, the LTOWB unit ISBT number, expiration date, and temperature before providing an electronic signature. The smart form must also be completed when a LTOWB unit is moved from one location to another in the system or in the rare instance when a deployed unit is taken off a vehicle and placed into refrigerated storage due to unit downgrade.

The survey also manages the intake and removal of LTOWB from the system. Upon intake from GWUH's blood bank, users can scan the LTOWB barcodes to accurately auto-populate the data into the ArcGIS system. For transfusion events, pertinent details—including the incident number, location, event type, and transport destination—are recorded to ensure comprehensive documentation of blood usage.

ArcGIS Dashboard

To ensure precise accountability of LTOWB, an ArcGIS dashboard was developed to reduce data entry errors and maintain a clear chain of custody. The system seamlessly integrates

data from Kronos Telestaff, SensorPush Dashboard, CAD event data, CAD AVL data, and Survey123. Automated data pulls capture information on the assigned EMS Supervisor, blood storage temperature in the vehicle, active event details, and specific blood unit identifiers, including ISBT number, expiration date, and blood type.

The LTOWB Dashboard is actively monitored around the clock by the Whole Blood Coordinator, EMS Battalion Chief, and Fire Operations Center. This dashboard provides real-time geographic locations of LTOWB-carrying units across the city, ensuring prompt deployment of the nearest LTOWB-equipped EMS Supervisor to critical incidents. It also monitors blood temperature continuously, ensuring it remains within the 1.5-5.5°C range.

To optimize stock rotation, the dashboard color-codes LTOWB units by expiration range. Units within 12-21 days of shelf life are marked with green bands, those at 11-6 days automatically turn yellow, and units within the last five days of expiration are flagged in red. In the final 24 hours before expiration, units are highlighted by a red shaded box to encourage utilization (when clinically indicated) before other units in the system with a longer residual shelf-life.

To maintain a zero-waste system, the Whole Blood Coordinator and EMS Battalion Chief closely monitor expiration dates, prioritizing the rotation of yellow and red-tagged products to high-usage units. To ensure maximum utility, blood nearing expiration is exchanged with green-banded products at high-usage locations (Appendix C Figure C1).

Data Mapping

Meticulous data collection for each transfusion event has been facilitated through ArcGIS Survey123, enabling robust visualization and analysis. A heat map illustrates the frequency of LTOWB use across the city, with lighter colors indicating high utilization zones. Comparative

charts by day and hour provide insights into LTOWB usage rates across various time periods. This data-driven approach informs potential program expansion considerations, ensuring any service gaps are identified and addressed effectively (Appendix C Figure C2).

Special Events

The dashboard includes an additional EMS Supervisor, designated as EMS 9, to enhance operational flexibility. EMS 9 is assigned as a special event EMS Supervisor, capable of responding to incidents within a geo-fenced area outside of standard operations. This role allows EMS 9 to be activated promptly during escalated incidents, supporting the expansion and capacity of steady-state response parameters. When this additional unit is staffed with a LTOWB-certified supervisor, the Survey123 workflow is completed, and the ArcGIS dashboard auto-populates all relevant information for seamless integration and oversight.

Program Supervision

EMS Battalion Chief

The EMS Battalion Chief plays a vital role in the daily operations of the LTOWB program, overseeing supply rotation and restocking. After a transfusion event, the EMS Battalion Chief and Sergeant (aide) are notified of the EMS Supervisor's need for restocking. The Supervisor hands over the transfusion record and ARC bag to the aide who reviews the record for completion and attaches it to the EHR. The aide then electronically removes the used unit from the dashboard, transfers a reserve LTOWB unit from the Credo Cooler® or storage refrigerator to the EMS Supervisor in the Survey123 app, and updates the ArcGIS dashboard and chain of custody records accordingly. Instead of issuing individual supplies to restock the ARC bag, a fully prepared replacement bag is issued, pre-sanitized, and restocked by the EMS Battalion Chief's office. This ensures that all required supplies are appropriately located in

standardized locations within the bag and prevents individual units from deviating from the standardized set-up.

