What does the pharmacist need to know?

Daniella Cristina Oliveira[1*], Jenifer Freitas da Silva[1]

1. Hospital Israelita Albert Einstein – Serviço de Farmácia Clínica Oncológica – São Paulo (SP), Brazil.

***Corresponding author:** daniella.oliveira@einstein.br

Section editor: Fernando Barroso Duarte

Received: Mar. 9, 2026 • **Accepted:** May 19, 2026

ABSTRACT

Objective: To describe the main knowledge and skills required of pharmacists who work or wish to work in chimeric antigen receptor T cells (CAR-T) cell therapy. **Methods:** This is a narrative literature review based on international guidelines, clinical trials, and recommendations from specialized societies in cellular therapy and oncology, focusing on pharmaceutical practice. **Results:** CAR-T cell therapy has emerged as a transformative treatment for patients with relapsed or refractory hematologic malignancies. Pharmacists play a critical role throughout the care continuum, including patient eligibility assessment, support during lymphodepletion regimens, and management of cellular product logistics, such as storage and traceability. Clinical pharmacists are also essential in the early recognition and management of adverse events, particularly cytokine release syndrome and immune effector cell-associated neurotoxicity syndrome, including the appropriate use of tocilizumab and corticosteroids. Additionally, medication reconciliation, drug interaction assessment, and education of healthcare teams and patients are key responsibilities. **Conclusion:** The involvement of pharmacists in CAR-T therapy is crucial to ensure patient safety and optimize clinical outcomes, requiring specialized training and strong integration within the multidisciplinary team.

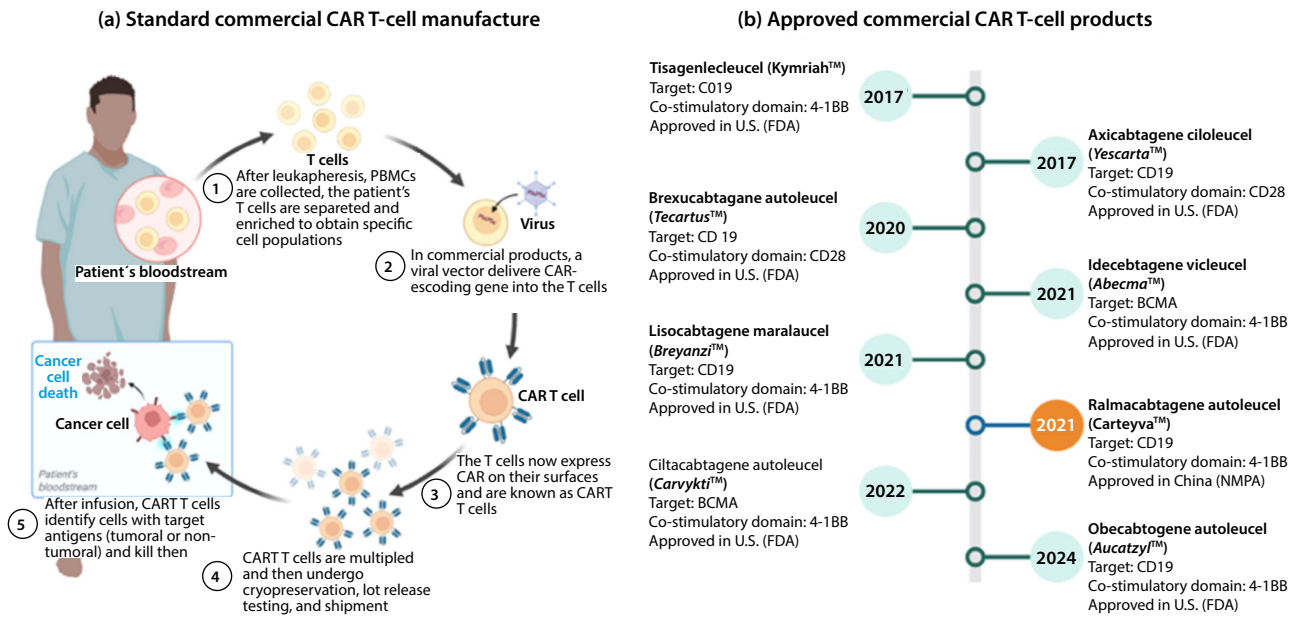
Keywords: CAR-T therapy; Pharmacyst; Immunotherapy; Toxicity management; Patient safety.

