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Knowledge generated in low- and middle-income countries can shape the future of acute leukemia therapies worldwide: the case of Clínica Ruiz in Puebla, Mexico

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Acute leukemias remain a major health challenge worldwide, particularly in children, adolescents, and older adults, with marked disparities in outcomes between high- and low-income regions. For more than four decades, The Clínica Ruiz in Puebla, Mexico, has contributed to leukemia research and treatment through pioneering strategies adapted to resource-constrained environments. The early adoption of immunophenotyping improved diagnostic accuracy in Mexico, while studies on nutritional status at diagnosis underscored its prognostic impact in pediatric acute lymphoblastic leukemia (ALL). The institution also demonstrated the feasibility and efficacy of pediatric-inspired regimens in adolescents and young adults with ALL, challenging the use of more toxic adult protocols. In acute myeloid leukemia (AML), contributions have included the description of regional prevalence patterns, molecular characterization, and the development of innovative outpatient therapeutic approaches. Clínica Ruiz further established one of the most active hematopoietic stem cell transplantation (HSCT) programs in Latin America, introducing cost-effective outpatient transplantation models—known as the "Mexican method"—for both autologous and allogeneic modalities, including haploidentical transplants. Collectively, these advances illustrate how strategies designed in Mexico for limited-resource settings have not only improved leukemia care locally but have also informed practices globally.

KEYWORDS

acute leukemia, acute lymphoblastic leukemia, acute myeloid leukemia, outpatient transplantation, low- and middle-income countries, nutritional status, pediatric-inspired therapy, Mexican method

Introduction

Leukemia is a hematologic malignancy characterized by uncontrolled proliferation of white blood cells (1), derived from transformed hematopoietic progenitor cells and accompanied by diffuse infiltration of the bone marrow (2). Leukemia can be classified by two different classification systems: disease course (acute vs. chronic) or by cell lineage (myeloid vs. lymphoid) (2). The major subtypes include acute lymphoblastic leukemia (ALL), chronic lymphocytic leukemia (CLL), acute myeloid leukemia (AML), and chronic myeloid leukemia (CML). Acute leukemias remain a significant cause of morbidity and mortality worldwide, particularly affecting children, adolescents, and older adults. ALL is the most common childhood cancer worldwide, particularly in children under 15 years, and accounts for approximately 80% of pediatric acute leukemia cases (3, 4).

Recognized risk factors for leukemia include advanced age, male sex, exposure to ionizing radiation, chemotherapy, rare congenital syndromes, pre-existing hematologic disorders, smoking and occupational or environmental contact with certain chemicals (5). According to GLOBOCAN 2020, leukemia accounted for approximately 2.5% of all new cancer cases and 3.1% of cancer-related deaths worldwide (6). By 2022, the estimated global incidence of leukemias increased to 5.3%. The highest proportions were reported in Asia (46.6%), Europe (22.1%), and Northern America (14.7%), reflecting both demographic structure and registry coverage. In terms of mortality, Latin America and the Caribbean ranked third with 28,670 deaths reported. These mortality figures refer specifically to regional data, not global comparisons. ALL has a higher incidence rate in the Latino population (2, 3).

In Mexico, ALL is the most frequent childhood malignancy, accounting for nearly half of all pediatric cancers. Flores et al. developed a study in Mexico City which reported acute leukemia (AL) incidence rate of 63.3 cases per million, being the highest reported worldwide (7). Despite recent breakthroughs in cellular therapies—such as CAR-T cells—access remains limited in low- and middle-income countries, making conventional treatment strategies the cornerstone of leukemia care in these settings.

Clínica Ruiz began contributing to leukemia research in the early 1980s. One of its earliest studies documented the use of low-dose cytosine arabinoside to induce cellular differentiation and achieve remission in acute leukemia—an early, pioneering attempt to explore non-intensive therapeutic strategies suitable for resource-limited environments (8).

