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**SUPPLEMENTAL DATA**

# Prognostic nomogram for overall survival in breast invasive micropapillary carcinoma integrating LODDS and treatment factors: A SEER-based study

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**Table S1. Full multivariable Cox proportional hazards model formula and regression coefficients**

| Variables | Categories | β coefficient |
|---|---|---|
| **Age** | Continuous | 0.039 |
| **Marital status** | Unmarried | Reference (0) |
| | Married | -0.511 |
| **Grade** | I | Reference (0) |
| | II | -0.139 |
| | III | 0.095 |
| **Tumor size** | Continuous | 0.020 |
| **M stage** | M0 | Reference (0) |
| | M1 | 1.197 |
| **Rural/Urban** | Rural | Reference (0) |
| | Urban | -0.598 |
| **Subtype** | HR+ | Reference (0) |
| | HER2+ | 0.191 |
| | HR-/HER2- | 0.365 |
| | HR+/HER2+ | 0.095 |
| **Radiotherapy** | No | Reference (0) |
| | Yes | -0.478 |
| **Chemotherapy** | No | Reference (0) |
| | Yes | -0.693 |

| | | |
|---|---|---|
| **LODDS** | Continuous | 0.215 |

To ensure the complete reproducibility of our nomogram, we present the specific mathematical formula and regression coefficients ($\beta$) derived from the final multivariable Cox proportional hazards model below.

The predicted hazard $h(t|X)$ at time $t$ for a patient with covariate vector $X$ is calculated using the following general formula:

$$h(t|X) = h_0(t)\exp\left(\sum_{i=1}^{p} \beta_i X_i\right)$$

where $h_0(t)$ represents the baseline hazard function at time $t$, and $\beta_i$ are the estimated regression coefficients for each corresponding predictor variable $X_i$.

The linear predictor, commonly referred to as the Risk Score, is calculated by summing the products of each variable's value and its corresponding $\beta$ coefficient.

The specific equation for our IMPC cohort is:

$$\begin{aligned}\text{Risk score} = {} & (0.039 \times \text{Age}) + (-0.511 \times \text{Marriage}_{\text{Married}}) + (-0.139 \times \text{Grade}_{\text{II}}) + (0.095 \times \text{Grade}_{\text{III}}) + (0.020 \times \text{TumorSize}) + (1.197 \times \text{M_Stage}_{\text{M1}}) + \\ & (-0.598 \times \text{RuralUrban}_{\text{Urban}}) + (0.191 \times \text{Subtype}_{\text{HER2+}}) + (0.365 \times \text{Subtype}_{\text{HR-/HER2-}}) + (0.095 \times \text{Subtype}_{\text{HR+/HER2+}}) \\ & + (-0.478 \times \text{Radiotherapy}_{\text{Yes}}) + (-0.693 \times \text{Chemotherapy}_{\text{Yes}}) + (0.215 \times \text{LODDS})\end{aligned}$$

Note: For categorical variables, the reference categories—Unmarried, Grade I, M0, Rural, HR+ Subtype, No Radiotherapy, and No Chemotherapy—are assigned a value of 0. If a patient belongs to a specific category, the corresponding variable is assigned a value of 1.

**Table S2. Stratified Cox model analyzed by chemotherapy and radiotherapy.**

| Characteristic | HR (95% CI) | *p* value |
|---|---|---|
| Marriage | | |
| Unmarried | — | |
| Married | 0.65 (0.50 to 0.85) | 0.002 |
| M_Stage | | |
| M0 | — | |
| M1 | 3.77 (2.26 to 6.29) | <0.001 |
| Grade | | |
| I | — | |
| II | 0.96 (0.59 to 1.55) | 0.857 |
| III | 1.33 (0.80 to 2.21) | 0.267 |
| RuralUrban | | |
| Rural | — | |
| Urban | 0.58 (0.39 to 0.87) | 0.009 |
| Subtype | | |
| HR+ | — | |
| HER2+ | 1.03 (0.50 to 2.12) | 0.942 |
| HR-/HER2- | 1.93 (1.16 to 3.21) | 0.011 |
| HR+/HER2+ | 0.98 (0.66 to 1.43) | 0.901 |
| Age | 1.05 (1.03 to 1.06) | <0.001 |
| TumorSize | 1.01 (1.01 to 1.02) | <0.001 |
| LODDS | 1.22 (1.08 to 1.37) | 0.001 |

Abbreviations: CI: Confidence interval; HR: Hazard ratio.