INTRODUCTION

Chimeric antigen receptor T cells (CAR-T), since August 2017, have became the first therapy to receive regulatory approval for the treatment of patients up to 25 years of age with B-cell precursor acute lymphoblastic leukemia that is refractory or in second or later relapse.[1] Since then, continuous growth in the number of CAR-T therapies authorized globally has been observed, as shown in the image below.[2] This expansion has brought not only therapeutic advances but also increased complexity in the organizational processes required to ensure their safe and effective administration (Fig. 1).[3]

As a highly complex therapy, CAR-T administration must occur in a hospital setting. In this context, pharmacists, together with cellular therapy teams, nursing, and medical teams, play an essential role in ensuring the rational and safe use of CAR-T therapies. Their technical responsibilities include the selection, acquisition, receipt, storage, preparation, and dispensing of these products. Furthermore, the management of CAR-T therapies requires the implementation of robust systems to ensure correct administration, as well as continuous follow-up and monitoring of their efficacy and safety, both in the short and long term.[4]

This paper aims to present the main aspects that pharmacists should understand to act competently in the management of patients undergoing CAR-T therapy.



CAR T-cell therapy manufacturing process and approved products. A. Standard commercial CAR T cell manufacture. Step 1 After leukapheresis, peripheral blood mononuclear cells PBMCs are collected and the patient's T cells are separated and enriched to obtain specific cell populations. Step 2 In commercial products, a viral vector introduces the CAR encoding gene into the T cells. Step 3 The modified T cells express the CAR on their surface and are now CAR T cells. Step 4 Cells are expanded then undergo cryopreservation, lot release testing, and shipment back to the clinical site. Step 5 After infusion, CAR T cells identify cells that carry the target antigen whether tumor or normal and kill them. Abbreviations in order of appearance: CAR, chimeric antigen receptor, PBMCs, peripheral blood mononuclear cells. B. Approved commercial CAR T cell products. Timeline of first approvals and core attributes. Abbreviations in order of appearance: CAR, chimeric antigen receptor; CD19, cluster of differentiation 19; 4 IBB the costimulatory receptor CD137; US, United States; FDA, Food and Drug Administration; CD28. the T cell costimulatory receptor CD28; BCMA B, cell maturation antigen; IsiMPA, National Medical Products Administration. Figure created using Biorender.

Source: Toro-Pedroza et al.[2]

Figure 1. CAR T-cell therapy manufacturing process and approved products.

