CELL & GENE THERAPY INSIGHTS

INNOVATOR INSIGHT

Cryopreserving CAR-T cells in a novel rigid container maintains their phenotype and function compared to conventional cryobags and cryovials

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CAR-T cell therapies are rapidly emerging as an effective treatment and even cure for malignant cancers. How these therapies are cryopreserved is essential to preserving their cancer killing function and how they are shipped is important in reliably delivering these life-saving treatments to patients. Here, we compared CAR-T cells cryopreserved in a novel, rigid-walled container—the CellSeal® CryoCase™ (CryoCase)—to those cryopreserved in the conventional cryobags and cryovials used in the industry. We found that CAR-T cells can be effectively cryopreserved in the CryoCase using the same controlled rate freezing profiles and methods used for standard cryobags and cryovials. CAR-T cells cryopreserved in the CryoCase maintained cell viability and cell recovery above 85%, similar to CAR-T cells cryopreserved in both cryobags and cryovials. Expression of the chimeric antigen receptor (CAR) on T cells was similar across all cryopreservation containers tested. CAR-T cell phenotype was also comparable across the different cryogenic containers, with no significant difference in the distribution of CD4+ helper T cells and CD8+ cytotoxic T cells, as well as naïve and memory T cells. The CryoCase was also compatible when tested in a fully automated and closed CAR-T manufacturing process, where it provided a robust and easy-to-use solution for product fill and finish, with critical quality attributes identical to CAR-T cells stored in cryobags and cryovials. Collectively, these results offer insight into a novel cryopreservation process and container for CAR-T cells, and explore how the fitness and function of CAR-T cells compares across the different containers that they are cryopreserved and stored in.

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INTRODUCTION

CAR-T cell therapies have revolutionized the treatment of malignant cancers, offering unprecedented efficacy and the potential for lasting remissions. The success of these therapies depends not only on the engineering of potent CAR-T cells, but also on the meticulous processes of cryopreservation and storage that ensure their viability and functionality from the lab to the clinic.

Since 2017, these cell-based immune-oncology products have continued to transition from translational research to approved advanced therapy products in major regulated jurisdictions around the world [1]. Accordingly, the reliance on legacy manufacturing processes, equipment, and components continues to evolve. Products developed specifically to support commercial scale-out of autologous manufacturing processes of cell-based therapeutics continue to be adopted, reducing the manufacturing challenges arising from the use of borrowed technology. For example, in the last few years, several closed-process fill systems have been released to reduce the manufacturing burden of final fill in Grade A spaces and provide more reproducible processes [2]. Notably, one aspect of manufacturing that has not significantly changed is the toolbox of final product containers. Traditional methods employing cryobags and cryovials have been the industry standard. However, cryobags pose limitations such as fragility and difficult-to-identify particulate burden, and cryovials support a limited range of volumes before the freezing profile across the sample becomes meaningfully different. For example, with respect to cryovials, the surface-to-area volume ratio of a 5 mL vial compared to a 50 mL vial results in substantially different freezing kinetics in the center of the sample. Bag fracture during storage or shipping in the frozen state is likely to result in complete product loss or the need to use a potentially contaminated cell suspension. Critically, discarding the product would lead to treatment delays with serious implications for patient outcomes. While there is variability in fracture rates across bag materials and manufacturers, processing has a major impact on physical stability and high rates of fracture can be observed [3]. Fracture represents a significant risk, and mitigation strategies during transport, shipping, and storage are very burdensome. Fracture may rank as one of the most critical product risks to mitigate in many cases. As made clear by recent regulatory actions [4], particulates are an area of focus and containers that allow improved inspection or manufacturing processes could result in a significant improvement in the industry.

This study explores the efficacy of a novel rigid-walled cryogenic container, the CryoCase, designed to overcome the limitations of existing solutions. We compared CAR-T cells cryopreserved in the CryoCase with those stored in conventional cryobags and cryovials, evaluating key parameters such as cell viability, recovery, phenotypic stability, and functional markers post-thaw. Our findings suggest that the CryoCase not only matches the performance of traditional containers, but also offers enhanced durability and flexibility, potentially setting a new standard in the cryopreservation of CAR-T cell therapies.

MATERIALS AND METHODS

CellSeal CryoCase

The CellSeal CryoCase is a rigid container manufactured from cyclic olefin co-polymer

(COC) with injection molded fill and vent tubes manufactured of ethylene-vinyl acetate (EVA). The fill tube is connected to polyvinyl chloride tubes with multiple Luer-type fittings. The fill tube can be connected using tube welding or through existing fittings. The vent line is fitted with a removable 0.22 µm disc filter to allow air escape and an in-line microbial barrier filter that remains for use post-cryopreservation. The container has a maximum recommended fill volume of 75 mL. Fill and cryopreservation are carried out in a vertical orientation, resulting in consistent surface area-to-volume ratios across a range of fill volumes. Comparable cell recovery and viability has been observed in various volumes ranging from 75 mL to less than 20 mL (data on file).

T cell culture, transduction, and harvest: G-Rex® flasks

CD3+ Pan T cells from normal healthy donors were purchased from Charles River Laboratories Cell Solutions (Cat#PB03NC-4). T cells were expanded in G-Rex 100 flasks for 8–9 days until fully confluent, per the manufacturer's recommended protocol [5]. Cells were expanded in TexMACs® GMP medium (Miltenyi Biotec, Cat#170–076–306), supplemented with 100 IU/mL IL-2 (R&D Systems, Cat#202-IL-050). T cells were activated using Human T Cell TransAct™ (Miltenyi Biotec, Cat#130–111–160) at the manufacturer's recommended concentration. One day after activation, T cells were transduced with a third-generation CD19 CAR lentivirus (Creative Biolabs, Cat# VP-CAR-LC69) at a multiplicity of infection (MOI) of 1 per the manufacturer's recommended protocol. After 8–9 days of culture, CAR-T cells were harvested from the G-Rex flasks and then washed and concentrated using a benchtop centrifuge (Sorvall ST). Cells were washed with Plasma-Lyte A (Baxter, Cat#2B2544X) containing 5% (v/v) of human serum albumin (HSA; Akron Bio, Cat#AK8228–0100) and concentrated to a target volume of 30×10^6 viable cells/mL prior to formulation and fill-finish into different containers.

