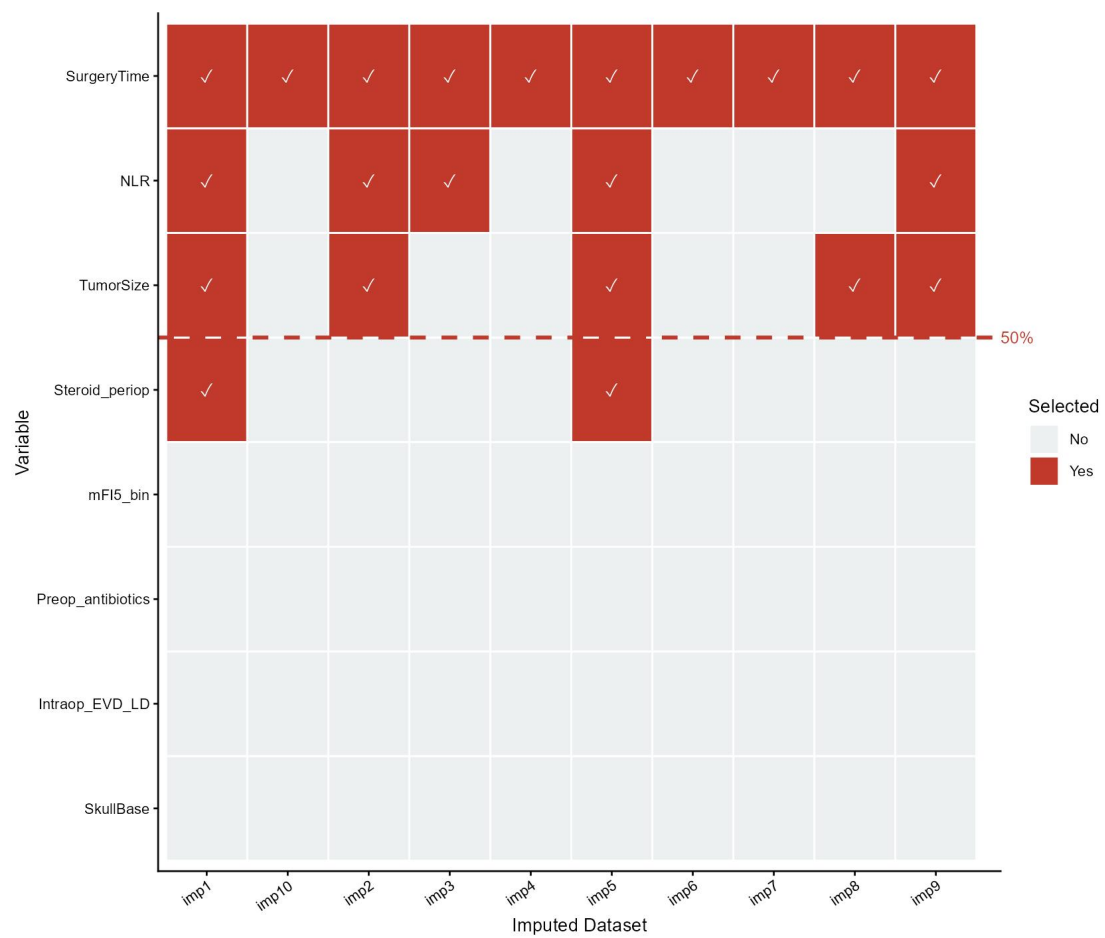
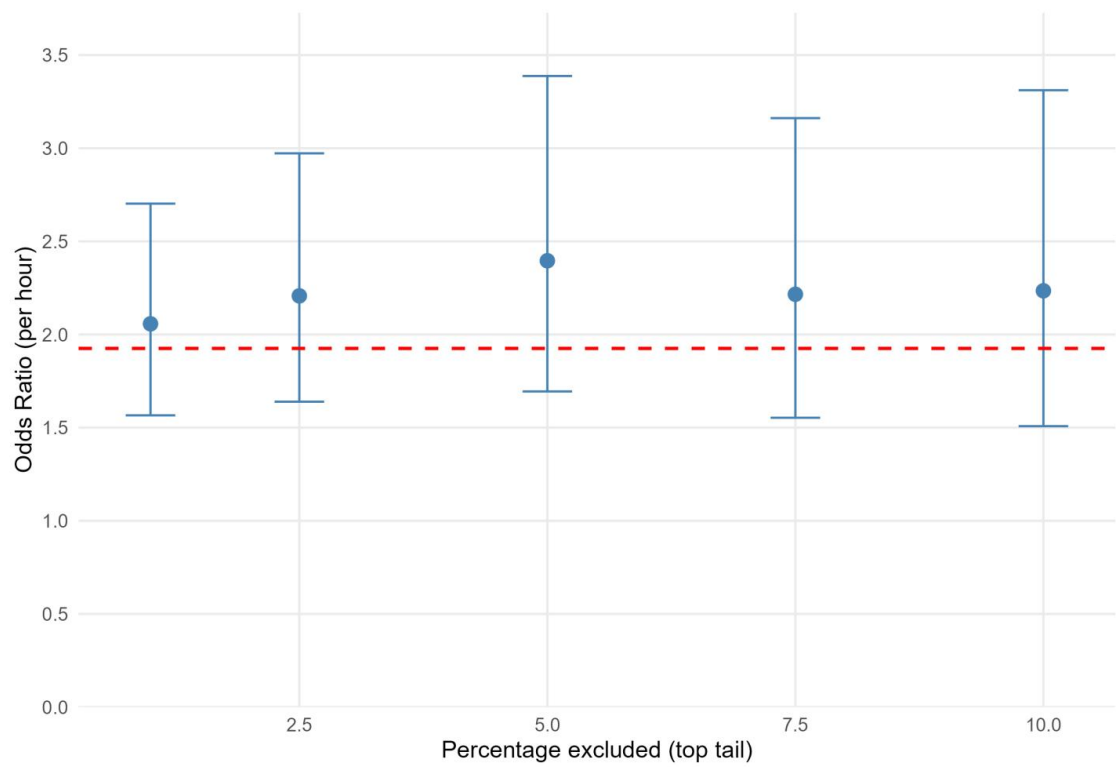
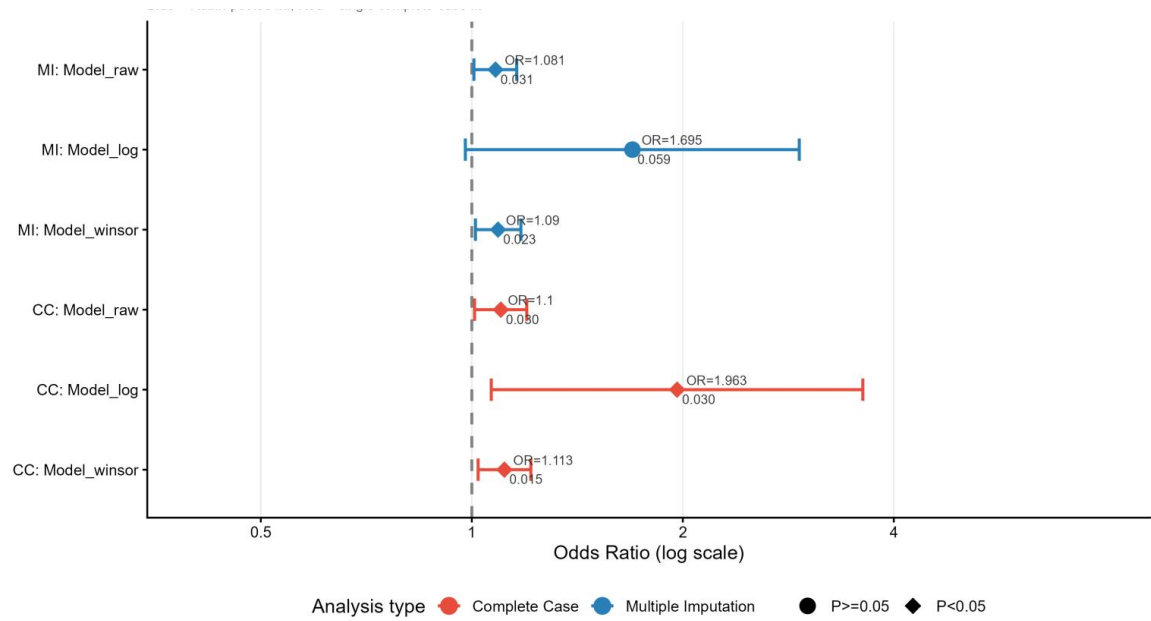