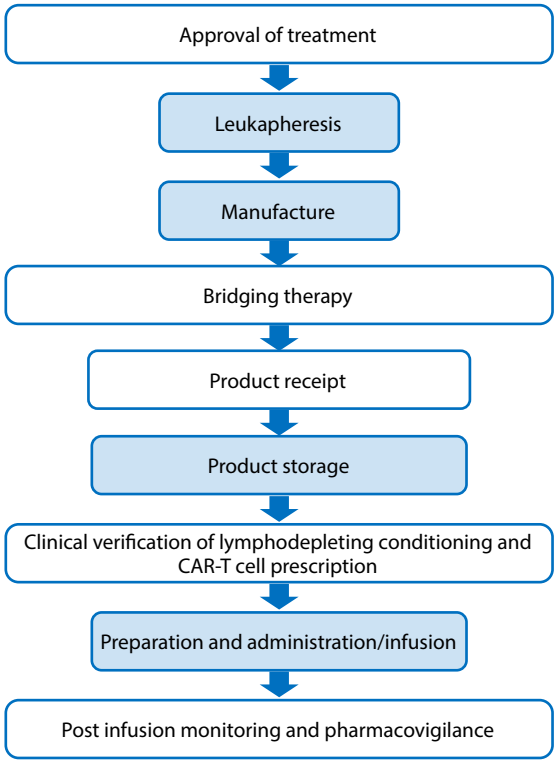
Main steps of CAR-T in a hospital

It is essential to define the workflows and standard operating procedures (SOPs) for all steps and responsibilities related to CAR-T therapy in advance. The distribution of responsibilities at each stage of the process may vary between institutions and will not always fall directly under the pharmacy's responsibility. It is worth noting that, in cellular therapy services, pharmacists are also involved and share several of the responsibilities mentioned here. The consensus of the GoCART Pharmacists Working Group recommends[5] (Fig. 2):

- Approval of treatment, bridging therapy, product receipt, clinical verification of lymphodepleting conditioning, and CAR-T cell prescription and post-infusion monitoring and pharmacovigilance: require direct pharmacist involvement.[5]
- Product storage, preparation, and administration/infusion: require pharmacist supervision.[5]
- Leukapheresis and manufacture: pharmacist involvement is not required, although familiarity with these areas may be beneficial.[5]

In view of this, we will emphasize the stages of greatest relevance for the pharmacist.

It is important to highlight that pharmacy services require an adequate number of qualified pharmacists who complete the training required by manufacturers and/or clinical studies. Furthermore, it is essential to maintain continuing education programs that ensure the ongoing updating of these professionals, including knowledge of the CAR-Ts currently available and those that may emerge in the future.[6,7]



Operational considerations throughout the patient and product-T pathway. The white boxes pertain to the direct role of the hospital pharmacy whereas shaded boxes indicate an accessory role of the hospital pharmacy.

Source: Nezvalova-Henriksen et al.[5]

Figure 2. Operational considerations throughout the patient and product-T pathway.

Patient eligibility and treatment approval

CAR-T cell therapy is an individualized and high-cost treatment, making it essential to ensure that it is prescribed only for patients who meet the eligibility criteria, which are recurrent and refractory diseases and two previous lines of treatment.[5] There must be a defined process for notifying new patients and treatments, verifying the eligibility and suitability of the patient for treatment, the method of collecting and sending T cells to the production unit, financial management, approval in the manufacturer's portal (when applicable), and product ordering.[5]

Multidisciplinary pre-assessment

Pharmacists can actively participate in this stage, given their importance in medication management. A detailed review of the patient's pharmacotherapeutic history is essential, as it directly influences the safety and success of the therapeutic process.[8]

Among the most relevant points of this assessment are the immunosuppressants and chemotherapeutic agents previously used, which can have prolonged effects on the immune system, impair hematologic recovery, and interfere with the post-infusion inflammatory response.[8] In addition, many of these agents present pharmacokinetic and pharmacodynamic interactions capable of altering toxicity, reducing therapeutic efficacy, or intensifying adverse events.[8]

Pharmacological management and washout periods: the following restrictions must be observed.

Medications that affect cell viability[9]

- Lymphotoxic agents (fludarabine, bendamustine, clofarabine, and alemtuzumab): avoid use prior to apheresis. Due to their prolonged cytotoxic effect, they require extensive washout periods to ensure successful collection.[9]
- Corticosteroids: discontinue at least 7 days before apheresis, as they induce lymphocyte apoptosis. Topical, inhaled, or intranasal use is permitted. Do not use antiemetic or pre-infusion prophylaxis.[9]

Targeted and specific therapies[9]

- Blinatumomab (anti-CD19) should be avoided, as it promotes depletion of the CD19 antigen, which is essential for the activation and expansion of various CAR-T products.[9]
- Ibrutinib: a 5-day pause before lymphodepletion is recommended.[9]
- Rituximab, bendamustine, and polatuzumab: a 2-week washout before lymphodepletion is recommended (especially for axicabtagene ciloleucel).[9]