For more than four decades, the *Centro de Hematología y Medicina Interna de Puebla*, located at *Clínica Ruiz* has been active in leukemia diagnosis, treatment, and clinical research. Its contributions range from pioneering the immunological classification of acute leukemias in Mexico —facilitating accurate diagnosis and risk stratification— (9) to generating critical evidence on the impact of nutritional status on the prognosis of children with ALL (10). This latter finding has been particularly relevant in the Mexican context, where undernutrition remains prevalent and may significantly compromise treatment intensity and outcomes (11). Over the years, the institution has played a key role in adapting and optimizing diagnostic and therapeutic regimens for both ALL and AML. This center's experience includes prospective studies in adolescents, treatment approaches tailored to favorable-risk subtypes based on molecular characterization, and, more recently, the implementation of venetoclax combined with azacitidine in elderly or unfit AML patients, in line with international standards (12). *Clínica Ruiz* has an extensive expertise in hematopoietic stem cell transplantation (HSCT), encompassing both autologous and allogeneic modalities (13, 14). Long-term outcomes with allogeneic HSCT have been particularly demonstrated in high-risk ALL and AML across both pediatric and adult populations, while autologous transplantation remains valuable in selected cases.

This review summarizes the historical and current contributions of Clínica Ruiz to the treatment of acute leukemias. Drawing exclusively on published data, we aim to contextualize this center's scientific output within global advances and highlight the relevance of tailored approaches in resource-constrained environments.

Acute leukemia immunophenotyping

In the mid-1980s, *Clínica Ruiz*, in collaboration with *Laboratorios Clínicos de Puebla*, became one of the first institutions in Mexico to implement monoclonal antibody-based immunophenotyping for the characterization of acute leukemias. At that time, diagnosis in most of the country relied on morphology and cytochemistry leading to inconclusive cases with atypical presentation. By employing a comprehensive panel of monoclonal antibodies against lineage-specific antigens—including von Willebrand factor (FVIII:vWF), glycoprotein IIb/IIIa (CD41), glycoprotein IX (CD42), and glycoprotein Ib (CD42)—the team was able to distinguish between ALL and AML subtypes, and to identify rare entities such as acute megakaryoblastic leukemia (M7-AML) (15). This methodology proved particularly valuable for cases with ambiguous morphology, where conventional cytochemistry alone was insufficient. The robustness of the approach was confirmed in a multicenter study—including three Mexican centers and one in Spain— which reported that 90% of M7-AML expressed two or more megakaryocytic markers, confirming the solidity of this immunologic approach. This early adoption of immunophenotyping improved diagnostic accuracy and prognostic stratification in patients treated at Clínica Ruiz and contributed to the progressive national adoption of this technique. Although the exact percentage of its current use at a national level remains undetermined, within our institution it has been consistently incorporated as part of the standard diagnostic approach. It also enabled the institution to establish research collaborations with international centers, including the Hospital Universitario de Salamanca, laying the groundwork for the subsequent incorporation of molecular and cytogenetic methods into leukemia diagnostics in Mexico (15).

Acute lymphoblastic leukemia

Building upon this diagnostic foundation, the institution also explored variables that were often overlooked in clinical practices, especially in resource-constrained settings. One such variable was the patient`s nutritional status at diagnosis. In a prospective study conducted at *Clínica Ruiz* and affiliated institutions, 103 children with newly diagnosed ALL were evaluated for weight-for-age at presentation. Patients were categorized as undernourished (≤80% of ideal body weight) or well-nourished (>80%). Findings demonstrated that undernourished children had a lower probability of remaining in continuous complete remission at 36 months (28% vs. 62%; $p < 0.05$), and a higher relapse rate (52% vs. 24%) compared to their well-nourished counterparts. Additionally, the cumulative chemotherapy dose administered to undernourished patients was significantly lower (mean 72% of planned dose) than that received by well-nourished patients (mean 94%), suggesting that nutritional deficits may limit treatment intensity due to increased toxicity. This work provided some of the earliest evidence from Latin America linking malnutrition to inferior leukemia outcomes (10). It underscored the need for nutritional assessment and intervention as integral components of pediatric ALL management, especially in low- and middle-income countries where undernutrition remains prevalent. Subsequent studies in other geographic and ethnic settings have corroborated these findings, further validating the prognostic importance of baseline nutritional status in childhood ALL, despite variations in patient populations (16).