**Table S3. Restricted cohort analysis: Cox model for surgical patients**

| Characteristic | HR (95% CI) | *p* value |
|---|---|---|
| Marriage | | |
| Unmarried | — | |
| Married | 0.63 (0.48 to 0.83) | 0.001 |
| M_Stage | | |
| M0 | — | |
| M1 | 2.00 (0.90 to 4.44) | 0.089 |
| Grade | | |
| I | — | |
| II | 0.88 (0.54 to 1.45) | 0.617 |
| III | 1.35 (0.80 to 2.27) | 0.260 |
| RuralUrban | | |
| Rural | — | |
| Urban | 0.56 (0.37 to 0.85) | 0.006 |
| Subtype | | |
| HR+ | — | |
| HER2+ | 0.94 (0.43 to 2.03) | 0.866 |
| HR-/HER2- | 2.17 (1.27 to 3.70) | 0.004 |
| HR+/HER2+ | 0.97 (0.64 to 1.46) | 0.881 |
| Age | 1.05 (1.04 to 1.06) | <0.001 |

| | | |
|---|---|---|
| TumorSize | 1.01 (1.01 to 1.02) | <0.001 |
| LODDS | 1.20 (1.06 to 1.36) | 0.005 |
| Radiotherapy | | |
| No | — | |
| Yes | 0.67 (0.51 to 0.87) | 0.002 |
| Chemotherapy | | |
| No | — | |
| Yes | 0.67 (0.48 to 0.94) | 0.020 |

Abbreviations: CI: Confidence interval; HR: Hazard ratio.

**Table S4. Subgroup analysis based on chemotherapy**

| | No | | Yes | |
|---|---|---|---|---|
| Characteristic | HR (95% CI) | *p* value | HR (95% CI) | *p* value |
| Marriage | | | | |
| Unmarried | — | | — | |
| Married | 0.65 (0.46 to 0.92) | 0.016 | 0.70 (0.46 to 1.07) | 0.096 |
| M_Stage | | | | |
| M0 | — | | — | |
| M1 | 6.71 (2.90 to 15.5) | <0.001 | 5.33 (2.48 to 11.4) | <0.001 |
| Grade | | | | |
| I | — | | — | |
| II | 0.92 (0.54 to 1.58) | 0.769 | 1.05 (0.32 to 3.44) | 0.935 |

| | | | | |
|---|---|---|---|---|
| III | 1.16 (0.64 to 2.08) | 0.629 | 1.74 (0.53 to 5.64) | 0.359 |
| RuralUrban | | | | |
| Rural | — | | — | |
| Urban | 0.55 (0.33 to 0.92) | 0.023 | 0.66 (0.34 to 1.27) | 0.213 |
| Subtype | | | | |
| HR+ | — | | — | |
| HER2+ | 0.34 (0.05 to 2.61) | 0.303 | 1.29 (0.58 to 2.88) | 0.530 |
| HR-/HER2- | 1.36 (0.55 to 3.42) | 0.507 | 2.79 (1.46 to 5.35) | 0.002 |
| HR+/HER2+ | 1.41 (0.82 to 2.43) | 0.211 | 0.73 (0.42 to 1.26) | 0.257 |
| Age | 1.08 (1.06 to 1.10) | <0.001 | 1.01 (1.00 to 1.03) | 0.160 |
| TumorSize | 1.01 (1.00 to 1.02) | 0.013 | 1.01 (1.00 to 1.02) | 0.002 |
| LODDS | 1.16 (0.98 to 1.36) | 0.082 | 1.26 (1.03 to 1.54) | 0.027 |
| Radiotherapy | | | | |
| No | — | | — | |
| Yes | 0.62 (0.44 to 0.86) | 0.004 | 0.71 (0.46 to 1.09) | 0.115 |

Abbreviations: CI: Confidence interval; HR: Hazard ratio.

