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Real-World Experience of HER2-Positive Advanced Breast Cancer (ABC) Treatment and Evaluation of Blood Biomarkers in a Public Institution in Latin America (LATAM)

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Abstract

Background: Advanced breast cancer (ABC) is an incurable disease, with a median overall survival (OS) of 3 years, even in high-income countries. Oncological treatment has improved survival rates, particularly for hormone receptor–positive and HER2-positive subtypes; however, access to new therapies in Latin American (LATAM) countries is limited.

Objectives: The impact of sequencing 2 lines of therapy in Peruvian patients with HER2-positive ABC in a single public institution was evaluated. First-line (1L) treatment consisted of trastuzumab and chemotherapy (CT, with taxanes), followed by second-line (2L) treatment with lapatinib plus capecitabine.

Design: In this retrospective study, we analyze clínico-pathological features (including blood biomarkers) collected from medical records of patients with HER2-positive ABC treated in a public Peruvian oncologic institution and its association with survival between 2020 and 2022.

Methods: Efficacy was measured using OS and progression-free survival (PFS). A discussion was added on the impact of OS based on clinicopathological characteristics, including outcomes in 2L "long-term responder" patients (who achieved response to 2L therapy $\geqslant$6 months) and the evaluation of blood biomarkers.

Results: Treatment sequencing has been demonstrated to enhance OS in patients with HER2-positive ABC, with a median OS of 34 months. This effect is more pronounced among long-term responders (37 months), particularly those without central nervous system (CNS) involvement, as compared with those with CNS metastases (51 vs 34 months). Blood biomarkers were not found to be prognostic indicators for either PFS or OS.

Conclusions: Treatment sequencing has been demonstrated to enhance OS in LATAM patients with HER2-positive ABC. This study did not identify any prognostic blood biomarkers. These outcomes could influence the selection criteria for patients to receive treatment sequencing in countries without full access to innovative oncological therapies.

Keywords

Advanced breast cancer; HER2-positive, sequencing treatment, overall survival, long-term responder patients, blood biomarkers

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Introduction

Breast cancer is the most frequently diagnosed cancer and causes cancer-related mortality among women worldwide.[1] It is also the most commonly diagnosed tumor in women in Latin America (LATAM) and the Caribbean, with an increase in both incidence and mortality rates.[2] According to GLOBOCAN 2022, breast cancer ranked first in incidence (7797 new cases) and seventh in mortality (1951 deaths) in Peru.[3] A report by Instituto Nacional de Enfermedades Neoplásicas (INEN, the cancer center reference in Lima, Peru) showed that breast cancer ranked second in incidence (25 344 new cases), with 10.41% of patients in stage IV de novo between the years 2000 and 2020.[4] In addition, the latest Cancer Registry of Metropolitan Lima (2013-2015), indicates that breast cancer ranks first in incidence and mortality among women in Lima.[5] Furthermore, a report by the Peruvian Ministry of Health (MINSA) in the first quarter of 2024 detected a 31% of stage IV advanced breast cancer (ABC) de novo,[6] which stands in contrast to the of information provided by the INEN, Lima, and the rest of the country. At present, breast cancer is regarded as a grave public health concern, as evidenced by the recent ministerial resolutions in Peru that prioritize the management of this neoplasm, in conjunction with cervical cancer, as a national priority for women.[7]