The centrally located EMS Battalion Chief can respond rapidly to deploy additional LTOWB units to critical patients in transit to a hospital. Since the program began, the EMS Battalion Chief and Sergeant have participated in over 10% of LTOWB incidents in the city, providing primary or secondary transfusion support to maximize patient access to this critical resource.

The EMS Battalion Chief is also responsible for coordinating LTOWB pick-ups and restocking from the GWUH blood bank. The Whole Blood Coordinator schedules pick-ups and provides the Battalion Chief and Sergeant with unit ISBT numbers via phone and email. Upon receiving the units, the Sergeant enters the LTOWB units into the Survey123 system, ensuring an updated inventory within the Department's system and display on the ArcGIS program dashboard.

Whole Blood Coordinator

The Whole Blood Coordinator ensures daily oversight of both administrative and operational aspects of the LTOWB program, emphasizing a minimal-waste approach. They manage unit rotation, stock levels, and real-time data across the system, responding promptly to notifications from BloodHub (American Red Cross), coordinating unit orders with the GWUH Blood Bank, and notifying the EMS Battalion Chief for both scheduled and urgent restocking needs.

When a unit is transfused, it is documented through the Survey123 app and later entered in BloodHub by the Coordinator, noting the usage date, time, and incident details. Following each LTOWB administration, the Coordinator reviews the EHR and transfusion record within 72

hours to verify adherence to administration protocols, documentation of any medications administered, and to ensure the narrative includes all necessary transfusion details. If additional documentation is needed, the Coordinator adds comments to the EHR and follows up with the EMS Supervisor for completion on their next shift.

The Coordinator also standardizes data collection, entering relevant EHR data into the LTOWB database. As the primary liaison with hospital Trauma Coordinators, they facilitate data sharing from the trauma registry and, when necessary, request additional patient information from ER or Trauma Coordinators. When appropriate, they also communicate with MPD Homicide for patient demographic and cause-of-death data confirmed by the Medical Examiner.

Program feedback and analytics are provided in a newsletter issued by the Whole Blood Coordinator after every fifty LTOWB administrations. The newsletter offers clinical education and programmatic statistical analyses, review of patient demographics, a catalog of recent medical and trauma related transfusion incidents, and when available, radiographic imaging (x-ray, CT, angiography) linked to the respective transfusion case. Data is presented in written and pictorial formats for clarity. Before publication, the Coordinator ensures compliance with HIPAA regulations in collaboration with the Department's legal counsel. Upon publication, the newsletter is distributed to both the department and external stakeholders, reinforcing the program’s commitment to transparency.

Lessons Learned

Expansion of Scope

When expanding the paramedic scope of practice to include LTOWB administration, it is expected that there may be a delay between program launch and initial use. This is a common aspect of introducing a high-risk, low-frequency skill, as providers may initially be overly

cautious in adoption. In such cases, targeted reassurance, provider support, and clinical education resources will be key in building confidence and readiness. After the first successful administration, utilization is likely to increase as providers become more familiar and comfortable with the process.

To ensure effective oversight of LTOWB administration within the Department, a controlled approach to initiating and expanding the number of trained transfusionists is essential. Limiting this novel skill set to projected high-frequency users and other methodically selected EMS clinicians may generate discontent from those not included in the initial training and roll-out. Therefore, decisions regarding which personnel are trained must be both rational and defensible, underscoring LTOWB as a specialized skill. This approach of only training a select group of EMS clinicians is intended to maximize patient safety when adopting this novel and potentially high-risk practice.

Slow is Smooth

Program expansion should be driven by thorough analysis rather than by initial success and excitement alone. Carefully reviewing collected data and evaluating the actual impact of LTOWB usage across operational areas are essential steps in determining whether additional blood-carrying units should be deployed. Conservation and stewardship of LTOWB are core pillars of the program, ensuring that resources are used effectively and efficiently. Premature expansion, without a data-backed justification, could lead to unnecessary waste and inefficiencies within the system. Therefore, a measured, data-driven approach allows the program to meet clinical needs responsibly while upholding the highest standards of resource stewardship.