T cell culture, transduction, and harvest: CliniMACS® Prodigy

To simulate a fully closed and automated CAR-T manufacturing process, CAR-T cells were activated, transduced, and expanded in the CliniMACS Prodigy platform (Miltenyi Biotec) according to previously published protocols. Briefly, CD4+ and CD8+ T cells were isolated from a cryopreserved, healthy donor leukopak purchased from Charles River Laboratories Cell Solutions (Cat#PB001CLP-RnD) using GMP CD4 Microbeads (Miltenyi, Cat#200–070–213) and GMP CD8 Microbeads (Miltenyi Biotec, Cat#200–070–215). T cells were cultured in TexMACs GMP medium (Miltenyi Biotec, Cat#170–076–306), supplemented with 100 IU/mL IL-2 (Akron Biotech, Cat#AR1045–0010). T cells were activated using Human T Cell TransAct (Miltenyi Biotec, Cat#200–076–204) at the manufacturer's recommended concentration. One day after activation, T cells were transduced with a third-generation CD19 CAR lentivirus (Creative Biolabs, Cat#VP-CAR-LC69) at an MOI of 1 per the manufacturer's recommended protocol.

After 8 days of culture, T cells were washed and formulated on the CliniMACS Prodigy according to its automated wash protocol and concentrated via the Prodigy to a target volume of 30×10^6 cell/mL prior to final formulation and fill-finish. Cells were washed with Plasma-Lyte A (Baxter, Cat#2B2544X) containing 5% (v/v) of HSA (Akron Biotech, Cat#AK8228–0100).

Formulation, fill-finish, and cryopreservation: G-Rex flasks

CryoStor® CS10 (BioLife Solutions) was added to cells formulated in Plasma-Lyte A with 5% HSA at a 1:1 (volume:volume) ratio

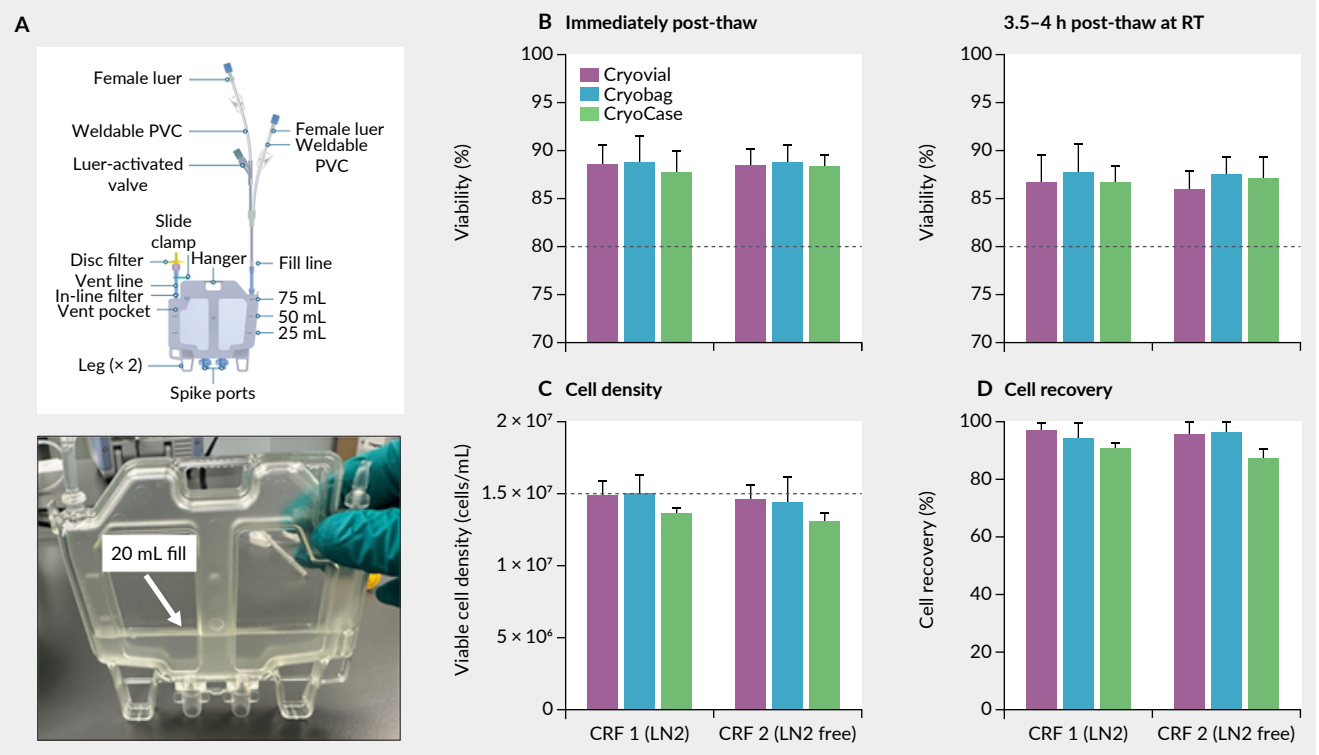
just prior to filling in different cryogenic containers. Final formulation of cell product was therefore 5% DMSO and 2.5% HSA, with a target cell concentration of 15×10^6 viable cells/mL. Formulated cells were then carefully filled into cryobags (Miltenyi Biotec, Cat#200–074–400), cryovials (Corning, Cat#431386), or CryoCases (BioLife Solutions) using a micropipette for small volumes (1 mL or less) or disposable volumetric syringes. Cryovials were filled with 1 mL of formulated CAR-T cells, whereas cryobags and CryoCases were filled with 20 mL or 50 mL of formulated CAR-T cells, as indicated. Filled containers were then transferred to either a liquid nitrogen controlled rate freezer (CRF; ThermoFisher Cryomed™) or a liquid nitrogen-free CRF (Cytiva VIA Freeze Quad) as indicated and underwent controlled rate freezing, according to previously published protocols [6]. Per the manufacturer's recommendations CryoCases were frozen standing up, cryobags were placed in aluminum cassettes and frozen in designated racks standing up, and cryovials were frozen in vial racks provided by the manufacturer of each CRF. Cryopreserved containers were stored in liquid nitrogen until further analysis and use.