Scientists in *Clínica Ruiz* conducted a prospective study evaluating a modification of the St. Jude Total XI protocol for the treatment of ALL in 43 adolescents aged 15–19 years. The complete remission (CR) rate after induction was 93%, with a median follow-up of 38 months. The probability of continuous complete remission (CCR) at 4 years was 56%, and the overall survival (OS) at the same time point was 63%. Treatment-related mortality was low, with only two deaths during induction. Importantly, outcomes in this adolescent cohort mirrored those reported in younger pediatric populations, challenging the historically poorer results observed when adult regimens were applied to this age group and reinforcing the rationale for pediatric-inspired protocols in adolescents and young adults. The results of this study were proved superior to those obtained with more aggressive combinations of chemotherapy, such as the Hyper-CVAD, with the additional advantage of the outpatient delivery of the treatment in most cases. The favorable results obtained in young adults were also found in children treated at Clínica Ruiz (17), thus making the "*Puebla modification*" to the St. Jude Total XI protocol a good therapeutic option for patients with ALL, preferable to the traditional Hyper-CVAD and similar regimens, which are still employed in several centers within the country and associated with increased morbidity and mortality (18). A high proportion of the Ikaros-gene deleted cases of ALL was found in Clínica Ruiz, higher than national averages. This difference may be related to the fact that other institutions in Mexico do not routinely perform this test, potentially underestimating its prevalence (19).

Acute myeloblastic leukemia

Scientists of Clínica Ruiz identified and described the first cases in Latin America of acute megakaryoblastic leukemias (M7-AML), suggesting therapeutic approaches for this by then newly identified variant of AML (15). The unusually high prevalence of acute promyelocytic leukemia (APL) in México, initially identified in Mexican-Americans in Los Angeles, CA, was confirmed by scientists of Clínica Ruiz, who were very active in describing

