

From gene to therapy: clinical utility of the BRCA1/BRCA2 genetic panel in precision medicine for breast cancer in Mexico

Del gen a la terapia: utilidad del panel genético BRCA1/BRCA2 en la medicina de precisión para el cáncer de mama en México

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Abstract

Breast cancer represents a priority public health challenge in Mexico, as it is the leading cause of cancer-related mortality among women. This scenario has driven the transition from generalized therapeutic approaches toward precision medicine, which tailors prevention and treatment to individual genomic characteristics. In this context, germline mutations in the BRCA1 and BRCA2 genes have been identified as the most relevant hereditary alterations, as they play a crucial role in DNA repair through homologous recombination and function as predictive biomarkers for preventive interventions and targeted therapies. The objective of this narrative review was to analyze the clinical utility of the BRCA1/BRCA2 genetic panel and its impact on breast cancer management, as well as to contextualize its value and the challenges associated with its implementation within the Mexican healthcare system. A literature review with a state-of-the-art approach was conducted, consulting high-impact databases and repositories of national and international clinical practice guidelines. Thirty articles published between 2015 and 2025 were included, prioritizing phase III clinical trials and observational studies with an emphasis on the Mexican population. The results confirmed that the BRCA1/BRCA2 panel is clinically actionable, as it enables risk stratification, intensified surveillance, surgical risk reduction, and the selection of targeted therapies such as PARP inhibitors, with demonstrated survival benefits. However, significant barriers to its implementation in Mexico were identified, including costs, infrastructure limitations, training gaps, and inequitable access. These findings underscore the need for public health policies aimed at bridging the gap between genomic knowledge and its effective clinical application.

Keywords: breast cancer; precision medicine; BRCA1/BRCA2; PARP inhibitors; clinical genetics

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Resumen

El cáncer de mama representa un desafío prioritario para la salud pública en México, al constituir la principal causa de muerte por cáncer en mujeres. Este panorama ha impulsado la transición de enfoques terapéuticos generalizados hacia la medicina de precisión, la cual adapta la prevención y el tratamiento a las características genómicas individuales. En este contexto, las mutaciones germinales en los genes BRCA1 y BRCA2 se han identificado como las alteraciones hereditarias más relevantes, al desempeñar un papel crucial en la reparación del ADN por recombinación homóloga y funcionar como biomarcadores predictivos para intervenciones preventivas y terapias dirigidas. El objetivo de esta revisión narrativa fue analizar la utilidad clínica del panel genético BRCA1/BRCA2 y su impacto en el manejo del cáncer de mama, así como contextualizar su valor y los retos de su implementación en el sistema de salud mexicano. Se realizó una revisión de la literatura con enfoque de estado del arte, consultando bases de datos de alto impacto y repositorios de guías clínicas nacionales e internacionales. Se incluyeron 30 artículos publicados entre 2015 y 2025, priorizando ensayos clínicos fase III y estudios observacionales con énfasis en la población mexicana. Los resultados confirmaron que el panel BRCA1/BRCA2 es clínicamente accionable, al permitir la estratificación de riesgo, la vigilancia intensificada, la reducción de riesgo quirúrgico y la selección de terapias dirigidas como los inhibidores de PARP, con beneficios demostrados en supervivencia. No obstante, se identificaron barreras significativas para su implementación en México, relacionadas con costos, infraestructura, capacitación y acceso equitativo. Estos hallazgos subrayan la necesidad de políticas públicas orientadas a cerrar la brecha entre el conocimiento genómico y su aplicación clínica efectiva.

Palabras clave: cáncer de mama; medicina de precisión; BRCA1/BRCA2; inhibidores de PARP; genética clínica



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INTRODUCTION

Breast cancer represents a major public health challenge in Mexico and remains the leading cause of cancer-related mortality among women. This scenario requires a shift from generalized treatment approaches toward precision medicine, a model that tailors therapeutic management to the genomic characteristics of each patient.

In this context, germline mutations in the BRCA1 and BRCA2 genes constitute the most clinically relevant hereditary alterations associated with breast cancer. These tumor-suppressor genes play a critical role in DNA repair through homologous recombination. Their dysfunction significantly increases cancer susceptibility and has been established as a key predictive biomarker in modern oncologic management. The clinical utility of BRCA testing is twofold: it enables targeted preventive interventions; it facilitates the use of high-efficacy targeted therapies, particularly poly(ADP-ribose) polymerase (PARP) inhibitors.

OBJETIVE

General Objective

To analyze the available evidence regarding the clinical utility of the BRCA1/BRCA2 genetic panel and its impact on breast cancer management, with the aim of contextualizing its value and identifying challenges related to its implementation within the Mexican health system.

Specific Objectives

- To describe the genetic and epidemiological foundations of hereditary risk in the Mexican population.
- To evaluate the role of BRCA testing as a preventive medicine tool and risk-stratification strategy.
- To review evidence supporting the panel as a predictive biomarker for targeted therapies, particularly PARP inhibitors.
- To identify access barriers limiting its implementation in Mexico.

METHODOLOGY

Study Design: A narrative literature review was conducted with a state-of-the-art approach.

Search Period and Sources: The literature search was performed between August and October 2023 using high-impact databases including PubMed/MEDLINE/Scielo/Google Scholar/Additionaly, clinical practice guidelines from key international and national organizations were reviewed, including NCCN, ASCO, ESMO, IMSS, and INCan.

Search Strategy: A combination of English and Spanish keywords was used, including "Breast cancer" "BRCA1" "BRCA2" "Precision medicine" "PARP inhibitors" "Genetic testing" "Mexico".

Selection Criteria: Thirty scientific articles and documents were analyzed. Priority was given to Evidence published in the last 10 years (2015-2023) Phase III clinical trials Observational studies focusing on the Mexican population.

RESULTS

The review confirms the existence of a distinct BRCA mutation spectrum in the Mexican population, including recurrent variants such as BRCA1 c63-1del. Evidence indicates that the BRCA1/BRCA2 panel is clinically actionable, guiding both preventive strategies and targeted therapies. Preventive strategies enabled by genetic testing

- Intensified surveillance
- Risk-reducing surgery (risk-reducing mastectomy or salpingo-oophorectomy)

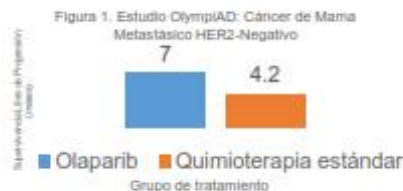


Figura 3: Barreras de Implementación de la Medicina de Precisión en México



CONCLUSIONS

The clinical utility of the BRCA1/BRCA2 genetic panel in Mexico is unequivocal and represents a paradigm shift in oncology. Genetic testing constitutes a transformative tool that enables personalized prevention strategies. Targeted therapies with improved survival outcomes. However, the primary challenge is not the lack of scientific evidence but the significant implementation gap within the Mexican healthcare system. Public health policies must prioritize equitable access to genetic testing. Investment in genomic medicine infrastructure. Training programs for healthcare professionals. Such measures are essential to translate genomic knowledge into accessible and effective clinical interventions for all patients in Mexico.

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