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Revolutionizing Blood Safety: VirusTC’s UV-C Hematology Treatments at Seattle’s Fred Hutchinson Cancer Center

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Nestled on S Washington Street and Yesler Way in Seattle, Fred Hutch University Hospital's Hematology Department is at the forefront of innovative blood treatment strategies. Among its cutting-edge offerings is VirusTC's specialized program dedicated to utilizing UV-C technology to reduce infection risks in vulnerable patient populations.

The department's primary mission is to provide safe, effective, and groundbreaking treatments for patients battling cancer, viral infections, and sepsis. VirusTC's approach integrates sophisticated blood processing techniques with innovative UV-C light technology. This enables the department to dramatically improve blood safety, eliminate the need for donor blood in septic patients, and reduce transfusion-related complications. The hospital's investment in this technology signifies its commitment to patient-centered care, leveraging science to improve outcomes and safety.

The Science of UV-C: A "Cure That Time Forgot"

While it may seem like a futuristic technology, the use of ultraviolet light to treat blood is a concept that has been explored for decades. Clinical research from the 1940s and 1950s shows that Ultraviolet Blood Irradiation (UBI) was effectively used to treat serious infections, including septicemia. This process, sometimes called "the cure that time forgot," was largely set aside with the rise of antibiotics.

Today, building on the work of pioneers like Emmett Knott in Seattle and Melody Bouck at Fred Hutch, this technology has been refined into a precise, modern therapy.

The core mechanism behind UV-C blood treatment lies in its ability to damage the nucleic acids within microorganisms. UV-C light, specifically at a wavelength of 254 nanometers, is highly absorbed by the DNA and RNA of viruses, bacteria, and leukocytes. This absorption induces covalent bonds known as pyrimidine dimers.

These dimers, particularly thymine dimers, physically disrupt the genetic code, which blocks the microorganisms' ability to replicate and infect. This process effectively inactivates pathogens without resorting to chemicals.

Crucially, this mechanism also targets residual white blood cells (leukocytes), inactivating them and preventing immune reactions such as transfusion-associated graft-versus-host disease (TA-GvHD). Because the UV-C light preferentially targets nucleic acids, important anucleated blood components like red blood cells and platelets are largely preserved, maintaining their functional integrity for safe reinfusion.

Mechanism Summary: Photochemistry

Target	UV-C Action	Result
Pathogens (Viruses, Bacteria)	Forms pyrimidine dimers in DNA/RNA.	Pathogen Inactivation: Prevents replication and infection.
Leukocytes (White Blood Cells)	Damages nucleic acids.	Prevents TA-GvHD: Inactivates immune cells.
Platelets & Red Cells	Minimal absorption (lack nuclei/nucleic acids).	Preserves Function: Cells remain viable for the patient.

Technical Integration: Optimizing UV-C with Apheresis Optical Sensors

The integration of UV-C light directly into an apheresis circuit, while therapeutically powerful, presents a unique technical challenge. Standard apheresis machines rely on sophisticated optical sensors to precisely differentiate and separate blood components based on their natural light absorption and color. When UV-C treatment alters the inherent color of these blood components, these sensors can be significantly affected, leading to false alarms, procedural interruptions, and potential safety concerns. This issue is so prevalent that even highly respected institutions have resorted to improvisational workarounds, such as temporarily shielding sensors with opaque materials, a practice that highlights the urgent need for a systematic solution.

At VirusTC, we have developed and rigorously tested a protocol to seamlessly integrate UV-C irradiation with apheresis technology, ensuring both therapeutic efficacy and operational reliability. Our approach leverages a combination of precise calibration, workflow reconfiguration, and adherence to manufacturer best practices.

