The ROKS nomogram for predicting a second symptomatic stone episode

Supplemental Methods

Validation

Criteria for a validated first-time symptomatic kidney stone in this study were: 1) the patient presented for clinical care between 1984 and 2003 with gross hematuria or pain, 2) a stone was either seen on imaging in a location consistent with partial, complete, or intermittent obstruction (ureter, uretero-pelvic junction, uretero-vesicular junction, kidney pelvis, or lower kidney pole) or there was documentation that it was voided, and 3) no prior symptomatic episodes from a kidney stone confirmed on imaging or voided. The pain could be typical renal colic or atypical (vague nonlocalized abdominal, pelvic, or back pain). Symptomatic lower pole stones required a clinical pattern of intermittent symptoms from intermittent obstruction at the ureteropelvic junction. In addition to obstructing stones, stone episodes were also considered valid if the patient presented with a symptomatic urinary tract infection from a struvite stone, even if the stone was not obstructing. Incidentally discovered asymptomatic kidney stones on imaging, bladder stones, and "suspected stones" (renal colic but no stone ever seen) were not considered valid episodes, but could meet the validation criteria at a later date. Any second symptomatic episode had to meet these same validation criteria and occur 30 days or more after the first episode with an interim asymptomatic period. Findings were nearly identical with a second episode defined as 90 days or more after the first episode (data not shown). We also identified second symptomatic episodes that were attributed to the same stone that caused the first symptomatic episode (symptoms resolved and then returned from the same stone).

Statistical Analysis

Follow-up was terminated at the second stone episode, last clinical care episode, or date of chart review (through 2012), whichever came first. Characteristics of subjects with and without recurrence were initially compared using chi-square and rank sum tests. The formal association of candidate predictors with time to symptomatic recurrence was assessed using Kaplan-Meier

plots and hazard ratios (HRs) derived from Cox proportional hazards models. Age and body mass index were assessed as linear predictors based on evaluation of Martingale residuals from the null model. The contribution of interactions of sex and age with other factors in the final model were assessed jointly and were not significant ($p>0.35$ for both age and sex). The multivariable model considered all candidate predictors that had univariate p-values ≤ 0.10. Another model included interaction terms between any asymptomatic non-obstructing stone and each other predictor. Additional models were limited to patients with computed tomography scans or excluded second symptomatic episodes attributed to the same stone that caused the first symptomatic episode. The concordance (C)-statistic, analogous to the area under a receiver operator characteristic curve, was used to summarize model discrimination. A plot of observed versus predicted 10-year recurrence (by deciles of predicted) was used to estimate calibration. To address model over-fitting, the C-statistic corrected for optimism was calculated (repeating the variable reduction step). A simplified nomogram based on the Cox model linear predictor was developed to predict the probability of symptomatic recurrence at 2, 5, and 10 years.