Advanced breast cancer is an incurable disease, with a median overall survival (OS) of approximately 3 years, and a 5-year survival rate of 25%, even in countries without access to new oncology treatments.[8] Approximately 15% to 20% of breast cancers are human epidermal growth factor receptor 2 (HER2)-positive, an aggressive subtype associated with poor outcomes.[9] Trastuzumab + chemotherapy (CT) has been shown to prolong OS, progression-free survival (PFS), and the objective response rate (ORR) when compared with CT alone in women diagnosed with the HER2-positive subtype.[10] However, patients often develop resistance to trastuzumab, leading to disease progression,[11] and up to 50% of patients with HER2-positive ABC will develop brain metastases (BMs). Recent oncological drugs, which are based on HER2 blockade, have transformed the standard of care and have enhanced OS. Pertuzumab + trastuzumab + taxane constitute the 1L therapy,[12] whereas trastuzumab deruxtecan (T-DXd) is the 2L.[13] Tucatinib + trastuzumab + capecitabine constitute a third-line (3L) option preferred in patients with active BMs.[14] Trastuzumab emtansine (T-DM1) is another 3L option. Fourth-line (4L) and subsequent therapy regimens include trastuzumab + other CT agents, trastuzumab + lapatinib, lapatinib + capecitabine, neratinib + capecitabine, and margetuximab + CT. These therapies are recommended by clinical practice guidelines (CPGs)[15,16] and are available in high-income countries. However, low- and middle-income countries (LMICs) cannot access most of these therapies.

In Peru (a middle-income country), most public institutions have limited access to anti-HER2 therapy for HER2-positive ABC.[17] In this study, we describe the outcomes of Peruvian patients treated with 1L trastuzumab + CT, followed by 2L lapatinib + capecitabine, at a single public institution.

Material and Methods

Patient eligibility

This retrospective study examined Peruvian patients aged 18 years or older with histologically confirmed stage IV, locally advanced, unresectable or recurrent HER2-positive breast cancer who were treated at the INEN (n = 102) between 2020 and 2022. Eligible patients were treated with 1L trastuzumab plus CT (taxanes), followed by 2L lapatinib plus capecitabine until progressive disease or unacceptable toxicity. The clinical, pathologic features, and immune-inflammatory blood markers (neutrophil-to-lymphocyte ratio [NLR], platelet-to-lymphocyte ratio [PLR], and prognostic nutritional index [PNI]) were evaluated.

For the calculation of the sample size, the estimate of the overall response rate (proportion of patients with complete or partial response) in patients receiving 2L lapatinib + capecitabine, which was reported as 22% in the pivotal study of Geyer et al, will be taken into account; therefore, considering a confidence level of 95% and a precision of 10%, the sample size is calculated as at least 66 patients.

Endpoints and statistical analysis

The Kaplan-Meier method was employed to generate survival curves for both OS and PFS. The log-rank test, was then used to evaluate differences in survival according to the characteristics of interest. A Cox regression model was used to evaluate the association between clinicopathological variables and OS and PFS.

The potential associations of the examined features with the ORR (using RECIST) were evaluated using the χ^2 test. No adjustments were made for multiplicity, and a P value of $<.05$ (SPSS) was considered significant. R Software (version 4.3.2) was used for calculations and graphs. Adverse event (AE) severity was graded according to the Cancer Institute Common Terminology Criteria for Adverse Events (CTCAE) version 4.0. Blood biomarkers were calculated from the following laboratory values before 1L trastuzumab + CT: neutrophils and lymphocytes (NLR), platelets and lymphocytes (PLR), and albumin (PNI). "Long-term responders" are defined as patients with durable clinical benefit (complete response, partial response, or stable disease as best overall response) that persisted for at least 24 weeks.[18]

Ethical statements

Before 1L treatment, all patients signed their informed consent which was recorded in their medical records. The authors acknowledge the significance of covering patient data compliance, confidentiality, and adherence to ethical principles in medical research involving human subjects according to the Declaration of Helsinki. Retrospective personal data were collected from medical records and protected with a code in an Excel spreadsheet to ensure confidentiality. In addition, this manuscript was approved on January 2, 2025, by the Institutional Review Board (IRB)

Table 1. Clinic pathological features of HER2 (+) ABC Peruvian patients (pts).

Clinic pathological features of HER2 (+) ABC Peruvian patients	N = 102
Age at diagnosis, y	
Median [Min-Max]	55 [31-82]
ECOG	
1	86 (84.3%)
2	16 (15.7%)
Disease status	
De novo	33 (32.7%)
Progressive	49 (48.5%)
Locally advanced unresectable	13 (12.9%)
Recurrent	6 (5.9%)
Luminal co-expression	
Yes	52 (51.0%)
No	50 (49.0%)
Menopausal status	
<50	31 (30.4%)
⩾50	71 (69.6%)
CNS metastases	
Yes	31 (33.0%)
No	63 (67.0%)

called: "Review Committee of the Instituto Nacional de Enfermedades Neoplásicas (CRPI-INEN) with code number "INEN 25-01."