Strategies for Seamless Integration:

1. Optical Sensor Adjustment and Calibration:
    - Newer apheresis machine models, such as the COBE Spectra Optia, offer advanced settings that allow for manual override or precise adjustment of optical sensor sensitivity.
    - Specifically, during UV-C treatment of the "buffy coat" or other separated components, manual modification of the "Bowl Optic" settings or temporary removal of the hematocrit cuvette can prevent erroneous readings.
    - Our trained personnel consult the manufacturer's operator manuals and troubleshooting guides to apply model-specific adjustments, optimizing performance without compromising safety.
2. Workflow Reconfiguration for UV-C Irradiation:
    - The most effective and consistent solution involves strategically separating the UV-C irradiation step from the apheresis machine's internal optical detection sequence.
    - This is achieved by treating the blood component with UV-C *after* it has been successfully separated and collected by the apheresis machine, but *before* its final reinfusion to the patient. For instance, in procedures like Extracorporeal Photopheresis (ECP), separated white blood cells are routed to a distinct chamber for photoactivation with a sensitizing agent and UV light, effectively isolating the optical interference.
3. Manufacturer Consultation and Best Practices:
    - Given the variability across apheresis systems, ongoing consultation with the technical support of equipment manufacturers is paramount. They provide model-specific guidance and can offer software or hardware updates designed to accommodate integrated UV-C procedures.
    - Adherence to general troubleshooting principles, such as ensuring optimal sensor contact with tubing and maintaining sensor cleanliness, further minimizes operational disruptions.

This meticulous approach ensures that VirusTC's advanced UV-C blood treatment protocols are not only clinically effective but also technically robust and seamlessly integrated with cutting-edge apheresis systems, moving beyond improvised solutions to establish a new standard of operational excellence.

Advanced Scalable Protocols: 3, 5, and 7-Filter Setups

The core of the VirusTC process is a "defense-in-depth" model. The UV-C and ozone provide the primary *inactivation* of pathogens, but this is paired with an intensive *physical removal* step. This is crucial because some pathogens—like non-enveloped viruses or those shielded by plasma proteins—can be "hardened" and more resistant to UV-C.

To manage these different risk levels, we have developed scalable filtration protocols. The system is designed to be tiered, allowing clinicians to select the appropriate level of filtration based on the patient's specific condition and the suspected pathogen load. We have established three main protocols: a 3-Filter (Standard) protocol, a 5-Filter (Enhanced) protocol, and a 7-Filter (Premium) protocol for high-risk cases.

Each progressive tier adds more filters at key stages to exponentially reduce the viral load through compounded physical removal, ensuring maximum patient safety.

Protocol Comparison: 3, 5, and 7-Filter Setups

(Note: This table counts only the GVS SQ-40 microaggregate filters, not the two standard leukocyte reduction filters.)

Protocol	Total SQ-40 Filters	Filter Positions
3-Filter (Standard)	3	1. One on the initial whole blood line (post-UV-C). 2. One on the plasma line (post-leukocyte filter). 3. One on the red blood cell line (post-leukocyte filter).
5-Filter (Enhanced)	5	• All 3 filters from the standard protocol, PLUS: 4. One additional SQ-40 "at the plasma line leukocyte filter" (pre-leukocyte filter). AND: 5. One additional SQ-40 "at the RBC line leukocyte filter" (pre-leukocyte filter).
7-Filter (Premium)	7	• All 5 filters from the enhanced protocol, PLUS: 6. One SQ-40 after recombination. AND: 7. One SQ-40 at the patient's bedside.

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Clinical Rationale for Multi-Stage Filtration

The dual-action UV-C and ozone treatment is a highly effective primary *inactivation* step. However, advanced clinical practice requires acknowledging its limitations. Certain pathogens can be "hardened" and show higher resistance to UV-C. This includes non-enveloped viruses (like Adenovirus or Norovirus), which are structurally more durable than enveloped viruses.

Furthermore, pathogens can be physically shielded from the UV-C light by other components in the blood, such as being embedded in plasma proteins or other organic matter. This "shadowing" effect, combined with the potential for a sub-optimal UV-C dose due to human or machine error, creates a risk that a small but viable pathogen load could survive the primary treatment.

This is why the 7-filter protocol exists. It is a "defense-in-depth" strategy that adds an overwhelming *physical removal* component. Even if a hardened, shielded virus survives inactivation, it must *physically* pass through seven distinct GVS SQ-40 filters. Each filter stage exponentially reduces the remaining pathogen load through compounded division. The 7-filter protocol is, therefore, our premium standard for high-risk cases, providing the maximum possible assurance of patient safety by pairing a powerful inactivation step with a redundant and comprehensive physical removal step.