Formulation, fill-finish, and cryopreservation: CliniMACS Prodigy

CAR-T cells were formulated and transferred to cryogenic containers (fill-finish) on the CliniMACS Prodigy via a GMP

FIGURE 1

Cell viability and recovery across different cryogenic containers.



(A) Top: Diagram of the novel CryoCase container. Bottom: Photograph of the CryoCase container containing 20 mL of formulated CAR-T cells. (B) Cell viability immediate after thawing each cryogenic container (left) and after 3.5–4 h post-thaw in each cryogenic container at room temperature. (C) Cell density and (D) cell recovery after cryopreservation and controlled thawing in each type of cryogenic container. Cells were cryopreserved in two different CRFs, one which uses liquid nitrogen (LN2 [CRF1]) and one which is liquid nitrogen-free (CRF2). Data shown: mean +/- SD; n = 3 donors. CRF: controlled rate freezers, SD: standard deviation.

Custom Application Program (CAP) developed by Miltenyi Biotec for Charles River Laboratories. Briefly, CryoStor CS10 (BioLife Solutions) was sterile welded onto the CliniMACS Prodigy, and the Prodigy added it to the cells formulated in Plasma-Lyte A with 5% HSA at a 1:1 (volume:volume) ratio just prior to filling in different cryogenic containers. After final formulation and automated mixing of the CAR-T product, 20 mL of cells were transferred via the Prodigy to a cryobag or CryoCase that was sterile welded onto the Prodigy. CAR-T cells were also transferred into a sample bag that was sterile welded onto the Prodigy, and these cells were subsequently aliquoted at 1 mL increments into standard cryovials to simulate samples collected for quality control. Filled containers were then transferred to either a liquid nitrogen CRF (ThermoFisher Cryomed) or a liquid nitrogen-free CRF (Cytiva VIA Freeze Quad) as indicated and underwent controlled rate freezing according to previously published protocols [6]. Per the manufacturer's recommendations, CryoCases were frozen standing up, cryobags were placed in aluminum cassettes and frozen in designated racks standing up, and cryovials were frozen in vial racks provided by the manufacturer of each CRF. Cryopreserved containers were stored in liquid nitrogen until further analysis and use.

Cell thawing, counting, and flow cytometry

Prior to analysis, frozen product containers were thawed at 37°C for 4 min using a water bath. Cell number and viability were assessed using the Via1Cassette™ (ChemoMetec, Cat#941–0012) with the NucleoCounter® NC-200™ (ChemoMetec).

Flow cytometry was performed using the BD FACS Lyric and BD FACSuite software (BD Biosciences). Cells were stained as previously described for the following cell surface markers [7]: CD3 (BioLegend, CA, Cat#317310), CD4 (BioLegend, Cat#344674), CD8a (BioLegend, Cat#344714), CD45RA (BioLegend, Cat#260246), CD19 CAR detection reagent (ACRO Biosystems, Cat#FM3-FY45G0), CD45RO (BioLegend, Cat#304224), CD57 (BioLegend, Cat#393304), CCR7 (BioLegend, Cat#353230), Programmed cell death protein 1 (PD-1; BioLegend, Cat#367428), and 7-AAD (BioLegend, Cat#420403).

Fracture evaluation

To evaluate fracture resistance, the CellSeal CryoCase or cryobags were filled to either 75 mL (CryoCase) or 30 mL (cryobags) and placed into liquid nitrogen for 30 min. Frozen containers were dropped from a height of 2 m onto an epoxy-coated concrete floor.

Data analysis

Data was analyzed and presented using GraphPad Prism software, version 10.X. For statistical comparison, data was analyzed via One-Way ANOVA unless otherwise indicated with Tukey post hoc test and $p<0.05$ defined as statistically significant. Data is presented as mean ± standard deviation (SD) or mean ± standard error of the mean (SEM) unless otherwise noted.