Results

Patient demographics and clinicopathological characteristics

Table 1 shows the clinicopathological characteristics of the patient cohort. The study encompassed a total of 102 female patients diagnosed with HER2-positive ABC, with a median age of 55 years (range: 31-82). Most patients (84%) had ECOG 0-1 performance status, whereas 70% were postmenopausal and 51% co-expressed hormonal receptors. Of these patients, one-third exhibited *de novo* disease, one-third had central nervous system (CNS) involvement. Furthermore, 48% of the female patients experienced visceral metastasis.

Efficacy

The median PFS among patients treated with 1L was 11 months (range: 1-41 months) (Figure 1). The PFS rates with 1L treatment at 12, 24, and 36 months were 41%, 14%, and 2%, respectively. The most common metastatic sites after 1L were the CNS (33%) and the lungs (9.8%). Moreover, 44% of patients received radiotherapy, with the most prevalent form being whole-brain radiotherapy. Postmenopausal women exhibited longer PFS than premenopausal women (12 vs 9 months, $P = .014$).

All patients were treated sequentially. The median 2L PFS was found to be 8 months (1-30) (Figure 2). The PFS rates with 2L treatment at 12, 24, and 36 months were 34%, 7%, and 0%, respectively. Furthermore, patients with an ECOG performance status of 1 had a longer PFS than those with an ECOG performance status of 2 (8 vs 4 months, $P = .008$). The ORR to 2L treatment was 18%.

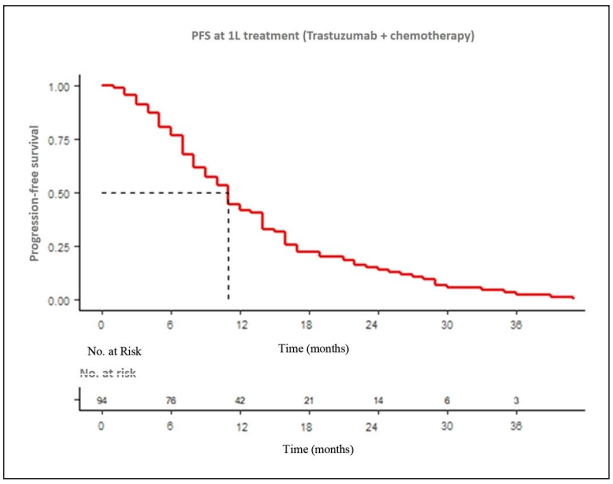

Figure 1. Estimated progression-free survival (PFS) in patients with HER2 (+) advanced breast cancer (ABC) at first-line (1L) treatment.

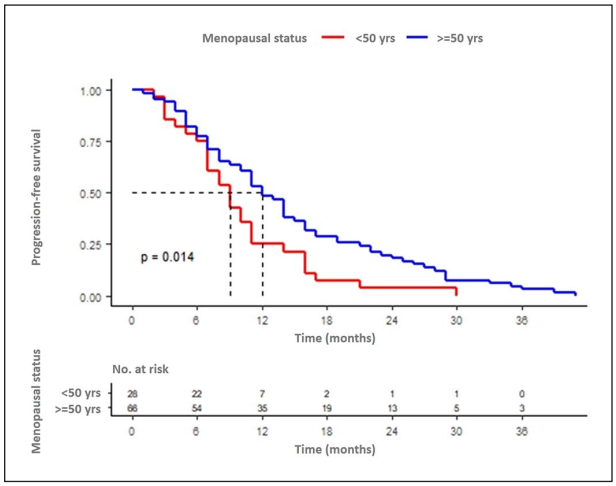

Figure 2. Estimated PFS at 1L according to menopausal status.