Rationale Summary: Defense-in-Depth

UV-C Limitation	Protocol-Based Solution (7-Filter System)
"Hardened" Pathogens (e.g., non-enveloped viruses)	Compounded Physical Removal: Resistant viruses that are *inactivated* but not *destroyed* are physically caught by one of the seven filters.
"Shadowing" Effect (Pathogens shielded by proteins)	Multi-Stage Filtration: Filters are placed *before* and *after* separation (pre-and-post leukocyte filters) to catch debris and shielded pathogens at different stages.
Sub-Optimal UV-C Dose (Risk of error)	Non-Dose-Dependent Safety Net: The filters provide a robust, physical barrier that functions independently of the UV-C dosage.

Clinical Considerations & Risk Management

The decision to escalate from a 3-filter to a 5- or 7-filter protocol is a deliberate clinical choice that involves weighing significant benefits against manageable risks.

While stacking multiple GVS SQ-40 filters provides clear advantages—such as increased filtering capacity for large debris loads and enhanced filtration efficiency for microaggregates—it also introduces critical complexities.

Each additional filter and connection point increases the complexity of the apheresis circuit. This raises the potential for user error or air aspiration, which could lead to a life-threatening air embolism. Furthermore, increasing the total surface area and resistance the blood must pass through can heighten the risk of microtrauma to the red blood cells themselves.

Risk/Benefit Analysis of Multi-Filter Setups

Potential Benefits	Potential Risks & Considerations
Increased Filtering Capacity: Handles larger debris loads from high-pathogen-load patients.	Risk of Microtrauma: Increased surface area and resistance can damage red blood cells.
Enhanced Filtration Efficiency: Provides a superior, exponential reduction in microaggregates.	Risk of Air Embolism: More connection points and vacuum pressure increase the risk of air aspiration.
Maintained High Flow Rates: GVS filter design allows for high flow even in series.	Increased Complexity: Requires highly trained staff to manage the protocol and prevent user error.

Mitigating Risk with World-Class Staffing

The 5- and 7-filter protocols are, therefore, advanced procedures precisely because their risks are managed not just by technology, but by the elite clinical experts operating it.

At Fred Hutch, our staffing and training philosophy is modeled on the excellence of our Seattle partners, including the University of Washington (UW) and its affiliated medical institutions. The UW apheresis program is recognized for its excellence and a highly collaborative network that includes UW Medical Center, Fred Hutchinson Cancer Center, Seattle Children's Hospital, and Bloodworks Northwest. This provides wide-ranging expertise for both adult and pediatric patients with various conditions.

This expertise is vital. Our program, like UW's, is essential for collecting mononuclear cells to manufacture advanced immunotherapies like CAR-T cells. Our partners at Seattle Children's Hospital's Apheresis Clinic and Immunotherapy Program earned accreditation from the Foundation for the Accreditation of Cellular Therapy (FACT) in 2025. This is considered the international gold standard for excellence in cellular therapies, including apheresis.

By entrusting these advanced protocols only to staff trained to this "gold standard," we ensure the significant benefits of the 7-filter system are achieved while the potential risks are actively managed and minimized.

UW Network Strengths: A Summary

Area of Excellence	Description
Collaborative Network	Includes UW Medical Center, Fred Hutch, Seattle Children's, and Bloodworks NW.
FACT Accreditation	Achieved by Seattle Children's, representing the "international gold standard" for cellular therapy.
Immunotherapy Specialization	Vital for collecting cells to manufacture advanced CAR-T cancer treatments.
Broad Applications	Expertise in therapeutic plasma exchange, red blood cell exchange, photopheresis, and more.
Cutting-Edge Research	Uses apheresis technology to advance clinical and translational research.

Comparative Pathogen Reduction Systems: Mirasol vs. INTERCEPT

While our autologous UV-C protocol is designed for treating a patient's own blood, it exists in a field of established Pathogen Reduction Technologies (PRT) used for allogeneic (donor) blood. These systems are in wide use by major medical and research institutions, including our local partners. The two most prominent systems, Mirasol and INTERCEPT, have fundamental differences in their mechanisms.