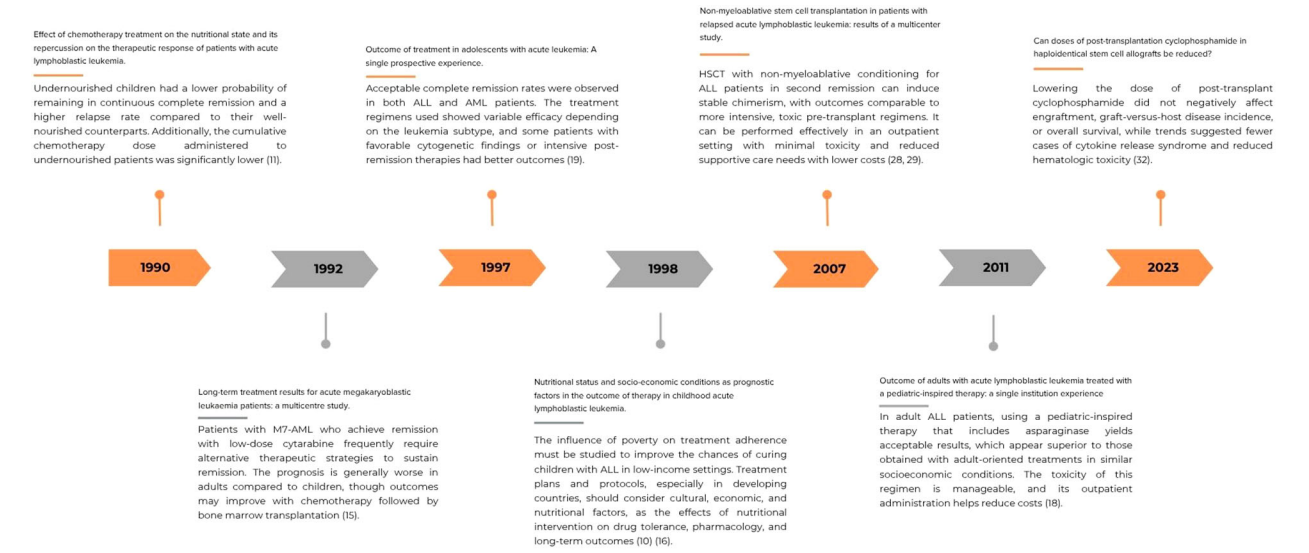

FIGURE 1
Clinical and scientific advances in acute leukemias at Clínica Ruiz in Puebla, México: A 40-Year timeline (1984-2025).

treatment methods of this type of acute myelogenous leukemia, proving that this malignancy can be effectively treated on an outpatient basis (20). International multi-institutional studies confirmed both the high prevalence of APL in Latin American mestizos (21) and the genetic origin of this difference as compared with Caucasians (22, 23). The first cases of the molecular classification of the AML in México were described in Clínica Ruiz (9), making clear that the prevalence of core-binding factor (CBF) mutated AML in México was similar to that described in Caucasians (24), and associated with an improved prognosis (15).

Hematopoietic stem cell transplantation program for AL

Over the last three decades, Clínica Ruiz has also established a highly active HSCT program. The first HSCT conducted in Clínica Ruiz was offered to a patient with relapsed ALL in 1983 (25) and since then autologous and allogeneic procedures in acute leukemias have been done to patients with acute leukemia in Clínica Ruiz. The HSCT program in Clínica Ruiz has been conducted in close relation to the HSCT program in Hospital Universitario de Nuevo León, and together papers describing the results of HSCT both in ALL and AML have been published (26, 27). A distinctive feature of this program has been the successful application of outpatient myeloablative chemotherapy and HSCT—an uncommon practice worldwide—achieved through stringent patient selection, meticulous supportive care, and rigorous outpatient monitoring, and the use of reduced intensity conditioning (28). This strategy has been associated with reduced infection rates, shortened hospital stays, comparable survival outcomes, diminished complications, diminished prevalence and severity of graft *versus* host disease and substantial cost savings, positioning it as a potentially replicable model for resource-limited settings. Collectively, these results underscore the dual contribution of the institution pioneering cost-effective outpatient transplantation models that may serve as a reference for resource-limited settings (25). Results of the modified methods to conduct HSCT (the now called "Mexican methods") in patients with either ALL or AML have been published (29, 30). After gaining expertise in outpatient-based allo-HSCT, transplanters at Clínica Ruiz have engaged in haploidentical transplantation, demonstrating that dose-reduction of post-transplant cyclophosphamide, allo-HSCT can be completed fully on an outpatient basis in most patients (31) and that the complications of the transplant are substantially diminished (32).

Conclusion

Clínica Ruiz has significantly shaped the landscape of acute leukemia care in México and possibly Latin America. Through early adoption of immunophenotyping, the institution advanced diagnostic precision and risk stratification beyond conventional cytochemistry. Pioneering studies on pediatric nutritional status revealed its critical influence on treatment intensity and outcomes, while innovative outpatient hematopoietic stem cell transplantation programs demonstrated that complex therapies can be safely and effectively delivered in resource-limited settings. The chronological progression of these achievements is illustrated in Figure 1, which summarizes the major milestones that have defined the institution's impact on acute leukemia care. Together, these contributions exemplify the integration of rigorous diagnostics, supportive care, and adaptable treatment strategies, positioning Clínica Ruiz as a benchmark for leukemia management in both regional and global contexts.