After a median follow-up period of 24 months (9-58), the median OS was 34 months (Figure 3). The OS rates at 12, 36, and 48 months were estimated at 93%, 47%, and 34%, respectively. The survival outcomes for women with CNS metastases were significantly inferior (Figure 4), with a median OS of 38 versus 24 months ($P = .0057$).

Long-term responder patients

The OS at 12, 36, and 48 months was estimated to be 92%, 54%, and 47%, respectively, for long-term responder patients (Table 2). The median OS was estimated to be 37 months (Figure 5). Patients without CNS metastases exhibited a longer OS compared with those with CNS metastases, with a median OS of 51 versus 24 months, $P = .0034$ (Figure 6).

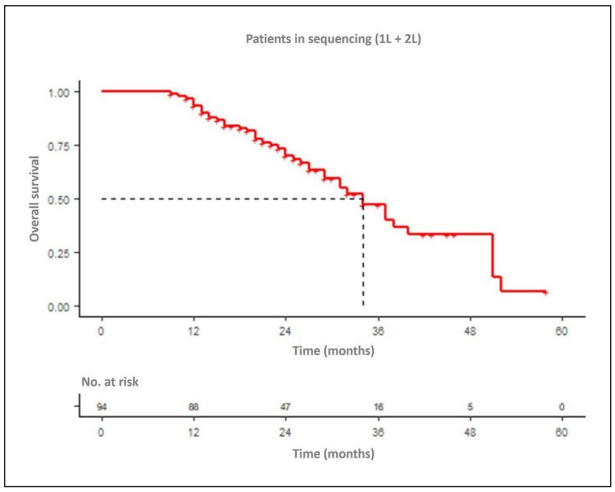

Figure 3. Estimated overall survival (OS) in Peruvian patients with HER2 (+) ABC treated in sequencing (1L + 2L).

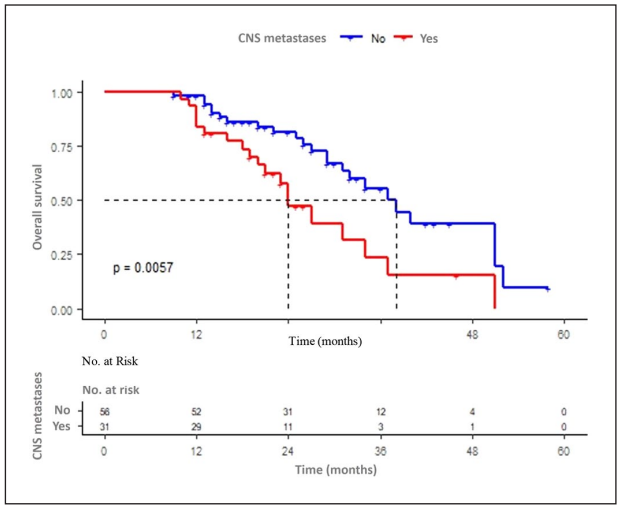

Figure 4. Estimated OS by central nervous system (CNS) metastases.

Among patients undergoing 2L treatment, 43% received subsequently received therapy, 22% received CT (most frequently gemcitabine), and 9% received palliative radiotherapy.

Safety

As indicated in Table 3, treatment-related AEs with 2L therapy were reported in 46% of patients. Most of these AEs were mild, with only 4% classified as grade 3. No cases of grade 4 AEs were reported. The most prevalent AEs were hand-foot syndrome (51%), followed by rash (11%) and diarrhea (9%). The study found that 22% of patients discontinued 2L treatment due to AEs. No deaths were attributed to the oncological treatment.

Blood biomarkers

No differences were found in PFS or OS among patients undergoing 1L or 2L therapy, with different inflammatory biomarkers including NLR, PLR, and PNI.

Table 2. Estimates of overall survival (OS) according to study features.