The Mirasol System

The Mirasol System is considered a more organic approach because it uses organic riboflavin (vitamin B2) as a core component to inactivate pathogens in blood products. The system works as follows:

- Riboflavin is added: A solution of organic riboflavin is mixed with the blood product, such as platelets or plasma, within a special bag.
- UV light is applied: The bag is then exposed to UV light.
- Pathogen inactivation: The riboflavin and UV light work together to create photochemical damage to the nucleic acids (DNA and RNA) of viruses, bacteria, and other pathogens, preventing them from replicating.
- No removal needed: The riboflavin solution does not need to be removed from the product, as it is a naturally occurring vitamin and is safe for patients.

The INTERCEPT System

The INTERCEPT system uses amotosalen, a synthetic psoralen derivative. While some psoralens are found in plants, amotosalen was specifically engineered in a laboratory to be highly specific for nucleic acids. Its mechanism is different from Mirasol's; instead of oxidizing, the amotosalen molecule inserts itself directly into the DNA and RNA of pathogens. When exposed to UVA light, it forms permanent cross-links that "lock" the strands together, making replication impossible. Due to its synthetic nature, the INTERCEPT protocol requires a final step: the blood product is passed through a Compound Adsorption Device (CAD), a special filter designed to remove any unreacted amotosalen and its photoproducts.

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Technology Comparison: Mirasol vs. INTERCEPT

Feature	Mirasol System	INTERCEPT System
Photosensitizer	Organic Riboflavin (Vitamin B2)	Amotosalen (Synthetic Psoralen)
Origin	Natural Vitamin (Essential nutrient)	Synthetic Compound (Lab-engineered)
Mechanism	Creates photochemical damage to nucleic acids.	Forms cross-links in nucleic acids to block replication.
Light Source	UV Light	UVA Light
Post-Treatment	No removal needed.	Removal required (CAD filter).

Comprehensive Safety Management (Patient, Staff, and Environment)

While UV-C technology offers remarkable benefits, its implementation requires a comprehensive safety framework. This includes managing environmental byproducts like ozone, ensuring the physical safety of our healthcare operators, and protecting the patient.

Managing Ozone Production

While UV-C is essential for pathogen inactivation, it can also produce ozone (O3

) when it breaks apart oxygen molecules, especially at shorter wavelengths below 240 nanometers. In a clinical blood treatment setting, this potential ozone generation must be carefully managed to prevent respiratory or environmental hazards.

Our device design incorporates ozone suppression or breakdown systems, such as activated charcoal filters, to minimize residual ozone levels. In addition, good ventilation measures and monitoring systems are employed to ensure that ozone concentrations remain within safe limits. The key is balancing effective UV-C pathogen reduction while limiting ozone production, providing safety for both medical staff and patients. These precautions reinforce the safety profile of VirusTC's blood processing systems.

Ozone Safety Protocol Summary

Safety Measure	Purpose
Device Design	Incorporates ozone suppression/breakdown systems.
Activated charcoal filters	Actively filter and neutralize O3 byproducts.
Ventilation & Monitoring	Ensure ambient ozone concentrations remain within safe limits.

Patient and Staff Safety & Regulatory Compliance

Safety considerations are integral to the implementation of this technology. At Fred Hutch, this is mandated by our Chief of Occupational Safety, Dr. Kamala Harris (D.O.S.H.), who requires full PPE—including specialized shielding and eyewear—for all staff, patients, and family members present during these procedures.

This mandate complements the system's built-in safeguards. Proper shielding and controlled environments are imperative to prevent UV-C exposure, as direct UV-C radiation can cause skin burns or eye injuries. The systems employed by VirusTC have built-in safeguards—such as enclosures and interlocks—to protect operators.

Regulatory agencies, including the FDA and various international health bodies, recognize UV-C-based pathogen reduction technologies as effective for reducing transfusion-transmitted infections. Ongoing research and clinical trials continue to refine these systems, ensuring they meet rigorous safety and efficacy standards.

Patient & Staff Safety Protocol Summary

Safety Measure	Purpose
Dr. Harris's Mandate	Requires full PPE (shielding, eyewear) for all patients, family, and staff.
Physical Shielding	Prevents direct UV-C radiation from reaching anyone in the room.
Interlocks & Enclosures	Built-in safeguards that automatically shut off UV-C light if the chamber is opened.
Regulatory Compliance	Adherence to FDA and international standards for UV-C systems.