Beyond these contributions, the experience of Clínica Ruiz highlights broader lessons for low- and middle-income countries (LMICs). Similar cooperative efforts in Brazil (GBTLI) and Central America (AHOPCA) also illustrate how resource-tailored strategies can improve leukemia care. Key enablers of Clínica Ruiz's success include its hybrid private–academic model, sustained leadership, and international collaborations. Major barriers such as economic constraints and limited access to novel therapies were overcome through pragmatic innovations such as outpatient HSCT. These experiences show that even highly complex therapies can be successfully adapted to resource-limited settings when stringent supportive protocols and patient monitoring are ensured. Looking ahead, the center aims to expand haploidentical HSCT and progressively integrate precision medicine and affordable cellular therapies, offering replicable strategies that can inform leukemia care in LMICs worldwide The progressive damage inflicted to the public health system in México and other LMICs should be envisioned as an opportunity to improve the private practice health system and in turn, to benefit a larger number of patients worldwide.

Data availability statement

The datasets presented in this article are not readily available due to privacy and confidentiality agreements. Requests to access the datasets should be directed to jolivares@hsctmexico.com.

Ethics statement

The studies involving humans were approved by Comité de ética de Clinica Ruiz de Puebla. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

LA: Writing – original draft, Writing – review & editing. MG: Writing – original draft, Writing – review & editing. SC: Writing – original draft, Writing – review & editing. PA: Writing – original draft, Writing – review & editing. MR: Writing – review & editing,

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References

1. Bose P, Bandyopadhyay S. A comprehensive assessment and classification of acute lymphocytic leukemia. *Math Comput Appl.* (2024) 29:452024.

2. Huang J, Chan SC, Ngai CH, Lok V, Zhang L, Lucero-Prisno DE3rd, et al. Disease burden, risk factors, and trends of leukaemia: A global analysis. *Front Oncol.* (2022) 12:904292. doi: 10.3389/fonc.2022.904292

3. Elisa Q, Ibrahim A, Vinod P, Eduardo R, Guido M, Dan D. The emerging story of acute lymphoblastic leukemia among the Latin American population – biological and clinical implications. *Blood Rev.* (2019) 33:98–105. doi: 10.1016/j.blre.2018.08.002. ISSN 0268-960X.

4. Belson M, Kingsley B, Holmes A. Risk factors for acute leukemia in children: a review. *Environ Health Perspect.* (2007) 115:138–45. doi: 10.1289/ehp.9023

5. Bispo JAB, Pinheiro PS, Kobetz EK. Epidemiology and etiology of leukemia and lymphoma. *Cold Spring Harb Perspect Med.* (2020) 10:a034819. doi: 10.1101/cshperspect.a034819

6. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin.* (2021) 71:209–49. doi: 10.3322/caac.21660

7. Flores-Lujano J, Duarte-Rodríguez DA, Jiménez-Hernández E, Martín-Trejo JA, Allende-López A, Peñaloza-González JG, et al. Persistently high incidence rates of childhood acute leukemias from 2010 to 2017 in Mexico City: A population study from the MIGICCL. *Front Public Health.* (2022) 10:918921. doi: 10.3389/fpubh.2022.918921

8. Marín-López A, Lobato-Mendizábal E, Munive-Ordóñez I, Ruiz-Argüelles GJ. Induction of cellular differentiation in the treatment of acute leukemias: preliminary report of the use of low doses of cytosine arabinoside for the induction of remission. *Rev Invest Clin.* (1984) 36:247–51.

9. Minutti-Zanella C, Gallardo-Pérez MM, Sánchez-Anzaldo FJ, Méndez-Laureano BJ, Vega-Escobedo MF, Ruiz-Delgado GJ, et al. Scientific productivity at the Clínica Ruiz in Puebla, México: A 66-year experience. *Rev Hematol Mex.* (2022) 23:169–212. doi: 10.24245/rev_hematol.v23i3.8186

10. Gómez-Almaguer D, Ruiz-Argüelles GJ, Ponce-de-León S. Nutritional status and socio-economic conditions as prognostic factors in the outcome of therapy in childhood acute lymphoblastic leukemia. *Int J Cancer Suppl.* (1998) 11:52–5. doi: 10.1002/(SICI)1097-0215(1998)78:11+<52::AID-IJC15>3.0.CO;2-3

11. Lobato Mendizábal E, Ruiz-Argüelles GJ. Leucemia y desnutrición. III. Efecto del tratamiento quimioterápico sobre el estado nutricional y su repercusión en la respuesta terapéutica de pacientes con leucemia aguda linfoblástica de riesgo estándar [Leukemia and malnutrition. III. Effect of chemotherapeutic treatment on the nutritional state and its repercussion on the therapeutic response of patients with acute lymphoblastic leukemia with standard risk. *Sangre (Barc).* (1990) 35:189–95.