	12 months	36 months	48 months	*P* value
All patients	93%	47%	34%	—
Age group, y				
<60	92%	44%	27%	.15
⩾60	97%	54%	45%	
ECOG				
1	95%	51%	35%	.72
2	87%	19%	-	
Disease status				
De novo	100%	40%	30%	.94
Other status	90%	52%	36%	
Luminal co-expression				
Yes	98%	50%	40%	.14
No	89%	46%	23%	
Menopausal status, y				
<50	86%	37%	37%	.31
⩾50	97%	51%	32%	
CNS metastases				
Yes	84%	24%	16%	.0057
No	98%	56%	39%	
Response to 2L treatment				
Complete response	100%	100%	100%	.22
Partial response	100%	76%	76%	
Stable disease	90%	47%	37%	
Progressive disease	100%	42%	28%	

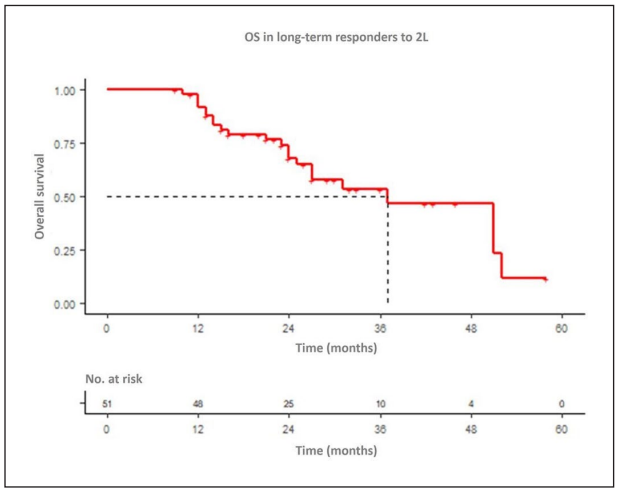

Figure 5. Estimated OS in long-term responder patients to 2L therapy.

Discussion

Treatment sequencing is recommended for patients with HER2-positive ABC; most whom had good performance status (ECOG 0-1) and a low proportion or no CNS involvement. Even in the CLEOPATRA trial, patients with active CNS metastases were excluded.[19] The present study enrolled more patients with de novo advanced disease, ECOG 2 and CNS involvement than the pivotal studies. The study also reported similar patients de novo rates (33%) compared with the CLEOPATRA trial (38%) and LATAM countries (30%-50%). Previous research of

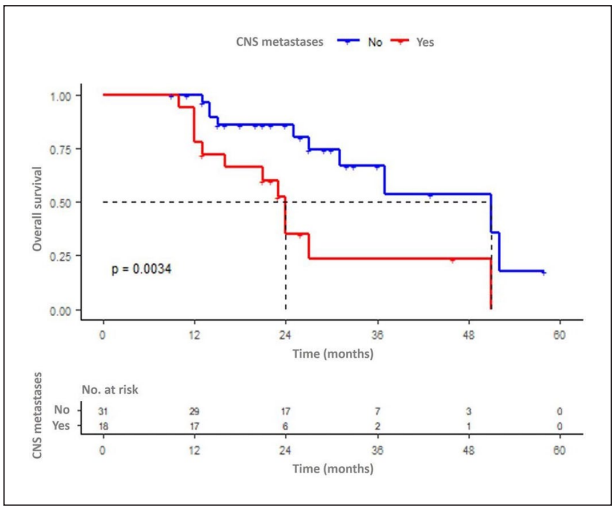

Figure 6. Estimated OS curves by CNS metastasis in long-term responders.

Peruvian patients with HR (+)/HER2-negative ABC revealed a tendency toward "aggressive disease" in this population, including rapid progression, and a high disease burden, which accounts for a higher incidence of de novo disease.[20] A real-life practice study reported a median OS of 40 months with 1L pertuzumab + trastuzumab + CT (taxanes) in patients with naïve HER2-positive ABC including only visceral metastases was reported, confirming the aggressive disease behavior in certain populations.[21]

The present study demonstrated an improvement in the OS time of 34 months using treatment sequencing, which falls within the time range reported in previous 1L trastuzumab + CT trials (similar to our sequence) where the median OS ranged from 25.1 to 38.1 months.[22-24] In a real-world study, the median 2L OS with T-DM1 was 41 months. However, it should be noted that this study was not conducted among a LATAM population.[25]