Jurisdictional Support

Launching a large-scale initiative like LTOWB in the prehospital setting requires substantial backing not only within the Department but also from the broader jurisdiction. From program inception through to its operational milestones, the ongoing support of the Executive Office of the Mayor and the Deputy Mayor for Public Safety and Justice has been invaluable in establishing the program's credibility and visibility. This support has been evident from the initial press conference announcing the program launch, to its regular feature at public events, and through notable recognitions such as the Mayor's press release commemorating the 125th patient transfused. These actions by top jurisdictional leaders underscore their commitment to advancing prehospital care, increasing public awareness, and highlighting the program's life-saving impact on the community. The visibility and endorsement provided by these leaders have been instrumental in securing stakeholder confidence and fostering a public understanding of LTOWB's critical role in emergency medical services.

Knowledge is Power

When implementing a program that expands the prehospital scope of practice, it is often necessary to address and navigate resistance from regulatory agencies. This resistance may stem from a limited familiarity with contemporary medical advancements. In cases where resistance delays program initiation, a well-founded knowledge base becomes essential. The safety, efficacy and necessity of prehospital whole blood administration can be effectively defended by presenting peer-reviewed research and highlighting the successes of similar programs nationwide.

To streamline communication and ensure regulatory bodies are well-informed, establishing a comprehensive information repository is recommended. This directory should include resources on the use of tranexamic acid (TXA), calcium supplementation, and whole

blood in prehospital settings, as well as evidence supporting its safety and effectiveness. By organizing and disseminating this information, all involved parties gain access to the latest clinical research and data on the program's implementation and outcomes, facilitating informed decision-making and reducing potential barriers to progress.

Bi-Directional Expectations

Data collection is a critical component of the LTOWB program, providing essential justification for its integration within the Department and advancing prehospital medicine both nationally and internationally. Currently, LTOWB programs lack a standardized data set and established key performance indicators.

Establishing Data Use Agreements (DUAs) with key partners from the outset is recommended. These agreements will allow both the LTOWB program and receiving hospitals to define clear parameters for data collection and facilitate the transfer of de-identified information. Leveraging standardized information already available in the Trauma Registry will enable data sharing with minimal impact on partner agencies, streamlining collaboration and enhancing the program's data integrity.

Interagency and Interdisciplinary Collaboration

To establish a successful LTOWB blood program, it is essential to build partnerships with all relevant external stakeholders. This includes maintaining open communication with the American Red Cross blood collector, partner hospital blood banks, receiving hospitals, trauma center associates and their coordinators, and helicopter emergency medical services agencies. Developing a network of these essential partnerships allows the LTOWB program to serve as a steward for evolving collaborations and ensures continuity of care between prehospital providers and hospital staff.

Equally important are internal partnerships within the jurisdiction. Key stakeholders include the regulatory agency for budgeting and procurement, information technology teams for dashboard development, and legal advisors who review data sharing and publication protocols. By fostering strong collaborations within government operations, the program becomes well-rounded, operationally effective, and defensible, supported by a network of cross-agency commitment.

Par Level Considerations

To prioritize LTOWB conservation and stewardship, it is critical to implement robust tracking and management of par levels across the system. Currently, the LTOWB blood program does not return units to the GWUH blood bank. Instead, the Whole Blood Coordinator is responsible for overseeing appropriate rotation and usage throughout the network, ensuring that units are utilized within their expiration period. The partnership with the American Red Cross and GWUH blood bank provides essential flexibility in ordering and adjusting par levels, as well as the capacity to develop a predictive ordering system based on usage trends. This collaborative approach enables more precise inventory management and enhances the program's effectiveness in blood resource stewardship.

Program Coordination

The Whole Blood Coordinator role was initially structured as an overtime position, given the uncertain workload associated with daily program demands. However, as the program has grown, with a strong emphasis on continuous and transparent feedback, the position's workload has regularly exceeded 40 hours per week. Additionally, the Whole Blood Coordinator provides 24/7 support to field providers for decision-making, troubleshooting, and guidance. Ongoing

monitoring of the coordinator's workload underscores the need to establish this role as a full-time position to ensure sustained support and program effectiveness.