12. DiNardo CD, Pratz K, Pullarkat V, Jonas BA, Arellano M, Becker PS, et al. Venetoclax combined with decitabine or azacitidine in treatment-naïve, elderly patients with acute myeloid leukemia. *Blood.* (2019) 133:7–17. doi: 10.1182/blood-2018-08-868752

13. Robles-Nasta M, Lira-Lara O, Olivares-Gazca JC, Ruiz-Delgado GJ, Ruiz-Argüelles GJ. 30 años de experiencia en trasplante de células hematopoyéticas en el Centro de Hematología y Medicina Interna de la Clínica Ruiz de Puebla. *Acta Méd Grupo Ángeles.* (2025) 23:132–7. doi: 10.35366/119475

14. Ruiz Arguelles GJ. Oupatient programs of myeloablative chemotherapy, autologous and allogeneic bone marrow transplantation. *Haematologica.* (2000) 85:1233–4.

15. Ruiz-Argüelles GJ, Lobato-Mendizábal E, San-Miguel JF, González M, Vidriales B, Gómez-Almaguer D, et al. Long-term treatment results for acute megakaryoblastic leukaemia patients: a multicentre study. *Br J Haematol.* (1992) 82:671–5. doi: 10.1111/j.1365-2141.1992.tb06942.x

16. Sala A, Rossi E, Antillon F, Molina AL, de Maselli T, Bonilla M, et al. Nutritional status at diagnosis is related to clinical outcomes in children and adolescents with cancer: a perspective from Central America. *Eur J Cancer.* (2012) 48:243–52. doi: 10.1016/j.ejca.2011.06.006

17. Cortés J, Gómez-Almaguer D, Meléndez-Zajgla J, López-Karpovitch X, Candelaria M, Ruiz-Argüelles GJ. Outcome of adults with acute lymphoblastic leukemia treated with a pediatric-inspired therapy: a single institution experience. *Leuk Lymphoma.* (2007) 48:64–9. doi: 10.3109/10428194.2010.529202

18. García-Villaseñor E, Cortés JE, Reyes-Cisneros OA, Fernández-Gutiérrez JA, Sánchez-Bonilla D, Bojalil-Álvarez L, et al. Long-term results of the treatment of adolescents and adults with acute lymphoblastic leukemia with a pediatric-inspired regimen delivered on an outpatient basis: A single institution experience. *Leuk Res.* (2022) 121:106935. doi: 10.1016/j.leukres.2022.106935

19. Ruiz-Delgado GJ, Cantero-Fortiz Y, León-Peña AA, León-González M, Nuñez-Cortés AK, Ruiz-Argüelles GJ. IKAROS gene deleted B-cell acute lymphoblastic leukemia in Mexican mestizos: observations in seven patients and a short review of the literature. *Rev Invest Clin.* (2016) 68:210–4. doi: 10.1016/S0034-8376(25)00278-5

20. Ruiz-Argüelles GJ, Morales-Toquero A, Gómez-Rangel JD, López-Martínez B, Ruiz-Delgado GJ, Reyes-Núñez V. Treatment of acute promyelocytic leukemia: A single institution experience. *Rev Invest Clin.* (2005) 57:415–9.