The OS in patients without CNS metastases was longer (38 vs 24 months, $P = 0.0057$). These findings underscore the poor prognosis of CNS metastasis, which impact the survival of patients with HER2-positive ABC, despite the use of lapatinib, which is traditionally known for its ability to cross the blood-brain barrier. The efficacy of this mechanism of action is augmented and substantiated by the administration of novel tyrosine kinase inhibitors such as tucatinib[26] and T-DXd[27] (both effective in CNS involvement). At present, there are more effective treatment options available for patients with HER2-positive ABC with BMs. These options include the untreated/active group, which has historically been excluded from randomized trials.

The median 1L PFS in our study was 11 months, which was longer in postmenopausal women. Regarding 2L PFS, a median PFS of 8 months was achieved, which is very similar to the pivotal trial (8.4 months),[28] and a significant difference in 2L was found with ECOG, highlighting the impact of an adequate performance status after 1L progression. A real-world European study that employed 1L pertuzumab + trastuzumab + CT, followed by 2L T-DM1 reported a median OS of 42 months. In addition, the 1L and 2L PFS were 13.4 and 6.6 months, respectively, which is similar to the treatment sequencing employed in the present study.[29]

In long-term responders, the median OS was found to be longer than the OS observed in the total population. Furthermore, patients without CNS metastases had a longer OS (51 vs 24 months, $P = .0034$). Certain cases of prolonged responses in HER2-positive ABC have been reported with trastuzumab + CT; however, the actual frequency of durable remissions remains indeterminate.[30-32] The end-of-study analysis of the CLEOPATRA trial reports that one-third of patients with ABC HER2 (+) are alive at 8 years of follow-up,[33] whereas an exploratory analysis evaluated the impact of an initial early radiological response (first tumor assessment at 9 weeks of treatment, 12.7% with CR, 67.1% with partial response (PR) and 20.2% with stable disease (SD)) showing that patients with CR + early radiological response had better PFS ($P < .001$) and OS ($P = .002$) than those who achieved PR or SD.[34] An analysis is necessary to identify any additional factors that may facilitate or elucidate cases of long-term responder patients.

The safety of our 2L treated patients was comparable and manageable with that of lapatinib + capecitabine in clinical trials. Most AEs were mild, with only 6.4% of patients experiencing grade 3 hand-foot syndrome, as reported in the pivotal trial (7%). The absence of grade 4 AEs or deaths related to lapatinib + capecitabine in the present trial corroborates the combination's acceptable toxicity profile. Although diarrhea was identified as the most prevalent grade 3 AE (12%), it was not reported in this study.

An updated consensus has emphasized the necessity of sequencing treatment in ABC, providing recommendations that are divided into subtypes.[35] In HER2-positive cases, many options beyond 3L or more are considered suboptimal before the appearance of new anti-HER2 therapies, such as T-DXd and tucatinib.[36] Treatment sequencing is constantly changing as new and effective therapies become available and high-quality CPGs are updated.[37]

Lapatinib plus capecitabine is considered a 4L or subsequent therapy option for HER2-positive ABC. However, current resource-stratified guidelines[38] and local consensus[39] support its use in resource-constrained settings, emphasizing the use of our 2L therapy. These recommendations arise from the need for sequence-available therapies due to the unavailability of new oncology drugs for HER2-positive ABC in most LATAM countries. Public health systems, including ethics statements, in LMICs must ensure the provision of effective oncological medication at affordable prices through the implementation of health policies. Peru has made significant efforts to enhance access to anti-HER2 therapies for patients with HER2-positive ABC. Initially, trastuzumab + CT was approved as a 1L treatment for metastatic disease in 2019 by the Ministry of Health (MINSA). Subsequently, our hospital (INEN) approved the use of lapatinib + capecitabine as a 2L therapy option in 2020, for patients with HER2-positive ABC who exhibited progression while receiving trastuzumab. Furthermore, in

Table 3. Treatment-related adverse events of Peruvian patients with HER2 (+) ABC with 2L lapatinib + capecitabine.