Receipt and storage of CAR-T products

The receipt and storage of CAR-T cells are essential steps to preserve the integrity, traceability, and quality of the cryopreserved material. Supervision involves a detailed check of the documentation, confirming that the patient's identity on the cassette label matches the label on the bag, inspection of the product's integrity, such as checking for breaks or cracks in the bag before thawing, and verification of the transport conditions, such as checking the temperature at ≤ -150 °C in the liquid nitrogen vapor phase, transported in cryogenic dry shippers, ensuring cell viability.[5,10]

Care for medical prescriptions: bridge therapy, lymphodepleting conditioning, and CAR-T prescription

One of the main responsibilities of the pharmacist is to ensure the safety of chemotherapy prescriptions, and this involves bridge therapy (chemotherapy treatment carried out between apheresis and lymphodepletion, indicated for patients who present aggressive and/or progressive diseases) and lymphodepletion (chemotherapy administered days before the CAR-T cell infusion, to temporarily reduce the number of the patient's lymphocytes), considering the following points[4]:

- Prescribed treatment compatible with the diagnosis.
- Prescription made by a qualified physician and according to protocol.
- Informed consent obtained.
- Laboratory tests within minimum parameters, with adjustments when necessary.
- Pre-medications, supportive medications, and prophylaxis are appropriately prescribed.
- Recalculation of medication doses.
- Verification of infusion time and medication infusion sequence.
- Confirmation of absence of drug allergies.
- Assessment of clinically relevant drug interactions, with communication to the medical team if identified.

For the prescription of CAR-T cells, it is important to note that, as a biological treatment, dosing may be reconsidered within a cell dose range. Each CAR-T product has specific recommendations regarding handling, thawing, and administration, including infusion time and method. Pharmacists must ensure that these parameters comply with the manufacturer's technical instructions and the institution's internal protocols.

Monitoring hematologic toxicity during and after all the therapies and stages mentioned is equally essential. Significant reductions in blood cells can compromise the safety of CAR-T infusion, as well as increase the risk

of infections and bleeding. The pharmacist should monitor these parameters, alert the team about critical findings, and contribute to therapeutic adjustments when necessary.[8]

Manufacturing and administration/infusion

The pharmacist can oversee the entire process of manufacturing and administering CAR-T cells, ensuring that thawing, handling, and infusion occur according to standards established by the manufacturer, regulatory authorities, and institutional protocols. They develop and approve SOPs, ensure that only trained professionals perform critical steps, and review prescriptions, and pre-infusion documentation.[5]

Post-infusion monitoring and pharmacovigilance

Their main objective is to anticipate risks whenever possible and ensure adequate monitoring based on pharmacotherapeutic evaluation, laboratory follow-up, and active participation in multidisciplinary rounds, in addition to ensuring strict compliance with pharmacovigilance regulations.[4,8]

Cytokine release syndrome (CRS) and immune effector cell-associated neurotoxicity syndrome (ICANS) represent the main adverse reactions related to this therapy during hospitalization and require prompt recognition by the nursing and medical team, as this allows immediate interventions, reducing complications for the patient.[4]

- CRS: resulting from the exacerbated activation of the immune system, presenting with fever, hypotension, hypoxia, tachycardia, and laboratory alterations. Management involves symptomatic control, using antipyretics and hydration, with or without the addition of tocilizumab (maximum dose of 800 mg), starting from grade 1 or 2, depending on medical conduct and the followed consensus. The use of corticosteroids is indicated from grade 2.[6,11] In cases of ineffectiveness, the use of anakinra, siltuximab, and pulse therapy with methylprednisolone is indicated.[11]
- Prolonged cytopenias (> 30 days): avoid the administration of granulocyte-macrophage colony-stimulating factors during the first 3 weeks after infusion, as CRS symptoms may worsen, in addition to the increased risk of infections.[4]
- ICANS: neurological manifestations such as confusion, drowsiness, seizures, and headaches. The assessment of ICANS involves the use of the immune effector cell encephalopathy (ICE) scale with a score from 0 to 10. Patients should undergo baseline neurological evaluation, including the ICE scale, with daily scoring from the infusion up to 21 days after CAR-T cell administration. Antiepileptic prophylaxis with agents such as levetiracetam is not routinely recommended, except in patients with a history of seizures or central nervous system disease.[6]
- Infections: previous use of immunosuppressants exposes the patient to an increased risk of infections. The pharmacist monitors the prescribed antimicrobial prophylaxis, in addition to educating about the main signs of infection and the need to seek immediate care.[12]
- Hypogammaglobulinemia: outpatient follow-up by the pharmacist, evaluating the use of prophylactic antibiotics and replacement therapy with intravenous immunoglobulins, according to tests, age, and standard guidelines.[4]