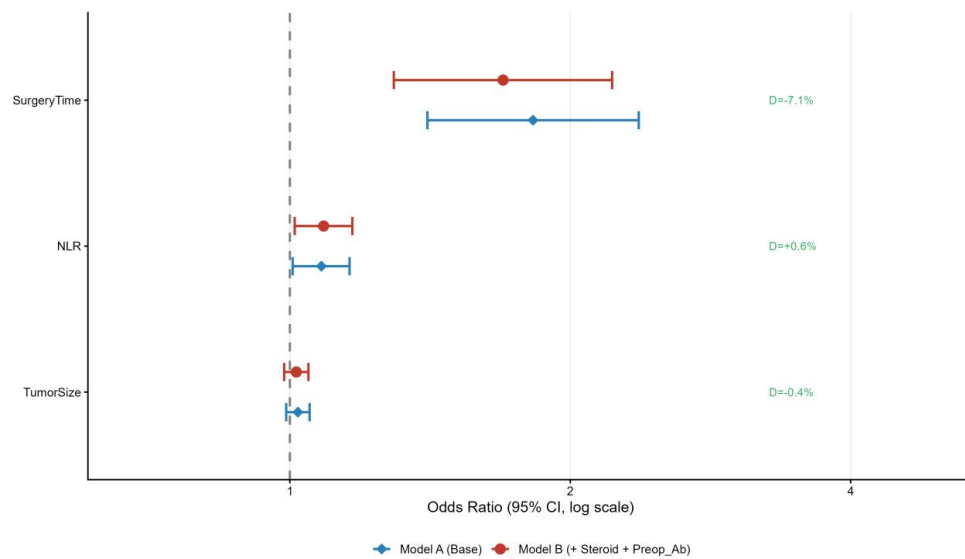
Supplementary Figure 1 Heatmap of variable selection frequency across the 10 imputed datasets under the lambda.1se criterion.