RESULTS AND DISCUSSION

Similar performance of a novel, rigid cryogenic container compared to cryobags and cryovials

The CryoCase container represents a novel solution for the cryopreservation and storage of cell therapies like CAR-T cells. Unlike cryobags, the CryoCase has a solid wall construction (Figure 1A) to improve rigidity and integrity. Like cryobags, it can hold a flexible volume (15–75 mL) and has multiple attachment points for bioprocessing and

spike ports for infusion and administration at clinical sites (Figure 1A). Given the different thickness and construction of the CryoCase, we sought to test how it would perform and preserve cell functionality during a controlled rate freezing process originally developed for cryobags. T cells from three independent donors were activated and expanded in G-Rex flasks and transduced with a third-generation CD19 CAR lentivirus to generate CAR-T cells. After enough CAR-T cells were expanded, the cells were harvested, washed and formulated before being aliquoted into the different cryogenic containers for cryopreservation. Two different CRFs—one that uses liquid nitrogen for rapid cooling, and another that is liquid nitrogen-free and more compact—were used to cryopreserve CAR-T cells filled into CryoCases, cryobags, or cryovials. CryoCases and cryobags were filled with CAR-T cells at the same viable cell density, 15×10^6 cells/mL, and with the same volume of formulated CAR-T product, 20 mL. Given their smaller size, cryovials were filled with 1 mL of the same CAR-T product. All containers were filled and cryopreserved in CRFs concurrently using previously published protocols [6]. After freezing, all containers were immediately transferred to liquid nitrogen freezers for longer term storage before thawing and cell analysis.

Both cell viability and cell density were remarkably similar across the different cryogenic containers. Using either CRF, the cell viability was above 85% post-thaw for CAR-T cells frozen in CryoCases, cryobags, or cryovials (Figure 1B). To simulate a delayed administration of the CAR-T drug product, cells in each container were held for 3.5–4 h at room temperature to compare changes in cell viability in each of the different containers. Cell viability was remarkably stable in each cryogenic container and remained above 85% even after 3.5–4 h at room temperature (Figure 1B). Cell density was likewise similar across all cryogenic containers (Figure 1C). Cell recovery—defined as the proportion of viable cells recovered post-thaw compared to the calculated number of viable cells originally filled into each container—was 85–90% for CryoCases, cryobags, and cryovials (Figure 1D).

These results suggest that controlled rate freezing programs developed for cryobags and cryovials can be used with comparable performance with the rigid-walled CryoCase. This is supported by the consistent results across two different types of CRFs, each using a different freezing program previously developed for cryobags.

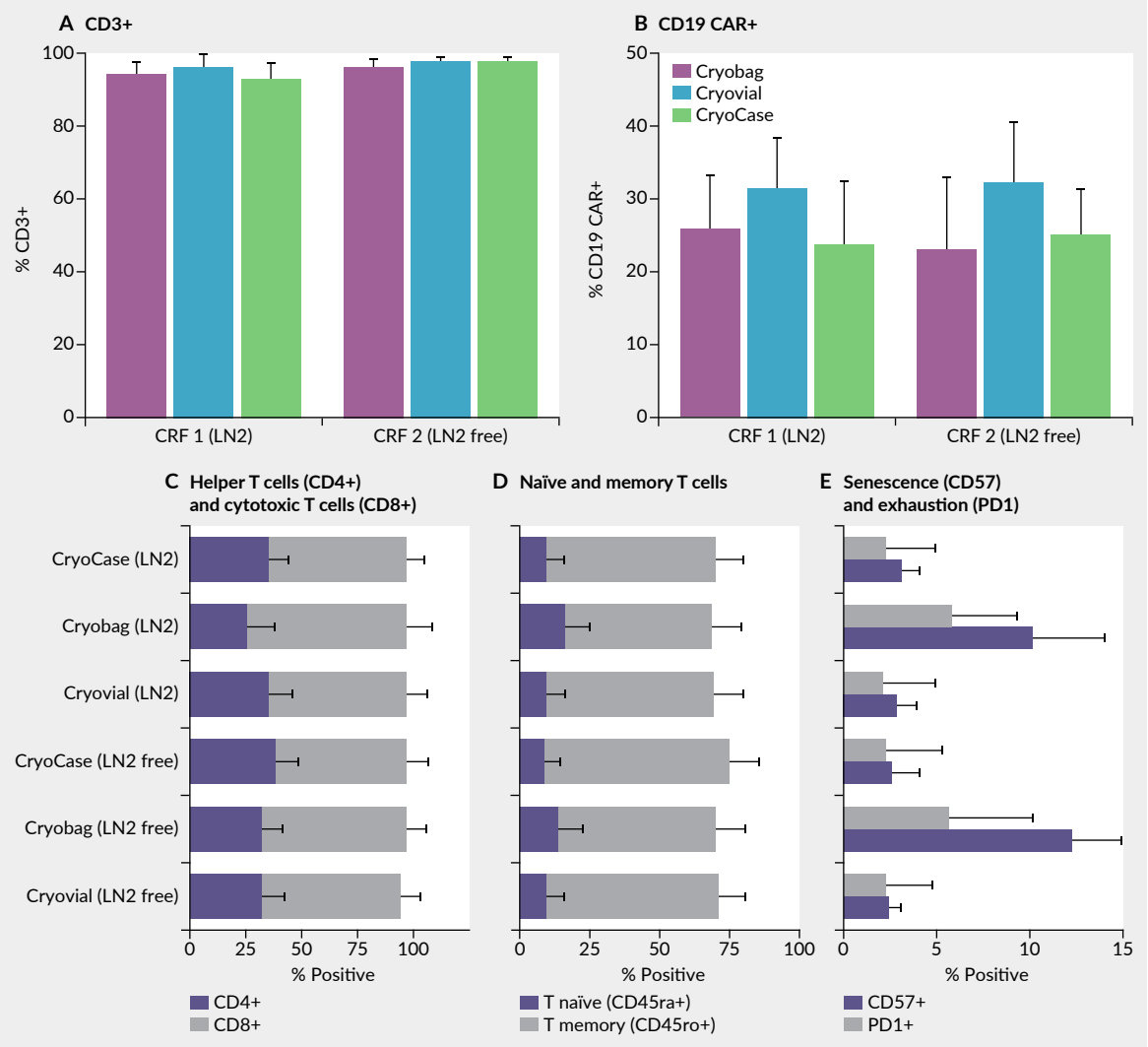
Consistent phenotype and functionality of CAR-T cells across different cryogenic containers