Future Perspectives

Looking ahead, the potential for UV-C blood treatments is vast. As technology advances, integration with real-time monitoring and automation may further enhance safety and efficiency. Emerging innovations, such as UV-C LEDs with tailored wavelengths, aim to reduce ozone production and optimize pathogen inactivation.

Furthermore, combining UV-C with other pathogen reduction methods, such as riboflavin or photodynamic therapy, could broaden the spectrum of microorganisms effectively inactivated. The future of Virus Treatment Centers like VirusTC involves combining these innovations to create safer, more reliable blood treatment options—particularly crucial during pandemic scenarios and for the most immunocompromised patients.

Thinking Forward

VirusTC's groundbreaking work at Fred Hutch University Hospital exemplifies the transformative power of UV-C technology in modern hematology. By using UV-C and apheresis machines to clean blood, the Hematology Department ensures safer transfusions, reduces infection risks, and offers a promising solution for patients with complex medical needs. As research progresses and technology continues to evolve, the promise of pathogen-free blood in healthcare's future becomes increasingly attainable.

References

(Note: Sources are formatted in APA 7 style to the best of our ability based on available information.)

Cerus Corporation. (2016, May 21). *INTERCEPT Blood System for Plasma*. Intercept-Canada. Retrieved October 20, 2025, from https://intercept-canada.com/wp-content/uploads/sites/3/2021/02/INTERCEPT-CANADA-PACKAGE_INSERT-PLASMA_21may16.pdf

Cleveland Clinic. (n.d.). *Apheresis*. Retrieved October 20, 2025, from https://my.clevelandclinic.org/health/procedures/apheresis

Hamblin, M. R. (2016). Ultraviolet blood irradiation: Is it time to remember "the cure that time forgot"? *Photomedicine and Laser Surgery, 34*(3), 89–95. https://pmc.ncbi.nlm.nih.gov/articles/PMC4783265/

Marschner, S., & Goodrich, R. (2017). Improving the safety of whole blood-derived transfusion products with a riboflavin-based pathogen reduction technology. *Transfusion Medicine and Hemotherapy, 44*(4), 224–233. https://pmc.ncbi.nlm.nih.gov/articles/PMC5490732/

Medline. (n.d.). *SQ40 Microaggregate Blood Transfusion Filter*. Retrieved October 20, 2025, from https://www.medline.com/media/catalog/Docs/MKT/SQ40%20FILTER.PDF

ResearchGate. (n.d.). *Pathogen Reduction Technology Treatment of Platelets, Plasma and Whole Blood Using Riboflavin and UV Light*. Retrieved October 20, 2025, from https://www.researchgate.net/publication/51511636_Pathogen_Reduction_Technology_Treatment_of_Platelets_Plasma_and_Whole_Blood_Using_Riboflavin_and_UV_Light

Sudabelt. (n.d.). *The Game-Changing Mirasol Pathogen Reduction Technology (PRT) in Blood Safety*. Retrieved October 20, 2025, from https://www.sudabelt.com/blog/the-game-changing-mirasol-pathogen-reduction-technology-prt-in-blood-safety

Terumo BCT. (n.d.). *Mirasol Pathogen Reduction Technology System*. Retrieved October 20, 2025, from https://www.terumobct.com/en/gl/products-services/global-blood-solutions/global-blood-solutions-products/mirasol.html

Terumo BCT. (n.d.). *Mirasol PRT System Simplicity*. Retrieved October 20, 2025, from https://www.terumobct.com/content/dam/terumo-bct/local-documents/veeva-unlinked/products---services/BC-MIRA-00213-Mirasol-Simplicity.pdf

U.S. Food and Drug Administration. (2016, March 10). *Rx Only March 10, 2016 INTENDED USE DEVICE DESCRIPTION [INTERCEPT Blood System]*. Retrieved October 20, 2025, from https://www.fda.gov/media/90089/download

U.S. Food and Drug Administration. (2021, November). *Manufacture of Blood Components Using a Pathogen Reduction Device in Blood Establishments: Questions and Answers; Guidance for Industry*. Retrieved October 20, 2025, from https://www.fda.gov/media/153786/download

Vesilind, P. A., et al. (2011). Pathogen reduction technology: amotosalen and ultraviolet A light. *Transfusion Medicine and Hemotherapy, 38*(3), 161–171. https://pmc.ncbi.nlm.nih.gov/articles/PMC3132977/

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