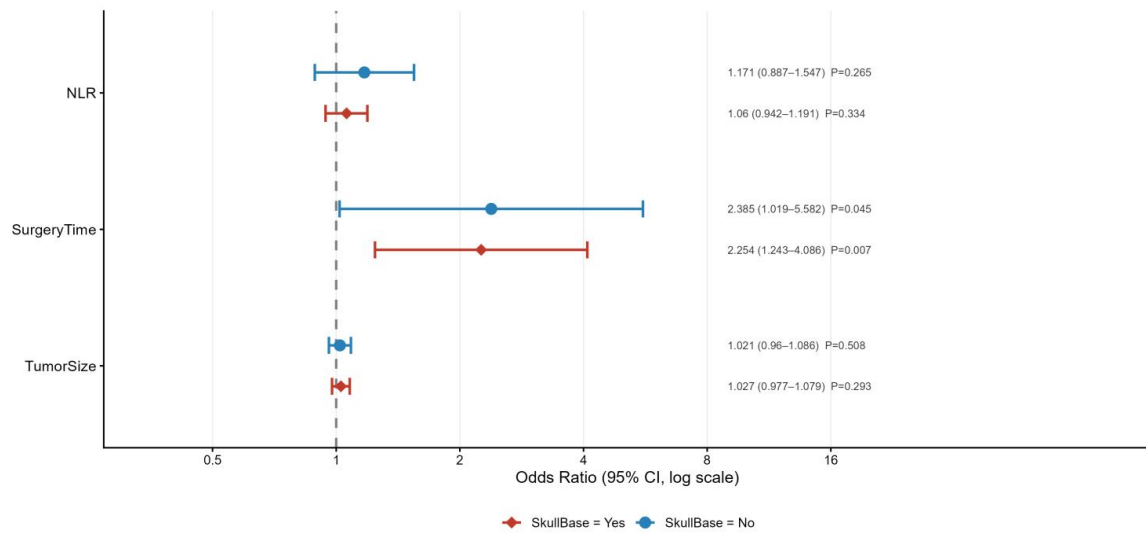
Supplementary Figure 2 Sensitivity analysis excluding cases with extreme surgery times.