To test the consistency of critical quality attributes of the CAR-T product, we performed a controlled thaw on the different cryogenic containers and compared their phenotypic composition and expression of functional cell surface markers. Cellular identity was consistent across all the cryogenic containers tested. Over 95% of cells expressed the pan T cell marker CD3 (Figure 2A). The proportion of CAR-positive T cells in the thawed product was also comparable between the different cryogenic containers, regardless of the CRF used for cryopreservation (Figure 2B), with 25–30% of CD3 T cells expressing the CD19 CAR averaged across the three different donors. The proportion of CD4+ helper T cells to CD8+ cytotoxic T cells was similar in CryoCases, cryobags, and cryovials (Figure 2C).

T cell phenotype was consistent across the different cryogenic containers. There was a similar proportion of CD45ro+ memory T cells (T-memory) and CD45ra+ naïve T cells (T-naïve) in CryoCases compared to cryobags and cryovials (Figure 2D). This phenotypic consistency across the different containers suggests that cryopreservation and storage in CryoCases does not significantly alter the CAR-T cellular product compared to freezing and storage in cryobags or cryovials.

FIGURE 2

CAR-T cell phenotype and functionality across different cryogenic containers.



(A) Expression of the T cell marker CD3 for the different cryogenic containers. (B) Proportion of CD3+ CD19 CAR+ T cells for each cryogenic container. (C) Ratio of CD4+ helper T cells to CD8+ cytotoxic T cells and (D) ratio of CD45ra+ naïve T cells to CD45ro+ memory T cells from each cryogenic container. (E) Comparison of the senescence marker CD57 and the exhaustion marker PD1 on T cells from each cryogenic container. Data shown: mean ± SEM; n = 3 donors. Analysis performed on cells from each container immediately post-thaw.

To gauge the functionality of CAR-T cells cryopreserved and stored in the different containers we looked at expression of the T cell exhaustion marker PD1 and the T cell senescence marker CD57. Expression of these markers was very low across all the cryogenic containers, with less than 5% of T cells expressing PD1 and less than 15% of T cells expressing CD57 (Figure 2E). Interestingly, cells cryopreserved in cryobags showed a slight increase in expression of these exhaustion and senescence markers (Figure 2E), but this difference was not statistically significant across the three donors tested ($p>0.05$, One-Way ANOVA). This data suggests that the functionality of the CAR-T cells is likewise preserved during cryopreservation in the CryoCase relative to freezing in cryobags and cryovials. However, future studies will need to look at metrics of

CAR-T potency, such as cytokine secretion or target tumor cell killing, to better assess if the functionality of CAR-T cells is similar across the different cryogenic containers.

Scaling product volume in the CryoCase container

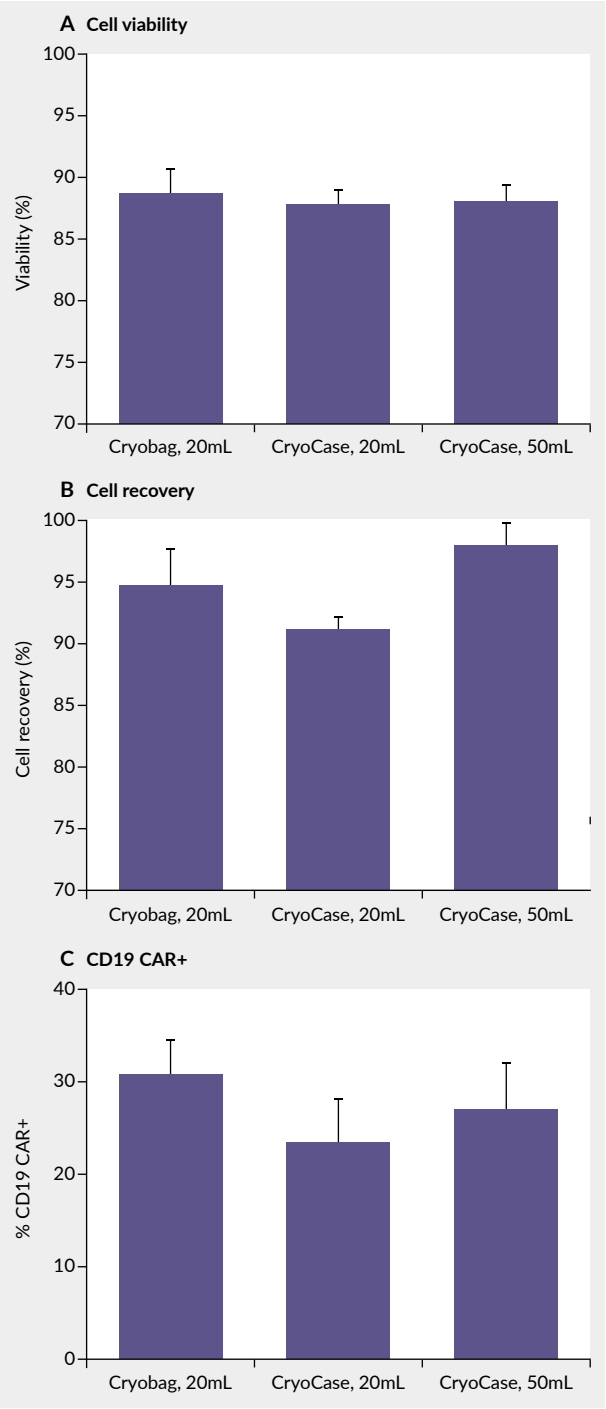
To test how cryopreservation in the new CryoCase container might be affected by the cell product volume, we also filled CryoCases with 50 mL of the same CAR-T product used for the 20 mL fill study of the cryobags and CryoCases. These higher-volume CryoCases were frozen using a liquid nitrogen CRF alongside the CryoCases and cryobags filled with 20 mL of product (due to capacity restraints in the liquid nitrogen-free CRF, additional higher volume samples could not be run). We found that cell viability was again high, above 85% for CryoCases filled with 50 mL and hence similar to the 20 mL fill conditions (Figure 3A). Cell recovery was above 95% for CryoCases filled with 50 mL of CAR-T product (Figure 3B), and CD19 CAR expression was similar to 20 mL cryobags and 20 mL CryoCases at 25–30% (Figure 3C). Cellular identity and phenotype were likewise uniform for the CryoCases filled with 50 mL of CAR-T cells compared to the CryoCases and cryobags filled with 20 mL of CAR-T cells (data not shown). These results suggest comparable performance for controlled rate freezing of CryoCases at different fill volumes, with no change needed in freezing profiles for CryoCases, even at larger product volumes.

