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BRIEF REPORT

Application of the Memorial Sloan Kettering Cancer Center Van Zee nomogram to a cohort of Algerian patients with breast tumours equal to or larger than 4 cm without clinical axillary invasion

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Abstract

Axillary node status remains the most important prognostic factor in breast cancer, although axillary lymph node dissection (ALND) is increasingly questioned in patients with positive sentinel lymph nodes (SLN). The Memorial Sloan Kettering Cancer Center Van Zee nomogram may support decision-making regarding completion of ALND after positive SLN. This study evaluated the performance of the Van Zee model in 32 Algerian patients with cN0 breast cancer ≥ 4 cm (8 cT2 and 24 cT3) and positive SLN who underwent routine ALND. Using a 35% cut-off, the nomogram achieved 88.9% sensitivity, 78.2% specificity, and 84.3% accuracy, with positive and negative predictive values of 84.2% and 84.6%, respectively. The area under the receiver operating characteristic (ROC) curve was 0.85, indicating good discriminatory performance. Predictors of non-SLN involvement included lymphovascular invasion, luminal subtype, and a higher number of positive SLNs. Although predictive models for axillary invasion are well established, data from the Middle East and North Africa region remain limited. These findings suggest that the Van Zee nomogram is applicable to Algerian patients with breast tumours ≥ 4 cm without clinical axillary involvement. However, larger studies are required before definitive validation.

Keywords: Large breast tumours; Sentinel lymph node; Nomogram; Cut-off values

1. Introduction

Node status is known to be the most important prognostic factor in breast cancer. However, in recent years, the axillary approach to breast cancer has become increasingly less invasive, to the point where conventional axillary lymph node dissection (ALND) has been called into question even in the case of positive sentinel lymph node (SLN) if certain conditions are duly met (ACOSOG Z0011 criteria, see Table 1).[1] In the case of a positive SLN, Van Zee's nomogram[2] is, in our opinion, an aid to the decision as to whether or not it is necessary to complete treatment of the axillary fossa with ALND, particularly when not all the ACOSOG Z0011 criteria are met.

The aim of our work is to evaluate the intrinsic values of the Van Zee nomogram in a population of Algerian patients with breast tumours measuring equal to or more than 4 cm, without clinical axillary invasion, for whom the SLN was positive on standard histological examination.

If the results are conclusive, we plan this integration as an aid in the decision whether or not to perform ALND for patients who do not meet the above-mentioned criteria, particularly patients who are candidates for mastectomy rather than breast-conserving procedure because of a large tumour volume.

Table 1. ACOSOG Z0011 criteria for omitting axillary lymph node dissection in patients with positive SLNs

No.	Criteria
1	Tumours less than 5 cm in size (T0-T1-T2), justifying breast-conserving surgery
2	Less than 3 positive SLNs on standard histology (not at immuno-histo-chemistry)
3	No extranodal extension in metastatic SLNs
4	Possibility of adjuvant treatment with chemotherapy or hormone therapy and radiotherapy covering the axillary area

Abbreviations: SLN: Sentinel lymph node.

2. Materials and methods

From a thesis conducted in our department involving 85 patients with breast tumours measuring ≥4 cm and no clinically evident axillary involvement[3], we identified a subgroup of 32 patients in whom the SLN samples were positive on standard histological examination. This study was prospective; it started in January 2016 and finished in December 2022. The inclusion criteria were female patients aged 18 years or older with breast tumours measuring ≥4 cm, sexually active or postmenopausal, and no clinically evident axillary lymph node involvement.

The exclusion criteria included:

(i) Pregnant women.
(ii) Previous breast surgery.
(iii) Patients who had received neoadjuvant chemotherapy.
(iv) Known allergy to products used in the dual-tracer SLN mapping technique (human albumin or Patent Blue).
(v) Obesity with a body mass index > 35.

The 32 patients in this subgroup underwent conventional ALND (Figure 1). Selected demographic and pathological characteristics are summarised in Table 2. The useful data collected were entered into the Van Zee nomogram on the Memorial Sloan Kettering Cancer Center (MSKCC) website: w3.mskcc.org/cancer-care/adult/breast/prediction-tools (Table 3).