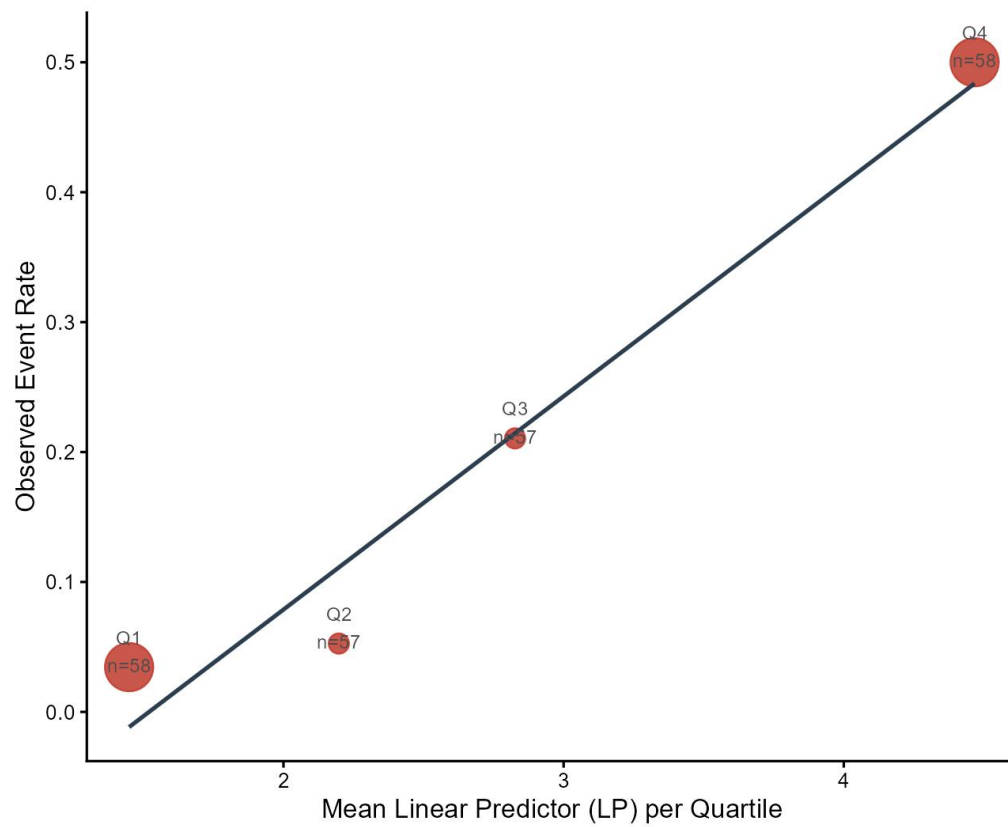
Supplementary Figure 3 Forest plot comparing the NLR effect estimate across log-transformed, winsorized, and complete-case analyses.