**Table S5. Time-dependent calibration metrics and prediction errors for the nomogram at 3-, 5-, and 10-year overall survival.**

| Time horizon | Brier score | Calibration intercept | Calibration slope (IPCW) | Mean absolute error | 90% quantile of error |
|---|---|---|---|---|---|
| 3-Year OS | 0.0492 | 0.28 | 1.136 | 0.0006 | 0.0016 |

| | | | | | |
|---|---|---|---|---|---|
| 5-Year OS | 0.0871 | 0.115 | 1.084 | 0.002 | 0.0039 |
| 10-Year OS | 0.1487 | 0.063 | 1.019 | 0.0034 | 0.0052 |

Calibration metrics, specifically the intercept and slope, along with the Brier score, were calculated using the IPCW method to effectively address right-censored data.
**Abbreviations**: OS: Overall survival; IPCW: Inverse probability of censoring weighting.

**Table S6. Reclassification and enhancement of the nomogram in comparison to the conventional TNM staging system for predicting OS at 3, 5, and 10 years**

| Time horizon | Continuous NRI (95% CI) | IDI (95% CI) | Interpretation of IDI (absolute risk gap increase) |
|---|---|---|---|
| 3-Year OS | 0.363 (0.189–0.487) | 0.077 (0.033–0.137) | 0.077 |
| 5-Year OS | 0.367 (0.250–0.456) | 0.108 (0.065–0.169) | 0.108 |
| 10-Year OS | 0.427 (0.338–0.514) | 0.184 (0.129–0.237) | 0.184 |

Abbreviations: TNM: Tumor–node–metastasis; OS: Overall survival; NRI: Net reclassification improvement; CI: Confidence interval; IDI: Integrated discrimination improvement.

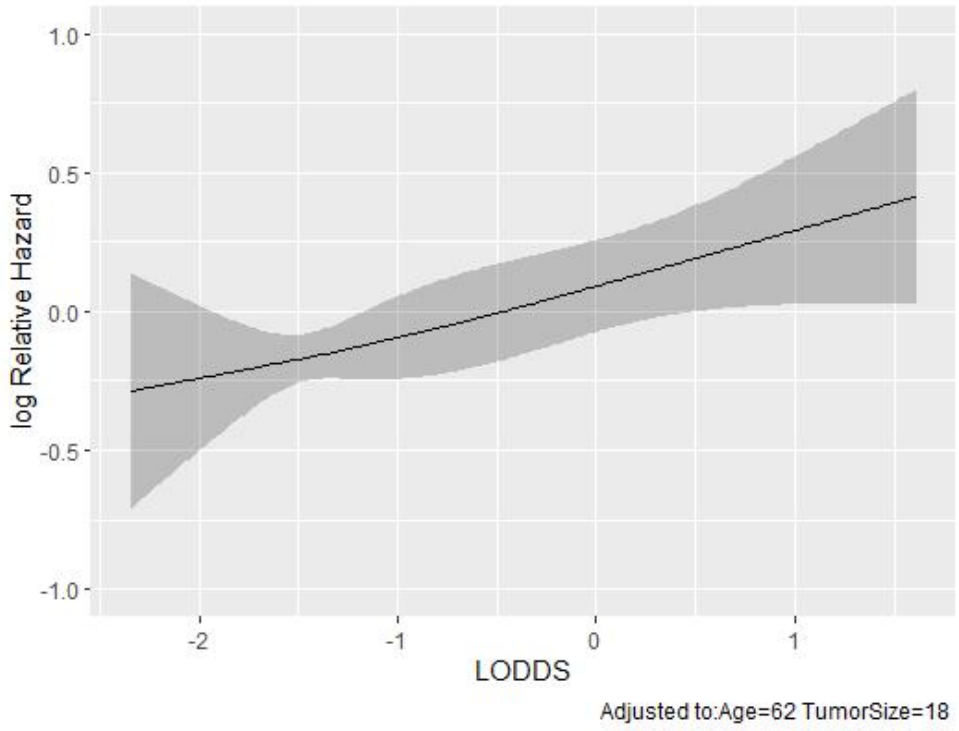



**Figure S1. RCS analysis of continuous variables in the Cox proportional hazards model.** The relationships between continuous predictors—**(A)** Age, **(B)** Tumor size, and **(C)** LODDS—and the log relative hazard of overall survival were assessed using restricted cubic splines with three knots. The solid black line indicates the estimated log relative hazard, while the shaded gray area represents the 95% CI. The *p* values for non-linearity for all three variables exceeded 0.05, indicating no significant deviation from linearity. Therefore, these variables were included in the final multivariable Cox model as linear continuous variables. **Abbreviations**: RCS: Restricted cubic spline; LODDS: Log odds of positive lymph nodes; CI: Confidence interval.