Moving Forward

Protocol Review

In collaboration with hospital partners, the Medical Director and Whole Blood Coordinator will conduct a comprehensive review of protocols for both adult and pediatric patients using the four-step PDSA model (Plan, Do, Study, Act). This review aims to develop an inclusive protocol that empowers providers to exercise clinical judgment and expertise in transfusion decisions. Current revision considerations include explicitly excluding patients with penetrating head trauma from the transfusion protocol, as well as updating vital sign parameters—such as blood pressure, heart rate, and End-Tidal Carbon Dioxide (ETCO2) levels—for adult medical and trauma patients.

A comprehensive review and revision of all DC Fire and EMS protocols is currently underway. Protocols where LTOWB administration is applicable will be clearly identified with a distinct symbol. This visual cue will alert providers to consider LTOWB when clinically indicated with the aim of ensuring EMS clinicians leverage all available resources for the most critically ill and injured patients.

Program Expansion

Program expansion is under consideration; however, further data is needed to support any adjustments to current program operations. This includes evaluating the feasibility of equipping additional EMS Supervisors with LTOWB or adding a second unit of LTOWB to EMS Supervisors assigned to zones with high rates of penetrating trauma. Leveraging ArcGIS and its heat map functionality, LTOWB administration cases can be overlaid with the response areas of

the respective EMS Supervisors. The program actively monitors the response times of EMS Supervisors to LTOWB cases as well as dispatch-to-administration times, both of which currently align with program expectations.

Advanced Resuscitation Protocols

Point of Care Ultrasound

Point-of-care ultrasound (POCUS) is rapidly becoming a standard of care in prehospital patient management. Studies have documented the positive impact POCUS can have on mortality rates, diagnostic accuracy, patient care metrics, and patient satisfaction (15). Recently, the Department procured AI-guided ultrasound devices and is exploring the expansion of EMS Supervisors' scope of practice to include POCUS.

Upon completing a comprehensive training program, EMS Supervisors will be equipped to use POCUS for both medical and trauma cases. For trauma patients, POCUS allows rapid clinical assessment through an Extended Focused Assessment with Sonography for Trauma (eFAST) exam. When combined with LTOWB administration, the eFAST exam may facilitate the early mobilization of trauma team resources for patients with severe injuries.

POCUS also provides valuable assessment capabilities for pregnant trauma patients, especially those with uncontrolled vaginal bleeding. In cases of traumatic maternal cardiac arrest, POCUS may assist in the coordination of multidisciplinary teams to optimize maternal and neonatal outcomes. The Obstetric Life Support Manual (16) outlines specific guidelines recommending an eFAST exam alongside the rapid infusion of blood products, emphasizing damage control resuscitation in these traumatic cases.

REBOA

Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) is in some unique and limited settings emerging as a highly specialized skill in prehospital trauma care. For prehospital application, REBOA involves catheter placement in Zone 1 (supraceliac) for managing non-compressible torso hemorrhage. Studies have demonstrated REBOA's association with improved proximal blood pressure and reduced early mortality within the first three to seventy-two hours post-injury (17). When used alongside LTOWB, REBOA can significantly enhance proximal blood pressure and myocardial perfusion in patients experiencing severe shock or traumatic cardiac arrest (TCA) due to subdiaphragmatic hemorrhage, optimizing resuscitative efforts (18). By analyzing the LTOWB dataset and monitoring injury patterns for blunt and penetrating trauma, REBOA may be evaluated as a potential intervention for use by highly skilled clinicians within the Department.

Finger Thoracostomy

Finger thoracostomy (simple thoracostomy) has the potential to provide much more effective prehospital treatment for both pneumothorax and hemothorax compared to needle thoracostomy. When coupled with a thoracic POCUS assessment, the decision to perform a finger thoracostomy can be made more confidently. In combination with LTOWB, finger thoracostomy supports rapid damage control resuscitation. Through collaboration with our hospital partners and analysis of LTOWB dataset injury patterns for blunt and penetrating trauma, finger thoracostomy is being evaluated as a potential intervention for use by skilled clinicians within the Department.

Dedication to Transparency and Research

The LTOWB program emphasizes transparency in data collection, publication, and ongoing research as its core foundation. In addition to the published newsletters that feature case

studies of patients receiving transfusions, the program has actively engaged in collaborations with hospitals, agencies, and departments for LTOWB-focused studies. These studies aim to expand the use of LTOWB where clinically appropriate.