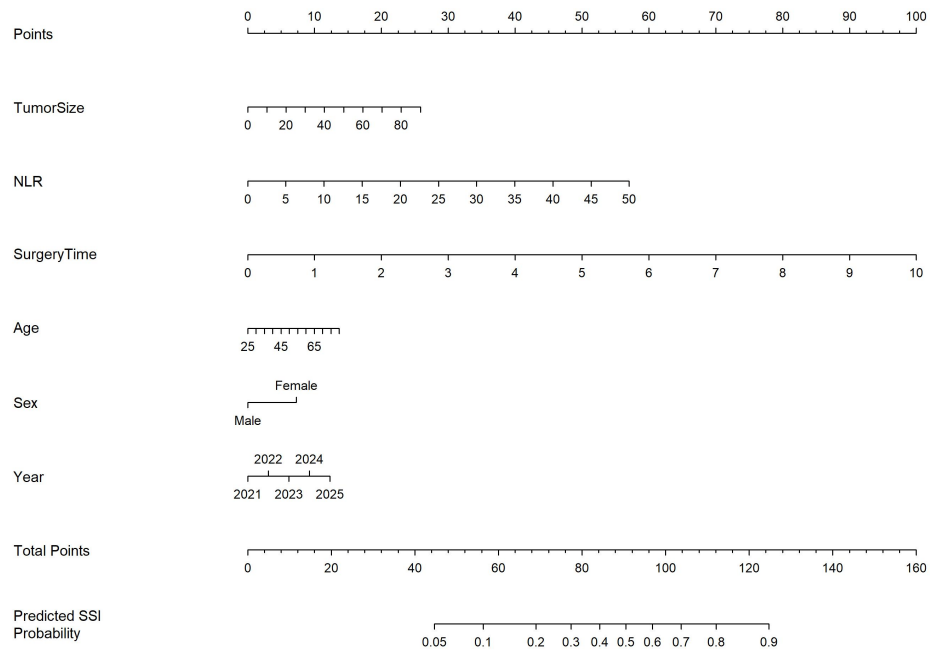
Supplementary Figure 4 Sensitivity analysis of core variables adjusting for corticosteroid use and antibiotic prophylaxis.



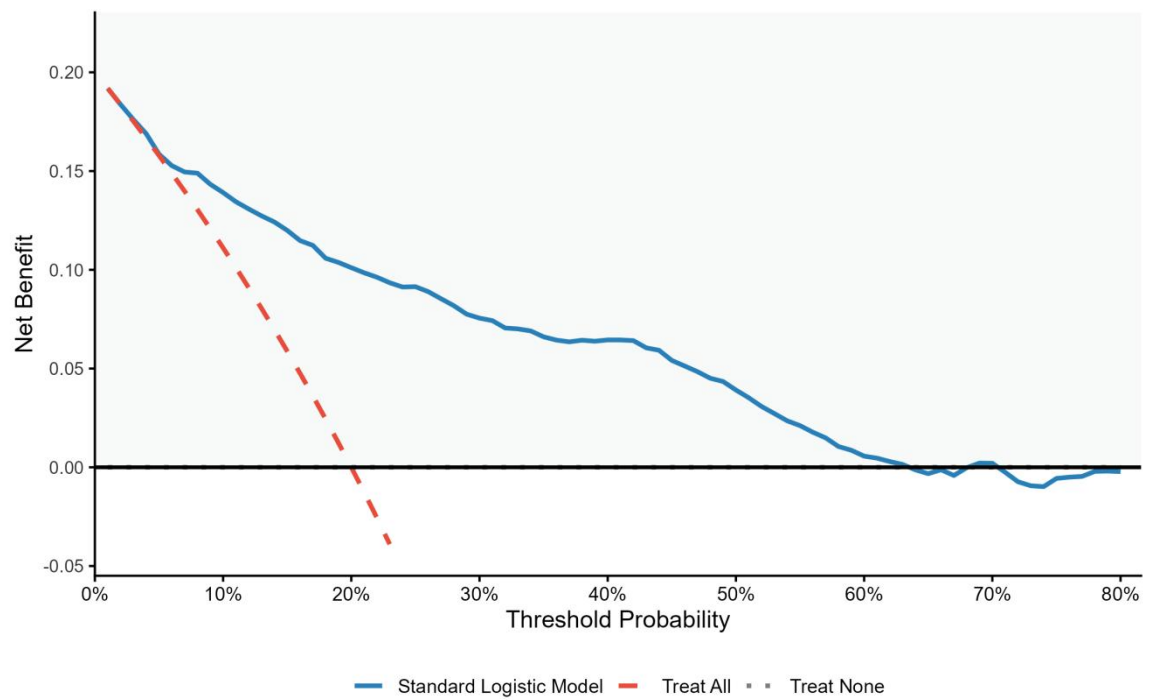
Supplementary Figure 5 Subgroup forest plot of the surgery time effect in skull-base versus non-skull-base meningiomas, with test for interaction.