The scores obtained using this software to determine the percentage risk of involvement of the axillary fossa were collected for all patients and plotted on a histogram (Figure 2).

Based on the results obtained, a cut-off value of 35% was set. Above this cut-off, we assume that there is a high probability of infiltration of the axillary lymph nodes. Below this cut-off, the probability of involvement of the axillary lymph nodes is low.

We then studied the intrinsic values with this cut-off and established the receiver operating characteristic (ROC) curve.

3. Results

We performed the final analysis of the data using IBM SPSS Statistics (version 22.0, IBM Corp., United States). This enabled us to produce frequency lists, cross-tabulations, calculations of means, graphical representations, and accompanying statistics such as distribution and trend diagrams.

First, a data-entry form was created based on the study project questionnaire, and then the information collected for each patient was entered. The data were analysed according to the prespecified analysis plan.

Using a 35% cut-off of the Van Zee score, sensitivity was 88.9%, specificity 78.2% and accuracy 84.3% (95% confidence interval [CI]: 0.718–0.970). The positive and negative predictive values were evaluated at 84.2% and 84.6%, respectively (see Table 3).

For a 35% cut-off, the area under the ROC curve was calculated using the following formula:

$$AUC = W1 - \frac{n1.(n1+1)}{2} / n1.n0 \quad (1)$$

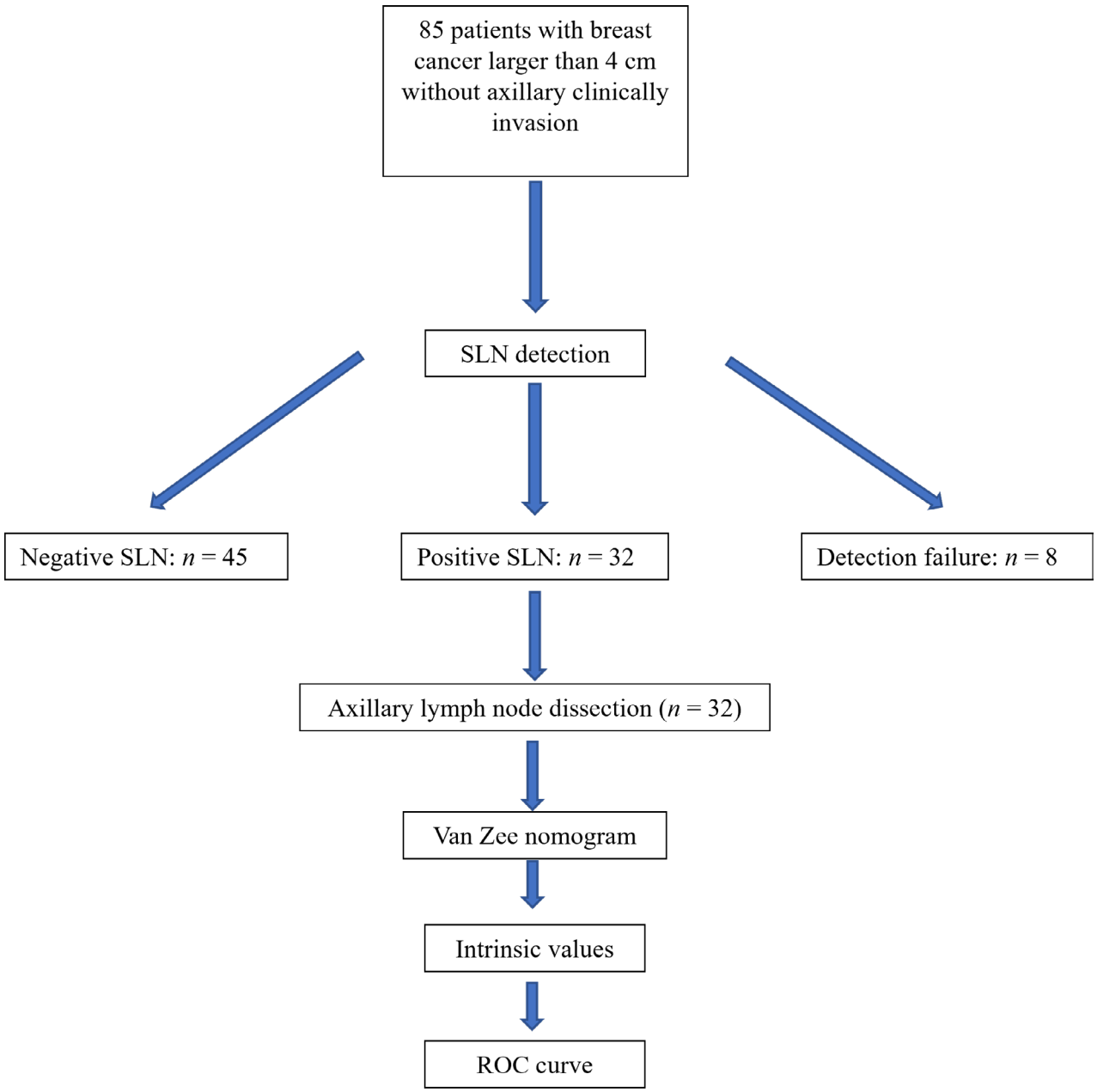


Figure 1. Study flowchart
Abbreviations: ROC: Receiver operating characteristic; SLN: Sentinel lymph node.