	Lapatinib + capecitabineN = 102			
	Number and percentage (%) of patients			
	Grade 1	Grade 2	Grade 3	Grade 4
Adverse events	33 (70.2)	12 (25.5)	2 (4.3)	0 (0)
General disorders and administration site conditions				
Asthenia[a]	0 (0)	1 (2.1)	0 (0)	0 (0)
Hematological disorders				
Anemia	3 (6.4)	0 (0)	0 (0)	0 (0)
Neutropenia	0(0)	1 (2.1)	0 (0)	0 (0)
Gastrointestinal disorders				
Diarrhea	1 (2.1)	3 (6.4)	0 (0)	0 (0)
Transaminitis[b]	0 (0)	2 (4.3)	0 (0)	0 (0)
Emesis	1 (2.1)	1 (2.1)	1 (2.1)	0 (0)
Nauseas	1 (2.1)	0 (0)	0 (0)	0 (0)
Abdominal pain	1 (2.1)	1 (2.1)	0 (0)	0 (0)
Hyperbilirubinemia	1 (2.1)	2 (4.3)	1 (2.1)	0 (0)
Skin and subcutaneous tissue disorders				
Hand-foot syndrome	9 (18.9)	12 (25.2)	3 (6.4)	0 (0)
Rash[c]	2 (4.3)	3 (6.4)	1 (2.1)	0 (0)
Infections				
Infection	0 (0)	1 (2.1)	0 (0)	0 (0)
Musculoskeletal and neurological disorders				
Peripheral neuropathy	1 (2.1)	0 (0)	0 (0)	0 (0)
Thoracic and mediastinal disorders				
Dyspnea	1 (2.1)	0 (0)	0 (0)	0 (0)

Severity of adverse events was graded according to Common Terminology Criteria for Adverse Events (CTCAE), version 4.0.
[a]Includes asthenia, decreased activity, fatigue, and malaise.
[b]Includes AST and/or ALT elevated.
[c]Includes dermatitis, dermatitis acneiform, erythematous rash, macular rash, papular rash, pruritic rash, erythema, and erythema multiform.

March 2023, pertuzumab + trastuzumab + docetaxel was approved as a 1L treatment for patients with HER2-positive ABC by the National Network for the Evaluation of Health Technologies ("Red Nacional de Tecnologias Sanitarias," RENETSA) for national use in Peru.[40] In addition, INEN has approved a local technical document (CPG) for the multidisciplinary management of ABC for national reference and application in oncologic institutions of MINSA.[41]

Regarding biomarkers, no subject has been identified as a prognostic factor in the present trial. The NLR and the PLR have emerged as prognostic biomarkers in many tumors. However, their predictive role has discordant outcomes except in the HER2-positive subtype. A phase II trial that included patients with HER2-positive ABC treated with pertuzumab and trastuzumab combined with eribulin (n = 30) or nab-paclitaxel (n = 21) evaluated absolute lymphocyte count (ALC), NLR, and PLR. The cutoff values for ALC, NLR, and PLR were established at 1000 or 1500 cells/μL, 2, and 250, respectively. Progression-free survival demonstrated enhancement in patients with ALC ⩾ 1500/μL versus those with ALC 1000 to ⩽1500/μL or ALC < 1000/μL ($P = .0106$). A high baseline ALC (⩾1500/μL) was found to be significantly associated with an improvement in PFS (HR: 0.37, 95% CI: 0.17-0.79; $P = .0108$), whereas PFS was not significantly enhanced with NLR or PLR. An enhanced PFSin patients with ALC ⩾ 1500/μL was observed independent of visceral metastasis or the type of CT. Baseline ALC was a predictive factor for PFS in a small group of patients with HER2-positive ABC treated with pertuzumab + trastuzumab + CT.[42]

A trial was conducted to evaluate the association between baseline NLR or PLR and PFS in patients with ABC, which was divided into 2 groups (HR-positive/HER2-negative, triple-negative). In patients with triple-negative ABC treated with platinum-based CT (n = 57), high NLR and PLR were associated with significantly reduced PFS in both univariate and multivariate analyses. Nevertheless, the trial did not find a significant association between NLR or PLR and PFS in the HR (+)/HER2 (−) group (n = 148). The NLR and PLR are only predictive of the benefit in patients with triple-negative ABC.[43]