Supplementary Figure 6 Calibration assessed by SSI risk across quartiles of the linear predictor.



Supplementary Figure 7 Nomogram for predicting SSI. This nomogram was derived from a standard logistic regression model (including age, sex, and year) for the purpose of clinical visualization. It provides approximate absolute risk estimates and is intended as a supplementary tool to the primary matched analysis.



Supplementary Figure 8 Decision curve analysis of the prediction model.

Supplementary Table 1 Missing Data of Variables in the Matched Cohort

Variable	Missing Percentage
Group	0
Year	0
Sex	0
Age	0
PreopDays	0
ASA	0
Wound_Class	0
BloodLoss	0
SkullBase	0
Recurrence	0
TumorSize	6.52
WHOGrade	2.61
Intraop_EVD_LD	0
Steroid_periop	0
Preop_antibiotics	0
mFI5	0
PNI	3.91
NLR	5.65
GNRI	2.61
Pre_existing_HAI_before_SSI	0
ID2	0
SurgeryTime	0
mFI5_bin	0

**Supplementary Table 2 Sensitivity Analysis – SurgeryTime Dichotomised
at 3.04 h**

Variable	OR	CI_lo w	CI_high	OR (95% CI)		P value	Z
TumorSize	1.032	1.005	1.060	1.032	(1.005 – 1.060)	0.022	2.290
NLR	1.059	1.000	1.121	1.059	(1.000 – 1.121)	0.049	1.966
SurgeryTime > 3.04 h	5.668	2.596	12.374	5.668	(2.596 – 12.374)	<0.001	4.355

**Supplementary Table 3 Sensitivity analysis: Multivariable Conditional
Logistic Regression based on lambda min**

Variable	OR (95% CI)	P value
SkullBaseYes	3.319 (1.210 – 9.110)	0.020
Intraop_EVD_LDYes	3.079 (1.053 – 9.005)	0.040
Steroid_periopYes	3.295 (1.279 – 8.490)	0.013
mFI5_bin>=1	2.466 (0.916 – 6.637)	0.074
TumorSize	1.026 (0.994 – 1.060)	0.117
NLR	1.091 (1.000 – 1.191)	0.049
SurgeryTime	1.420(1.061 – 1.900)	0.018

Supplementary Table 4 Stratified analysis based on operative duration >3 hours

Variable	Infection Cases / Total	Proportion of SSI Cases(%)	OR (95% CI)
SurgeryTime> 3h+			
No intraop antibiotic redose	20/61	32.79	1.00 (Reference)
SurgeryTime > 3h+			
Intraop antibiotic redose	13/17	76.47	6.07 (1.85–19.98)

Supplementary Table 5 Model Performance Evaluation-Final multivariable conditional logistic regression model

Category	Metric	Value
Discrimination	AUC (Rubin-pooled, DeLong SE)	0.828
Discrimination	AUC 95% CI	0.751 – 0.884
Discrimination	AUC range across imputations	[0.820, 0.841]
10-fold CV	CV AUC (mean ± SD)	0.800 ± 0.015
10-fold CV	CV Cal Slope (mean ± SD)	1.093 ± 0.194
Bootstrap (B=200)	Boot Apparent AUC	0.828 ± 0.006
Bootstrap (B=200)	Boot Optimism	0.0098 ± 0.0023
Bootstrap (B=200)	Boot Optimism-corrected AUC	0.818 ± 0.006
Bootstrap (B=200)	Boot Cal Slope (mean ± SD)	0.883 ± 0.019