where *n1* represents the number of patients with concordant results (MSKCC score ≥ 35% with positive non-sentinel lymph node [NSLN] or MSKCC score < 35% with negative NSLN), *n0* represents the number of patients with discordant results (MSKCC score ≥ 35% with negative NSLN or MSKCC score < 35% with positive NSLN), and *W1* represents the sum of the orders of the patients with a concordant result.

We obtained an area under the curve (AUC) of 0.85 (95% CI: 0.7716–0.9284). The test can therefore be considered discriminative with this cut-off.

The factors associated with NSLN involvement in this cohort were: the existence of lympho-vascular emboli, the luminal type, and the high number of positive SLNs. The collected variables were entered into the Van Zee nomogram on the MSKCC website; the input parameters

Table 2. Principal demographic and anatomopathological features of the 32 patients with positive SLN

Serial no.	Age (years)	Tumour size (cm)	Grade (Scarff–Bloom–Richardson)	Molecular subtype	LVI
1	44	6	II	NP	Yes
2	59	5.5	II	Luminal B	Yes
3	47	7	II	Luminal B	Yes
4	43	6.5	II	Luminal B	NP
5	41	8	II	Luminal A	Yes
6	68	6	NP	Luminal A	Yes
7	51	5.5	II	Luminal A	Yes
8	49	10	II	Luminal A	Yes
9	73	6	II	Luminal B	No
10	38	5.5	II	Luminal A	Yes
11	47	8	II	Luminal B	Yes
12	42	9	II	Luminal B	Yes
13	79	4	II	Luminal A	Yes
14	46	11	II	Luminal A	Yes
15	47	6	II	Luminal B	No
16	44	6.5	II	Luminal B	NP
17	54	5	III	NP	Yes
18	30	4	II	Luminal B	Yes
19	48	4.5	II	NP	Yes
20	51	5	II	Luminal B	Yes
21	52	6	II	Luminal A	No
22	73	7	I	Luminal B	Yes
23	53	6	III	Luminal B	Yes
24	75	10	II	NP	Yes
25	47	5	II	Luminal B	Yes
26	54	9	II	Luminal B	Yes
27	50	6	I	Luminal A	NP
28	37	6.5	I	Luminal B	Yes
29	67	4	II	Luminal B	Yes
30	70	4	II	Luminal A	No
31	51	6	II	NP	No
32	38	6	II	Luminal B	Yes

Abbreviations: LVI: Lymphovascular invasion; NP: Not specified; SLN: Sentinel lymph node.

are listed in Table 4.