Suitability of CryoCase container in an automated and closed CAR-T manufacturing process

We next sought to perform a case study to evaluate how the CryoCase container performs in an automated, full-scale CAR-T manufacturing process. We used the CliniMACS Prodigy system from Miltenyi Biotec to isolate T cells and activate and transduce them according to the manufacturer's recommended protocols [8]. After 8 days

FIGURE 3

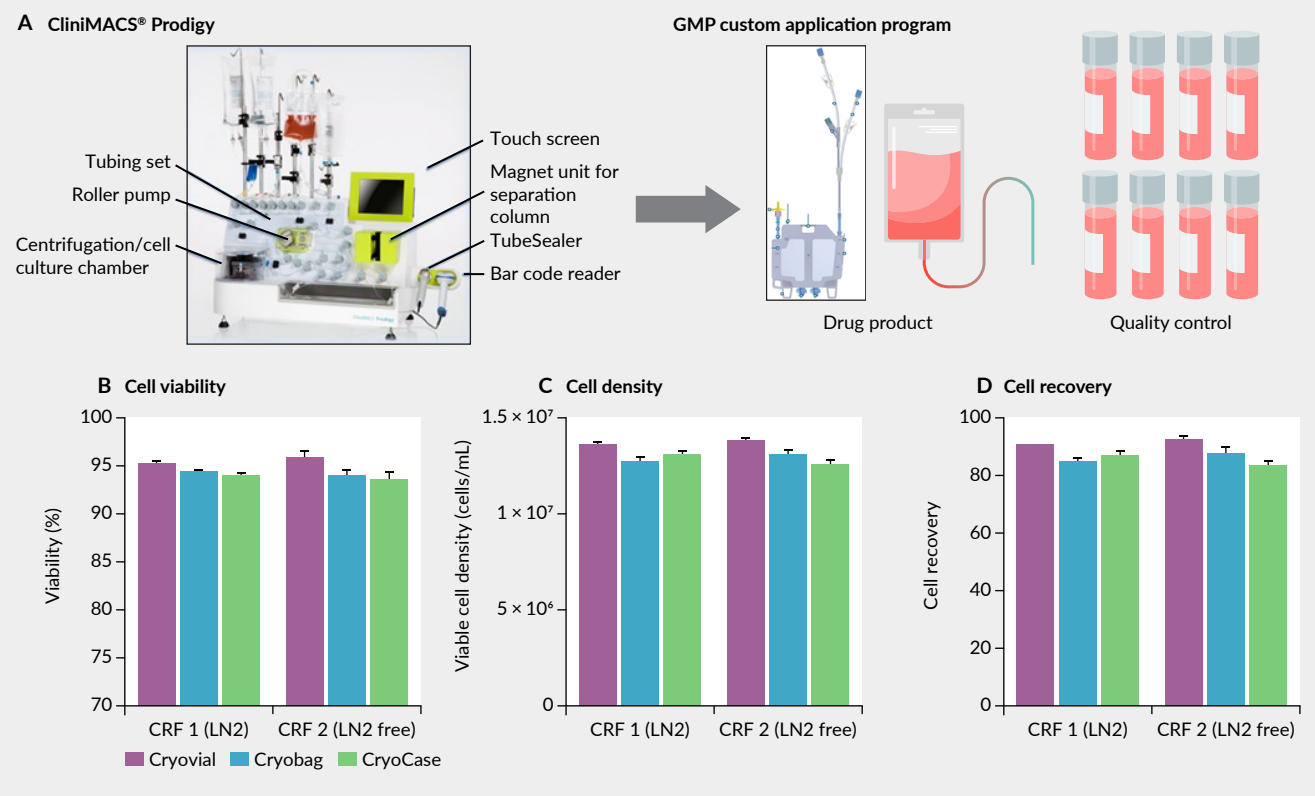
Scaling CAR-T product volume in the CryoCase container.



(A) Cell viability, (B) cell recovery, and (C) ratio of CD19 CAR+ T cells in CryoCases filled and frozen with 50 mL of formulated CAR-T product compared to CryoCases and cryobags filled and frozen with 20 mL of the same CAR-T product. Data shown: mean ± SEM; n = 3 donors.

FIGURE 4

An automated and closed CAR-T manufacturing process utilizing different cryogenic containers.