The pharmacist needs to ensure the availability of essential medicines and other supportive therapies, maintaining adequate stocks that are easily accessible in emergencies. In addition, they guide the multidisciplinary team on indications, preparation, stability, administration, and monitoring of the medications used in the management of toxicities.[4]

Within the scope of pharmacovigilance, the pharmacist records and reports adverse reactions and potential medication errors, promoting analyses that contribute to the continuous improvement of processes and the prevention of future events.[5]

Patient education and guidance

Patient education and the education of their care partners are essential for the safety and success of CAR-T therapy, especially after hospital discharge. To ensure adherence to home medication treatment, it is the pharmacist's responsibility to develop individualized guidance regarding all prescribed pharmacotherapies.[13]

This follow-up involves the development of educational strategies, such as spreadsheets with clear instructions and defining the best times for medication administration, always considering the patient's routine. It also includes assessing possible drug interactions, continuously clarifying doubts, and providing a communication channel for support after discharge.[13]

It is essential that the pharmacist establishes a bond with the patient from the beginning of the last hospitalization, facilitating contact and continuity of care at the time of discharge. Outpatient follow-up is also indispensable to ensure the continuity of care, allowing the early identification of changes that require intervention.[13]

Through this structured and continuous educational approach, the pharmacist contributes significantly to patient safety, to the understanding of the treatment, and to achieving better long-term clinical outcomes.[6]

CONCLUSION

The pharmacist acts as a key professional in CAR-T therapy, ensuring safety, standardization, efficacy, and quality at all stages of the process. Mastery of workflows, risks, and management strategies is essential for therapeutic success and for excellence in patient care.

CONFLICT OF INTEREST

Nothing to declare.

DECLARATION OF USE OF ARTIFICIAL INTELLIGENCE TOOLS

The authors used ChaGPT (OpenAI) solely for language editing and improving text clarity. All content was critically reviewed by the authors, who take full responsibility for the manuscript.

AUTHOR CONTRIBUTIONS

Conceptualization: Oliveira DC; **Investigation:** Oliveira DC, Silva JF; **Methodology:** Oliveira DC, Silva JF; **Formal Analysis:** Oliveira DC, Silva JF; **Data Curation:** Oliveira DC, Silva JF; **Project Administration:** Oliveira DC; **Funding Acquisition:** Oliveira DC, Silva JF; Writing: Oliveira DC, Silva JF; **Supervision:** Oliveira DC; **Final Approval:** Oliveira DC, Silva JF.

DATA AVAILABILITY STATEMENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

FUNDING

This research did not receive any specific funding from public, commercial, or not-for-profit funding agencies.

ACKNOWLEDGEMENTS

Nothing to declare.

REFERENCES

1. Novartis. FDA approves Novartis CAR-T cell therapy Kymriah® for adult patients with relapsed or refractory diffuse large B-cell lymphoma (DLBCL). [S. l.]: Novartis; 2018 May 1. [cited 2026 May 25]. Available from: https://www.novartis.com/news/media-releases/kymriah-tisagenlecleucel-first-class-car-t-therapy-from-novartis-receives-second-fda-approval-treat-appropriate-rr-patients-large-b-cell-lymphoma