Table 3. Intrinsic values of the MSKCC nomogram with a cut-off of 35% in patients with positive SLN

MSKCC score	NSLN status		
	NSLN infiltrated	NSLN not infiltrated	Total
MSKCC ≥ 35%	TP = 16	FP = 03	PPV = 84.2%
MSKCC < 35%	FN = 02	TN = 11	NPV = 84.6%
Total	Se = 88.9%	Sp = 78.2%	Accuracy = 84.4%

Abbreviations: FN: False negative; FP: False positive; MSKCC: Memorial Sloan Kettering Cancer Center; NPV: Negative predictive value; NSLN: Non-sentinel lymph node; PPV: Positive predictive value; Se: Sensitivity; SLN: Sentinel lymph node; Sp: Specificity; TN: True negative; TP: True positive.

Table 4. Parameters used to calculate the Van Zee nomogram score

Parameter	Value/range
Frozen section performed	Yes or No
Pathological size	0 to 11 cm
Tumour type and grade	Ductal or lobular
Number of positive SLNs	1 to 7
Method of detection of SLN	Simple or dual
Lymphovascular invasion	Yes or No
Multifocality	Yes or No
Oestrogen receptor status	Yes or No

Abbreviation: SLN: Sentinel lymph node.

4. Discussion

A nomogram is a statistical tool used to predict an event as a function of several variables. The role of nomograms in predicting axillary invasion in breast cancer is a crucial subject in oncology, as they enable the risk of lymph node metastases to be better assessed and treatment strategies to be adapted to the clinical profile of each patient. In the case of breast cancer, factors predictive of axillary invasion have been well studied in the medical literature.

These factors may include:

(i) Tumour size: A larger tumour may be associated with a higher risk of spread to the lymph nodes.
(ii) Tumour grade: High histological grade is often associated with more aggressive tumour behaviour, increasing the risk of lymph node metastases.
(iii) Hormone receptor status (oestrogen and progesterone): A tumour that is negative for these receptors is generally more aggressive and may have a higher risk of spreading to the lymph nodes.
(iv) Patient age: Younger women may have a higher risk of axillary metastases due to the more aggressive biology of their tumours.
(v) The presence of lympho-vascular emboli or other tumour-specific biological features.

Most nomograms use these factors to establish a predictive score. We chose the Van Zee model because of its practicality and the fact that it is available online, enabling us to enter the data and immediately obtain the score

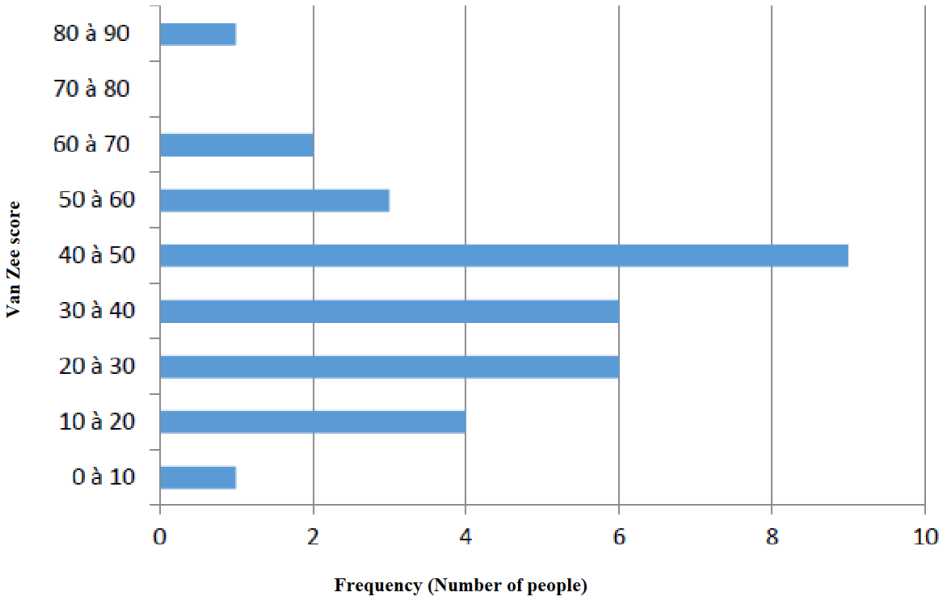


Figure 2. The predictive scores for axillary invasion obtained using the Van-Zee nomogram for the 32 patients with tumours equal to or larger than 4 cm without clinical axillary invasion.

without having to resort to complex statistical calculations.