(A) Overview of the CliniMACS Prodigy instrument for the fully automated and closed production of CAR-T cells, with formulation and fill-finish of the CAR-T product into different cryogenic containers via a GMP compliant CAP developed for the Prodigy. (B) Cell viability, (C) cell density and (D) cell recovery of CAR-T cells manufactured on the Prodigy after cryopreservation in each type of container. Data shown = mean ± SD, n = 1 donor. Picture of CliniMACS Prodigy from Miltenyi Biotec (miltenyibiotec.com). CAP: custom application program.

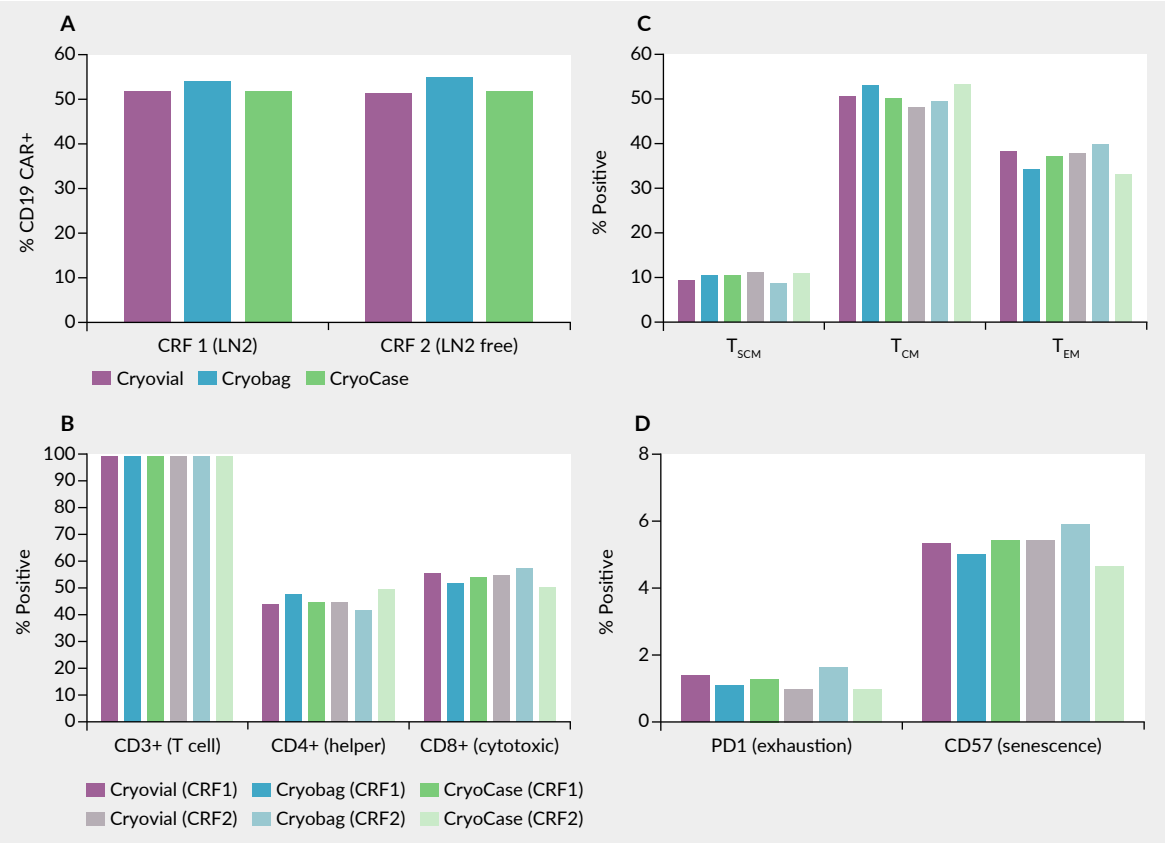
of culture, the Prodigy was able to wash, formulate, and transfer the final CAR-T product into both cryobags and CryoCases via a GMP-compliant custom application program (CAP) developed for fill-finish of the Prodigy (Figure 4A). This CAP allows for a fully automated and closed CAR-T manufacturing process, with both cryobags and CryoCases attached to the Prodigy via sterile welding, and quality control vials further sub-aliquoted from a sample pouch attached to the Prodigy. Unlike cryobags, the CryoCase container did not require air removal from the container after fill-finish, thereby eliminating a step in the manufacturing process.

The CryoCase container delivered a CAR-T product with key critical quality attributes comparable to both cryobags and cryovials. Post-thaw cell viability across all cryogenic containers was above 90% (Figure 4B), and no appreciable difference was observed in cell density of the final product for the different containers (Figure 4C). Cell recovery was similar and above 80% for cryovials, cryobags, and CryoCases (Figure 4D), with no difference observed for cryopreservation in either liquid nitrogen or liquid nitrogen-free CRF.

Cell phenotype was also consistent across the different cryogenic containers and CRFs. CD19 CAR expression was between 50–55% for each of the cryogenic containers (Figure 5A). Over 95% of cells expressed the pan T cell marker CD3 (Figure 5B), and the proportion of CD4 helper T cells

FIGURE 5

Critical quality attributes of a manufactured CAR-T cell product cryopreserved in different containers.



(A) Proportion of CD19 CAR+ T cells from different cryogenic containers for a cell therapy product manufactured, formulated and filled on the CliniMACS Prodigy. (B) Ratio of CD3+ T cells, CD4+ helper T cells, and CD8+ cytotoxic T cells after cryopreservation, LN2 storage, and controlled thawing in each type of cryogenic container. (C) Phenotypic breakdown of CAR+ T cells across different cryogenic containers after thawing. TEM: effector memory T cells, CD45RO+, CCR7-; TCM: central memory T-cells, CD45RO+, CCR7+; TSCM: stem cell memory T-cells, CD45RA+, CCR7+ (D) Portion of PD1+ T cells and CD57+ T cells for different cryogenic containers. Data shown: mean +/- SD; n = 1 donor. SD: standard deviation.