A trial was conducted to assess the NLR in patients with HER2-positive ABC treated with T-DM1 (n = 53). Neutrophil-to-lymphocyte ratio in the peripheral blood was measured at baseline and after one cycle. The cutoff value for the NLR was 2.56. The PFS of patients with NLR-low at baseline (n = 26) was significantly better than that of NLR-high patients (n = 27) (HR: 0.22; 95% CI: 0.11-0.49, $P = .0001$). Furthermore, a prolonged OS was found to be

significantly associated with NLR-low (HR: 0.38, 95% CI: 0.17-0.91, $P = .0296$). The subgroup analysis of this trial indicated that patients with a NLR-low had longer PFS than those with NLR-high, irrespective of the number of prior CT regimens, prior trastuzumab use, visceral metastasis, HR status, and HER2 score. The treatment efficacy of T-DM1 is mediated by immune system activation. In patients diagnosed with HER2-positive ABC, a baseline NLR-low status appeared to be favorable for treatment with T-DM1.[44]

The present study has potential limitations. First, it was based on a retrospective analysis of the medical records. Second, the sample size was small and could have affected the outcomes. In addition, a real-world data report is provided (usually, real-world data report different results from pivotal studies that include highly selected populations).

Conclusions

Treatment sequencing revealed that administering 1L trastuzumab + CT, followed by 2L lapatinib + capecitabine increased the OS among Peruvian patients with HER2-positive ABC, exhibiting an acceptable safety profile, finding the greatest benefit was observed in postmenopausal patients with an ECOG 1, and without CNS involvement. Furthermore, a group of long-term responders was identified, with the finding that those without CNS metastases demonstrated a longer OS than those with CNS involvement. No prognostic blood biomarkers were identified in this study. These outcomes obtained in the 2L therapy, demonstrate this sequencing to be an effective treatment option in a middle-income population with limited resources. This assertion is validated by local consensus and CPGs.

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Ethical considerations

This study was approved by the Ethics Committee of the Instituto Nacional de Enfermedades Neoplásicas (Ethics Code: INEN 25-01 on January 2, 2025). All participants provided written informed consent prior to medical treatment. This study was conducted in accordance with the World Medical Association Declaration of Helsinki guidelines.

Consent to participate

Written informed consent for treatment was obtained from patients prior to 1L treatment for HER2-positive ABC.

Authors contributions

Guillermo Valencia: Conceptualization; Investigation; Supervision; Validation; Writing—original draft; Writing—review & edi-ting.
Patricia Rioja: Conceptualization; Investigation; Supervision; Validation; Writing—review & editing.
Olenka Peralta: Conceptualization; Investigation; Supervision; Validation.
Miguel Chirito: Conceptualization; Investigation; Supervision; Validation.
Raul Mantilla: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Software; Supervision; Validation.
Carlos Castaneda: Conceptualization; Investigation; Supervision; Validation; Writing—review & editing.
Zaida Morante: Investigation; Supervision; Validation; Writing—review & editing.
Hugo Fuentes: Investigation; Supervision; Validation; Writing—review & editing.
Tatiana Vidaurre: Investigation; Methodology; Supervision; Validation; Writing—review & editing.
Mónica Calderón: Conceptualization; Investigation; Supervision; Validation; Writing—original draft; Writing—review & editing.
Silvia Neciosup: Investigation; Supervision; Validation; Writing—review & editing.
Henry L Gómez: Conceptualization; Investigation; Methodology; Supervision; Validation; Visualization; Writing—review & editing.

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Data availability statement

This study used third-party data made available under license that the author does not have permission to share. Requests to access the data should be directed to the Department of Statistics and Informatics, Instituto Nacional de Enfermedades Neoplásicas (INEN) at http://www.inen.sld.pe/ and/or comunicaciones@inen.sld.pe

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