21. Douer D, Preston-Martin S, Chang E, Nichols PW, Watkins KJ, Levine AM. High frequency of acute promyelocytic leukemia among Latinos with acute myeloid leukemia. *Blood.* (1996) 87:308–13. doi: 10.1182/blood.V87.1.308.308

22. Sanz MA, Grimwade D, Tallman MS, Lowenberg B, Fenaux P, Estey EH, et al. Management of acute promyelocytic leukemia: recommendations from an expert panel on behalf of the European LeukemiaNet. *Blood.* (2009) 113:1875–91. doi: 10.1182/blood-2008-04-150250

23. Ruiz-Argüelles GJ, Garcés-Eisele J, Reyes-Núñez V, Gómez-Rangel JD, Ruiz-Delgado GJ. More on geographic hematology: the breakpoint cluster regions of the PML/RARα fusion gene in Mexican Mestizo patients with promyelocytic leukemia are different from those in Caucasians. *Leuk Lymphoma.* (2004) 45:1365–8. doi: 10.1080/10428190310001657344

24. Ruiz-Delgado GJ, Macías-Gallardo J, Lutz-Presno J, Garcés-Eisele J, Hernández-Arizpe A, Montes-Montiel M, et al. Core binding factor acute myeloid leukemia (CBF-AML) in Mexico: A single institution experience. *Rev Invest Clin*. (2011) 63:25–30.

25. Gómez-Cruz GB, Olivares-Gazca M, Murrieta-Álvarez I, Olivares-Gazca JC, León-Peña A, Cantero-Fortiz Y, et al. À-propos of the 1000th stem cell transplant conducted at the Clínica Ruiz in Puebla, Mexico. *Rev Hematol Mex*. (2019) 20:150–83.

26. Ruiz-Argüelles GJ, Gómez-Almaguer D, Ruiz-Argüelles A, González-Llano O, Cantú OG, Jaime-Pérez JC, et al. Results of an outpatient-based stem cell transplantation program in Mexico. *Bone Marrow Transpl*. (2000) 25:821–5. doi: 10.1038/sj.bmt.1702354

27. Ruiz-Argüelles GJ, Gómez-Almaguer D, Ruiz-Delgado GJ, Cantú OE, Morales-Toquero A, Cortés J, et al. Outpatient hematopoietic stem cell transplantation in adults with acute leukemias: results of a multicenter study. *Bone Marrow Transpl*. (2001) 27:1313–6.

28. Murrieta-Álvarez I, Olivares-Gazca JC, León-Peña A, Pérez-López R, Vallejo-Villalobos MF, Ruiz-Delgado GJ, et al. El programa de trasplantes de la Clínica Ruiz de Puebla: a 25 años de su creación/The transplant program at Clinica Ruiz of Puebla: 25 years after its creation. *Rev Hematol Mex*. (2018) 19:141–52.

29. Ruiz-Argüelles GJ, Gómez-Almaguer D, Ruiz-Delgado GJ, Tarín-Arzaga MC. Ocho años de experiencia con el "Método Mexicano" en la realización de trasplantes de células hematopoyéticas alogénicas. *Gac Med Mex*. (2007) 143:231–5.

30. Olivares–Gazca JC, Pastelín–Martínez ML, Montes–Robles MA, Gallardo –Pérez MM, Hernández–Flores EJ, Robles–Nasta M, et al. Can doses of post –transplantation cyclophosphamide in haploidentical stem cell allografts be reduced? *Hematology*. (2023) 28:2242176. doi: 10.1080/16078454.2023.2242176

31. Gallardo-Pérez MM, Gutiérrez-Aguirre CH, Olivares-Gazca JC, Ruiz-Argüelles GJ. More about post-transplant cyclophosphamide in haploidentical grafts: full or reduced doses? *Hematology*. (2024) 29:2313357. doi: 10.1080/16078454.2024.2313357

32. Colunga–Pedraza PR, Cantú OE, Treviño–Montemayor OR, Jaime–Pérez JC, Olivares–Gazca M, Ruiz–Argüelles GJ, et al. Outpatient haploidentical stem cell transplantation using post–transplant cyclophosphamide is safe and feasible. *Transplant Cell Ther*. (2021) 27(3):259.e1-259.e6. doi: 10.1016/j.jtct.2020.12.006