One of the main advantages of nomograms is their ability to personalise care. For example, depending on the nomogram results, some low-risk patients may be able to avoid an ALND, which is an invasive surgical procedure with risks of complications (itching, pain, lymphoedema, reduced shoulder muscle strength). Instead, they can benefit from a sentinel node biopsy, a more targeted and less invasive procedure. This reduction in the number of overtreated patients is a step towards de-escalation of treatment in the axillary approach to patients with breast tumours.

Although nomograms are valuable tools, their use is not without its challenges. They rely on statistical data that are based on specific populations. Their reliability may therefore be limited in groups of patients with clinical characteristics different from those on which the model was trained. van den Hoven *et al.*[4] studied 9 different nomograms in 120 patients. They found considerable inter-group and, above all, inter-individual variability ranging from 4% to 94%, particularly in patients considered to be at low risk by the Van Zee model. This is why the results of these nomograms can be refined by dividing the patients into more homogeneous groups.

In our work, the AUC obtained (0.85) is better than in other series in the literature (Figure 3), where they did not exceed 0.67 as in the German series by van la Parra *et al.*[5] This result is certainly due to the homogeneity of our chosen subgroup (all with positive SLN, including tumours equal to or larger than 4 cm). Most recently, Wu *et al.*[6] whether 1-2 metastatic SLNs require ALND is debatable. The probability of metastasis in non-sentinel lymph nodes (NSLNs integrated ultrasound features, including absence of the lymph node hilum, with clinicopathological predictors in machine-learning models, resulting in an AUC of 0.759.

More recently, these nomograms are used as an aid in the evaluation of axillary lymph node status after neoadjuvant chemotherapy, with AUCs ranging from 0.837 to 0.850.[7]

The sample size is important, since in the Reyal series from the Institut Curie, samples of less than 200 patients can lead to erroneous results[8] we applied two validated predictors (Tenon Score and MSKCC Nomogram.

In addition, nomograms do not always take into account all the biological or clinical variables specific to each patient,

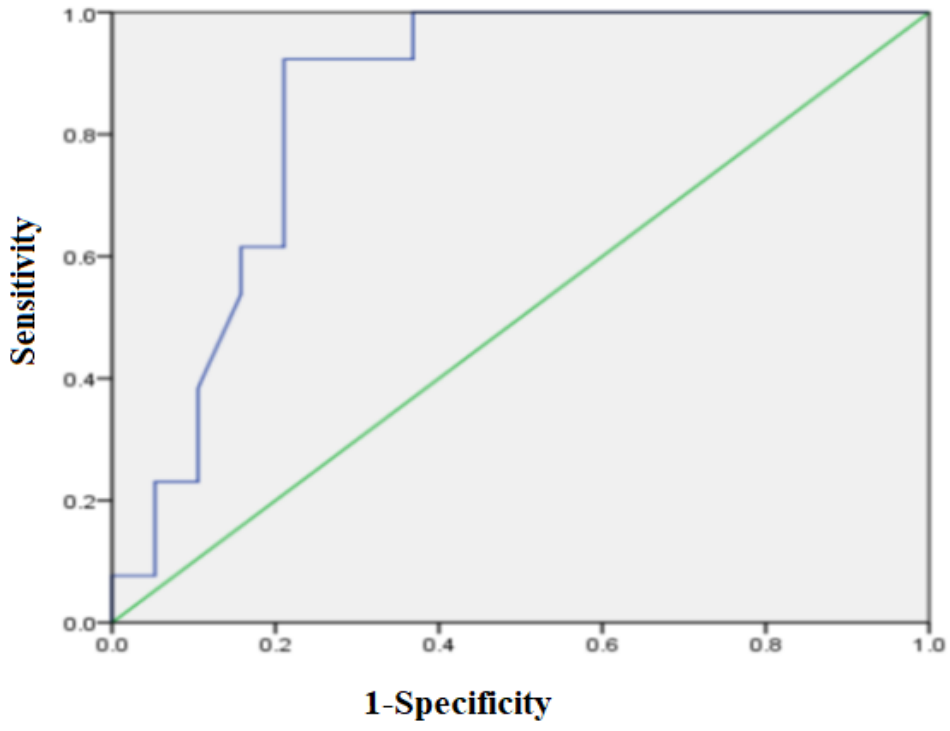


Figure 3. The receiver operating characteristic curve with the MSKCC nomogram (Van Zee) applied to our population with positive sentinel lymph node with a cut-off at 35%. Area under the curve = 0.85.

and certain factors may not be included in the model, such as genetic variations. Furthermore, decision-making in oncology is multidimensional. Emotional factors, patient preferences and practical medical constraints can also influence the choice of treatment.