The Medical Director and Whole Blood Coordinator are currently investigating whether the shock index (SI) alone justifies LTOWB administration or if additional vital signs are necessary to support its use. A secondary study is being proposed to examine the application of LTOWB in traumatic cardiac arrest (TCA) cases occurring prior to department arrival and to assess the feasibility of resuscitation in such scenarios. The LTOWB team, in collaboration with the Department's data analysts, Tulane University, and New Orleans EMS, is working to publish a comprehensive analysis of LTOWB data within an urban setting.

Additionally, Chief Trauma Surgeons from partner hospitals have proposed several research projects. The first aims to conduct a historical analysis of trauma registry data and LTOWB administration to validate its role in reducing mortality rates for patients with similar injury profiles, as determined by the Abbreviated Injury Scale (AIS) or Injury Severity Score (ISS). Additional proposed research includes mortality rate comparisons for patients with similar injury severity scores transported and transfused by EMS versus those that arrive to hospitals by other means and receive transfusion after hospital arrival.

Cold Chain Storage Programming

The principles of cold chain storage implemented in the LTOWB program have been thoroughly documented and validated, establishing the necessary controls to support expansion across other areas within the Department. The Mobile Integrated Health program has substantially broadened its scope of practice and the services available to District residents. One area of expansion includes a comprehensive at-home immunization program, offering multiple

vaccines and other temperature-sensitive medications. By applying the temperature monitoring standards developed for the LTOWB program, the Department can ensure that all vaccines are maintained within the critical 2-8°C range.

Closing

The integration of low-titer type-O whole blood transfusion (LTOWB) into the DC Fire and EMS catalog of clinical and operational capabilities was a complex and challenging process. The proposition that our prehospital clinicians could effectively identify patients in need of transfusion and safely administer this treatment—traditionally reserved for in-hospital teams with immediate access to blood banks—was met with initial skepticism. However, our persistence in advancing this initiative was driven by valuable information sharing and support from agencies already engaged in similar practices, alongside the recognition that, when equipped with the right tools, our EMS clinicians could significantly improve outcomes for patients suffering from hemorrhagic shock.

In the first seven months of the DC Fire and EMS whole blood transfusion program, nearly 170 units of whole blood were safely administered. Notably, approximately 80% of the transfused patients were victims of penetrating trauma, many of whom were treated east of the Anacostia River, an area lacking trauma centers. Through this innovative program, DC Fire and EMS has made strides in improving health equity by providing our most geographically and socioeconomically disadvantaged patients with a greater opportunity for optimal outcomes. Of the transfused patients, 69% survived to hospital admission, and when excluding those found in traumatic cardiac arrest (cardiovascular collapse), an exceptional 93% of transfused patients survived.

Research by Duchesne et al (13) has reinforced that "every minute matters" for patients experiencing exsanguination. In the critical window between injury and hospital arrival, our EMS system and the dedicated clinicians within it play a pivotal role. The integration of EMS care into the broader healthcare system is essential for achieving optimal patient outcomes. The success of the DC Fire and EMS whole blood transfusion program underscores this idea and demonstrates the profound impact that a well-supported and innovative program can have on saving lives.

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Appendix A

Justification for Use Graphics

Figure A1: DC Fire and EMS Receiving Facilities Map

Figure A2: Washington DC CY2023 hot-map of violent crime locations with calculated and overlaid 10-minute drive times for each deployed EMS transfusionist

Appendix B

Administration and Documentation

Figure B1: Catalog of items contained in the transfusionists equipment bag

Figure B2: Transfusionist record triplicate form

Figure B3: Customized prehospital electronic health record (EHR) dropdown fields (Digitech Computer LLC, Chappaqua, New York, USA) used to document LTOWB transfusion

Figure B4: Customized narrative template (Digitech Computer LLC, Chappaqua, New York, USA) used to document LTOWB transfusion

Appendix C

Operational Mapping and Management

Figure C1: DC Fire and EMS ArcGIS Whole Blood dashboard which integrates data from staffing software, temperature monitoring devices, computer aided dispatch (CAD), automatic vehicle location (AVL) and Survey123

Figure C2: A heat map of LTOWB transfusion events in Washington DC with lighter colors indicating higher utilization zones