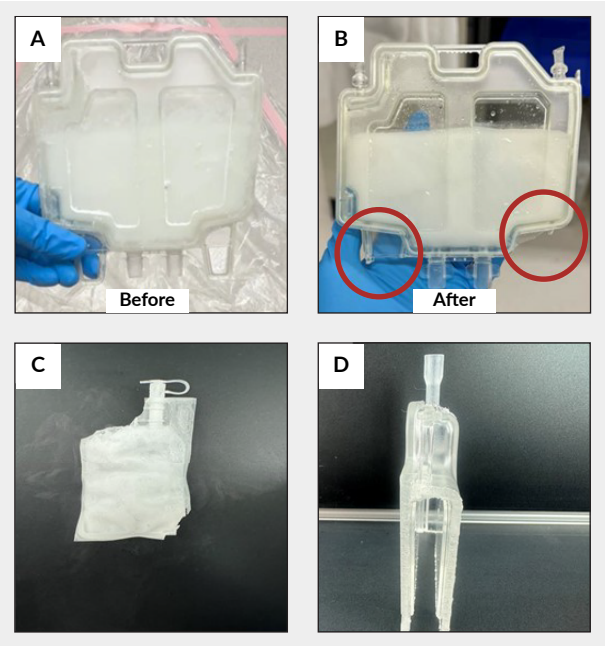
to CD8 cytotoxic T cells was again similar for each of the different containers. In all containers, most T cells were a central memory (CD45RO+ CCR7+) or effector memory phenotype (CD45RO+ CCR7-), with less than 10% comprising a stem cell memory phenotype (Figure 5C). This was uniform across the different cryogenic containers and CRFs tested. Expression of the exhaustion marker PD1 and the senescence marker CD57 was low for all cryogenic containers tested, with less than 7% of T cells expressing either of these markers in the final product (Figure 5D). These results underscore the phenotypic uniformity and quality of CAR-T cells possible in each type of cryogenic container and highlight how new technologies like the CryoCase can be incorporated into automated and closed CAR-T production technologies and workflows.

Container integrity following drop testing

Ten frozen CryoCase containers and five frozen cryobags were removed from liquid nitrogen and dropped onto a laboratory floor from a height of 2 m. This height was selected to represent the possible impact a frozen

FIGURE 6

Before and after images from the rigidity drop test.



The COC used for CellSeal vials and the CellSeal CryoCase is fracture resistant at -196°C. (A) CryoCase immediately after removal for storage in liquid nitrogen. (B) Ten frozen CryoCases were dropped from approximately 2 m. The only observed failures were at the protective shock absorption legs designed to protect the spike ports. (C) Five cryobags were dropped from approximately 2 m. All five units exhibited catastrophic failures. (D) Cross sectional view of the COC walls and weld bead of the CryoCase. COC: cyclic olefin co-polymer.

container might experience during shipment rather than the potential for drop during transport in the manufacturing or clinical setting. In all cases, the CryoCase was found to have either no damage or only damage to the spike port protectors (legs). All five bags were found to have catastrophic fractures compromising the integrity of the sample-containing area of the bag (Figure 6).

CONCLUSIONS

CAR-T cells cryopreserved in the CryoCase maintain high cell viability and recovery and have a phenotypic profile and functionality on par with those frozen in cryobags or cryovials. Whereas cryobags can be fragile and prone to cracking or breaking, and cryovials can have a limited range for fill volumes and offer less flexibility, the CryoCase may provide a robust yet adaptable system that preserves biological activity and product quality for CAR-T cells. The CryoCase system is compatible in automated and closed CAR-T cell processes and can deliver a cellular product with biology and quality on par with cryobags and cryovials. These results offer insight into a novel cryopreservation process and container for CAR-T cells and show that the new CryoCase is compatible with controlled rate freezing systems and programs already developed for cryobags and cryovials.

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AUTHORSHIP & CONFLICT OF INTEREST

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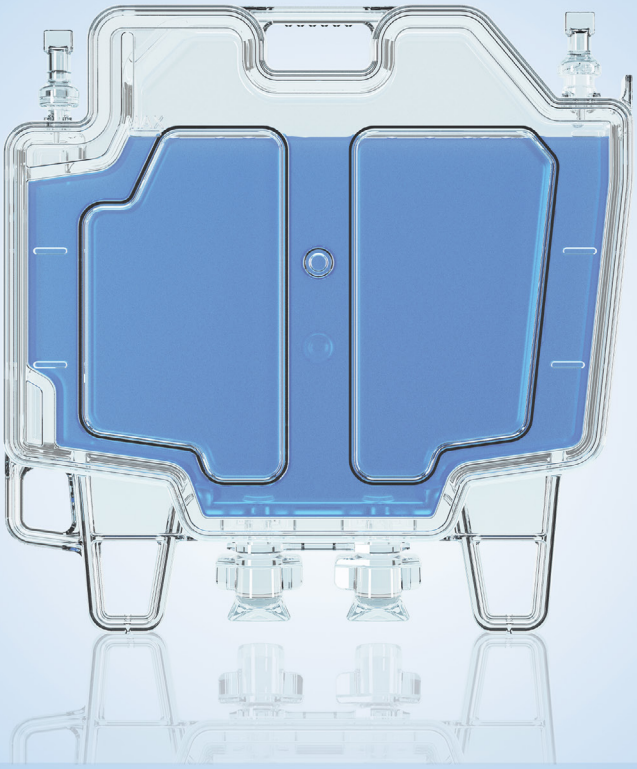

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