Supplemental Figures

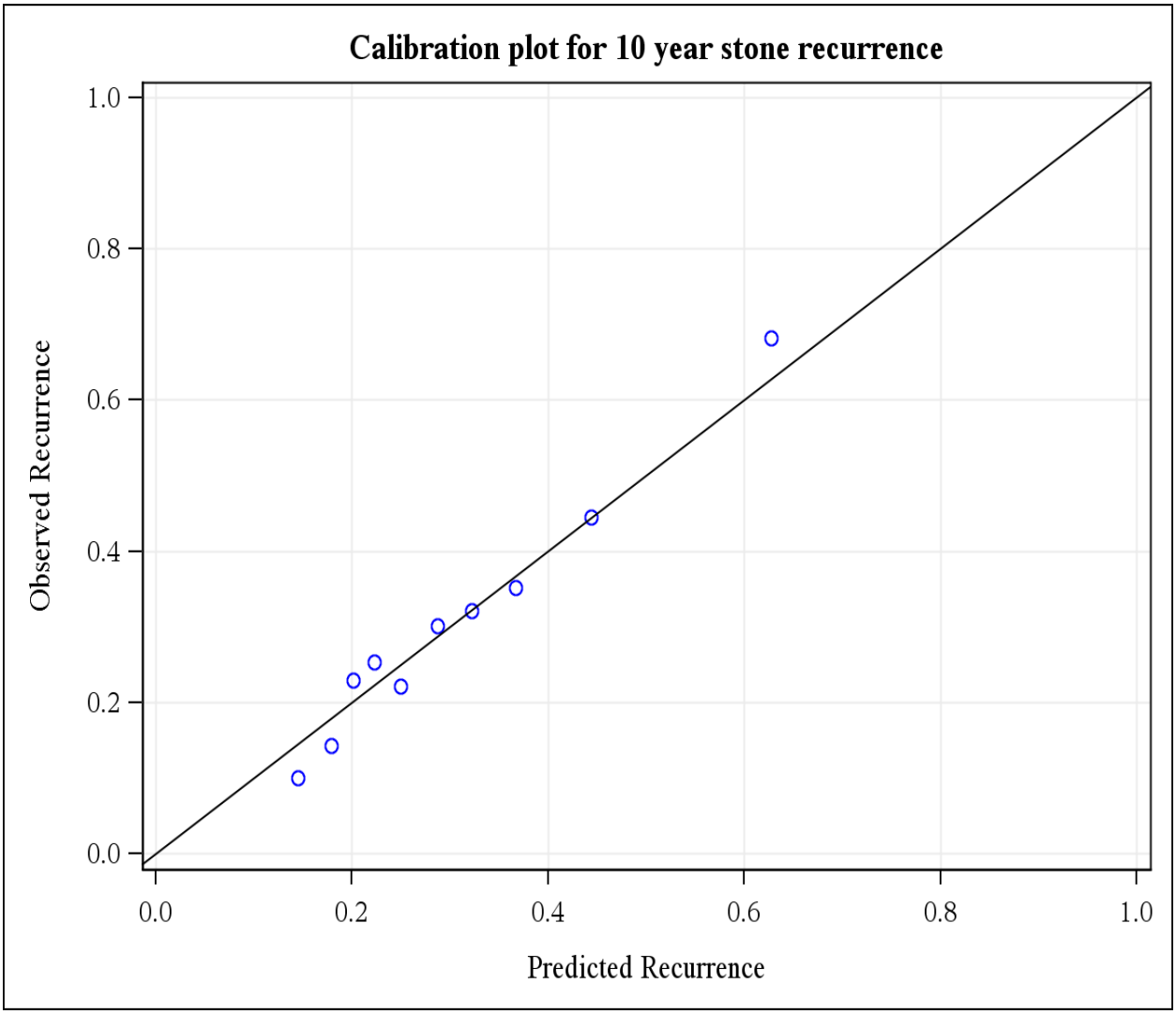

Figure S1. Calibration plot for 10-year recurrence risk for a second symptomatic stone by decile of total points. Model predicted (x-axis) versus observed 10-year recurrence (y-axis).

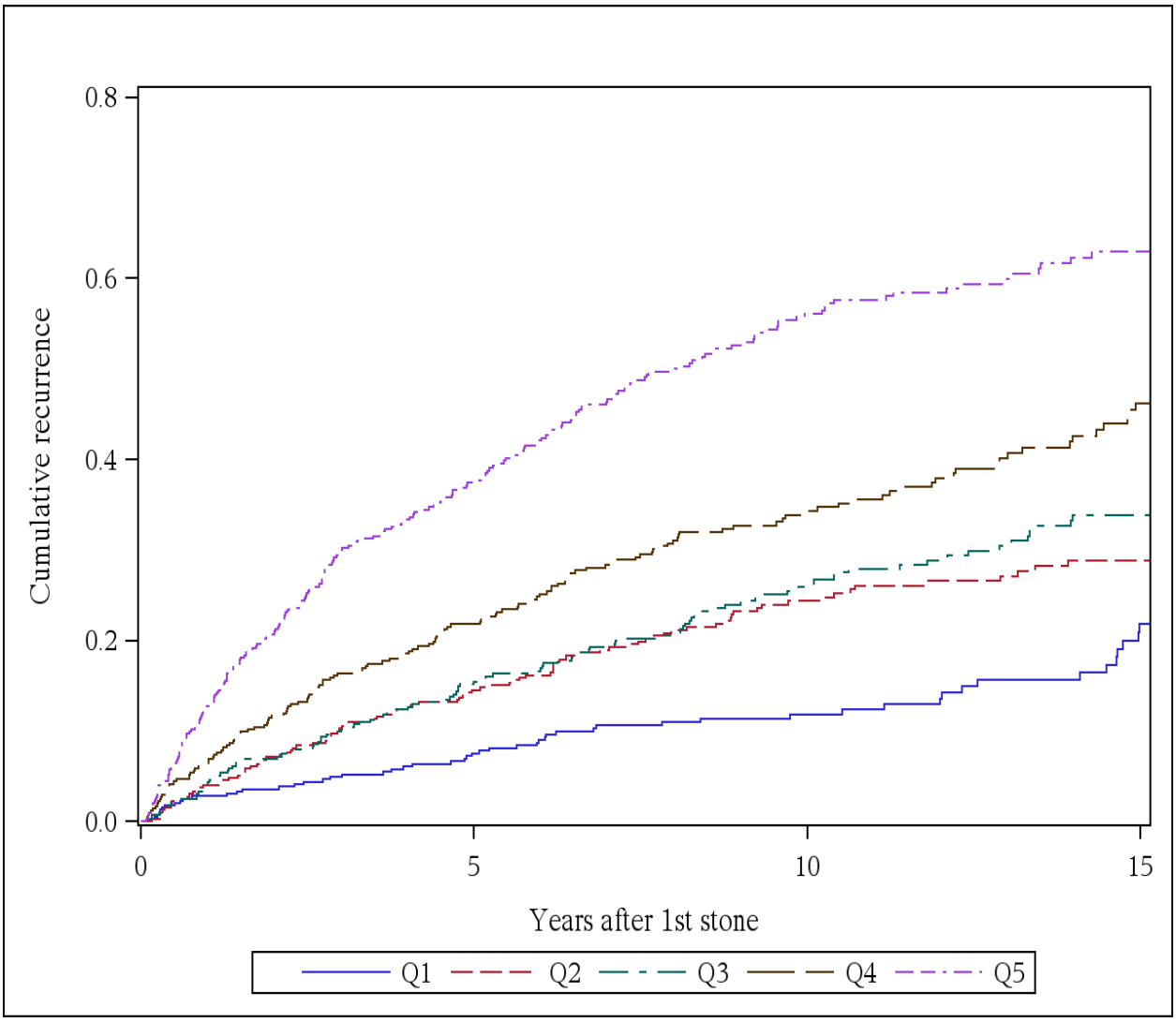

Figure S2. Cumulative risk of recurrence for a second symptomatic episode by the final model total points quintiles (Q1 toQ5).