2. Toro-Pedroza A, Victoria JS, Cardona-Sepúlveda M, García-Robledo JE, Rios-Serna LJ, Loukanova A, Ortiz-Guzman J, et al. Advancing CAR-T cell manufacturing in Latin America: current landscape, future directions, and challenges. Crit Rev Oncol Hematol. 2026 Jan;217:105041. https://doi.org/10.1016/j.critrevonc.2025.105041

3. van Sinderen N, Dolva J, Riillo C, Espada R, Scheid C, van Dorp S, et al. Operational burden and fragmented implementation in CAR T-cell therapy: insights from a multinational survey by the GoCART Coalition and the JACIE Quality Managers Committee. HemaSphere. 2025;9:e70243. https://doi.org/10.1002/hem3.70243

4. Moreno-Martínez ME, Vinent-Genestar J, Muñoz-Sánchez C, Carreras-Soler MJ. Hospital pharmacist's roles and responsibilities with CAR-T medicines. Farm Hosp. 2020 Jan 1;44(1):26-31. https://doi.org/10.7399/fh.11333

5. Nezvalova-Henriksen K, Langebrake C, Bauters T, Bredius R, de Witte M, Hayden PJ, et al. Implementation and operational management of marketed chimeric antigen receptor T cell (CAR-T Cell) therapy: a guidance by the GoCART Coalition Pharmacist Working Group. Bone Marrow Transplant. 2023;58:1069-74. https://doi.org/10.1038/s41409-023-02072-7

6. Kröger N, Gribben J, Chabannon C, Yakoub-Agha I, Einsele H, eds. The EBMT/EHA CAR T Cell Handbook. Cham: Springer; 2022. https://doi.org/10.1007/978-3-030-94353-0

7. Foundation for the Accreditation of Cellular Therapy. FACT standards for immune effector cells. 8th ed. Omaha (NE): FACT; 2021. [cited 2026 May 25]. Available from: https://www.ebmt.org/sites/default/files/2025-10/STS_5_2_041_FACT-JACIE%20Standards%20Eighth%20Edition_8_1_R2_12142021_ForWeb.pdf

8. Marzal-Alfaro MB, Escudero-Vilaplana V, Revuelta-Herrero JL, Collado-Borrell R, Herranz-Alonso A, Sanjurjo-Saez M. Chimeric antigen receptor T cell therapy management and safety: a practical tool from a multidisciplinary team perspective. Front Oncol. 2021 Mar 11;11:636068. https://doi.org/10.3389/fonc.2021.636068

9. Palmer R, Evans N. Medication restrictions for patients receiving CAR-T therapy. Pharm J. 2022;309(7963). https://doi.org/10.1211/PJ.2022.1.148345

10. Jandová M, Lánská M, Sýkorová A, Gregor J, Rozsívalová P, Beková L, et al. Current role of CAR-T therapy in haematological care. Adv Exp Med Biol. 2025;1486:193-216. https://doi.org/10.1007/978-3-031-97297-3_16

11. Cléa DV, Hirayama AV, Alencar AJ, Costa LJ, Feliciano JVP, Mattos ER, et al. Associação Brasileira de Hematologia, Hemoterapia e Terapia Celular Consensus on genetically modified cells. I: structuring centers for the multidisciplinary clinical administration and management of CAR-T cell therapy patients. [cited 2026 May 25]. Available from: https://repositorio.usp.br/item/003215574

12. Lee DW, Santomasso BD, Locke FL, Ghobadi A, Turtle CJ, Brudno JN, et al. ASTCT consensus grading for cytokine release syndrome and neurologic toxicity associated with immune effector cells. Biol Blood Marrow Transplant. 2019;25(4):625-38. https://doi.org/10.1016/j.bbmt.2018.12.758

13. Oluwole OO, Oluwole TY, Ahmed N, Faramand R, Jain T, Lin Y, et al. Chimeric antigen receptor T-cell therapy in the outpatient setting: an expert panel opinion from the American Society for Transplantation and Cellular Therapy. Transplant Cell Ther. 2024;30(2):131-42. https://doi.org/10.1016/j.jtct.2023.11.008