5. Conclusion

Following these encouraging results, we believe that Van Zee's model is suited to the characteristics of our population, which consists of patients with breast tumours measuring equal to or more than 4 cm without clinical axillary invasion. As a result, it may support decision-making regarding whether to perform ALND in patients with positive SLNs. However, the final decision is made in the multidisciplinary breast cancer board, in the presence of the relevant specialists (radiotherapist, medical oncologist, breast surgeon, etc.).

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Conflict of interest

The authors have no conflict of interest to declare.

Author contributions

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Ethics approval and consent to participate

Ethical approval for this study was obtained from the scientific committee of our Central Hospital of the Army. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and relevant institutional and national research guidelines. Informed consent to participate was obtained from all participants prior to their inclusion in the study.

Consent for publication

Informed consent for publication was obtained from all participants prior to their inclusion in the study.

Availability of data

Data are available from the corresponding author upon reasonable request.

References

1. Giuliano AE, Ballman KV, McCall L, *et al*. Effect of axillary dissection vs no axillary dissection on 10-year overall survival among women with invasive breast cancer and sentinel node metastasis: the ACOSOG Z0011 (Alliance) randomized clinical trial. *JAMA*. 2017;318(10):918-926.

   doi: 10.1001/jama.2017.11470

2. Van Zee KJ, Manasseh DM, Bevilacqua JL, *et al*. A nomogram for predicting the likelihood of additional nodal metastases in breast cancer patients with a positive sentinel node biopsy. *Ann Surg Oncol*. 2003;10(10):1140-1151.

   doi: 10.1245/ASO.2003.03.015

3. Haddadi S, Touati R. *Ganglion sentinelle: Elargissement des indications aux tumeurs de plus de 03 cm sans envahissement axillaire clinique (Grands T2N0M0 et T3N0M0)* [thesis]. Faculté de Médecine, Université d'Alger 1 Benyoucef Benkhedda; 2023.

4. van den Hoven I, van Klaveren D, Voogd AC, Vergouwe Y, Tjan-Heijnen V, Roumen RMH. A Dutch prediction tool to assess the risk of additional axillary non-sentinel lymph node involvement in sentinel node-positive breast cancer patients. *Clin Breast Cancer*. 2016;16(2):123-130.

   doi: 10.1016/j.clbc.2015.09.003

5. Van Lappara RFD, de Roos WK, Constant C, Bavelaar-Croon CDL, Barneveld PC, Bosscha K. A prospective validation study of sentinel lymph node biopsy in multicentric breast cancer: SMMaC trial. *Eur J Surg Oncol*. 2014;40:1250-1255.

   doi: 10.1016/j.ejso.2013.11.004

6. Wu Q, Deng L, Jiang Y, Zhang H. Application of the machine-learning model to improve prediction of non-sentinel lymph node metastasis status among breast cancer patients. *Front Surg*. 2022;9:797377.

   doi: 10.3389/fsurg.2022.797377

7. Sun S, Chen Y, Liu Y, *et al*. A multicenter cohort study on ultrasound-based deep learning nomogram for predicting post-neoadjuvant chemotherapy axillary lymph node status in breast cancer patients. *Acad Radiol*. 2025;32(3):1252-1263.

   doi: 10.1016/j.acra.2024.09.065

8. Reyal F, Belichard C, Rouzier R, *et al*. Non-sentinel lymph node metastasis prediction in breast cancer with metastatic sentinel lymph node: impact of molecular subtypes classification. *PLoS ONE*. 2012;7(10):e47390.

   doi: 10.1371/journal.pone.0047390