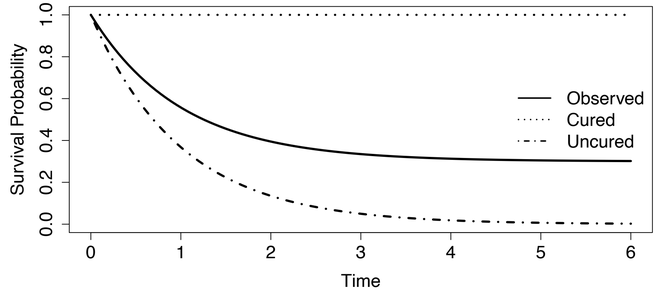
# RECeUS: Ratio Estimation of Censored Uncured Subjects, A Different Approach for Studying Sufficient Follow-Up in Studies of Long-Term Survivors

Subodh Selukar and Megan Othus

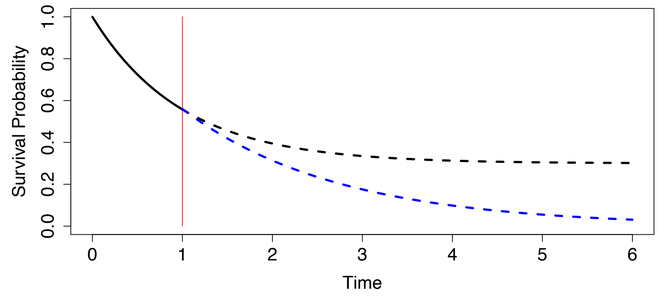
## MOTIVATION

### Mixture-Cure Models




Mixture-cure models assume the observed data arise from a mixture of cured and uncured subpopulations

### Sufficient Follow-Up




If a study ends too early, the right tail of the distribution may not be identifiable

## Problem

Existing methods may:

- Falsely conclude sufficient follow-up, causing bias
- Falsely claim insufficient follow-up, possibly leading to additional, costly data collection

## PROPOSAL

### RATIO ESTIMATION OF CENSORED UNCURED SUBJECTS

$$\hat{r}_n = \frac{\hat{S}_{uc}(\tau)}{\hat{S}(\tau)}$$

- $\hat{S}_{uc}(\tau)$: estimate of proportion uncured remaining at study end
- $\hat{S}(\tau)$: estimate of proportion overall remaining at study end

### RECeUS Advantages

Flexible

- Parametric or semiparametric mixture-cure models

Interpretable

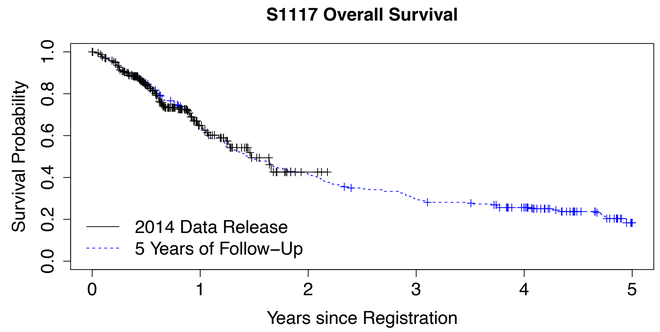
- Standardized version of proportion uncured remaining at study end
- Smaller $\hat{r}_n$, cure model more appropriate

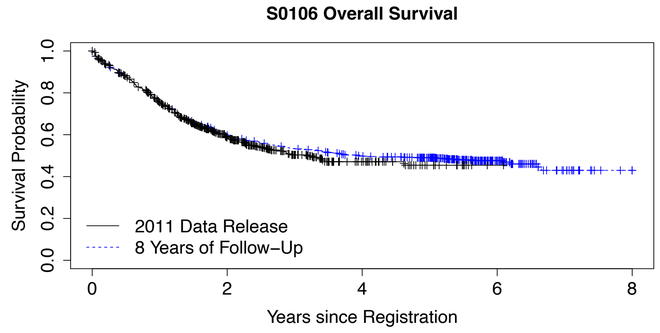
## SIMULATIONS

| Truth | Rates of Concluding Cure Model Appropriateness* | | |
|---|---|---|---|
| **Cure Model Appropriate?** | **RECeUS** | **Maller & Zhou (1994)** | **Shen (2000)** |
| No | Low | High | Low |
| Yes | High | High | Low |

*Based on simulations from Weibull, Log-Logistic and Gamma mixture-cure distributions, where RECeUS used an AIC-based model selection procedure to estimate $\hat{r}_n$ and a criterion of (1) $\hat{r}_n < 0.05$ and (2) estimated cure fraction of at least 2.5%

## DATA EXAMPLES




| Cure Model Appropriate? | RECeUS | Maller & Zhou (1994) | Shen (2000) |
|---|---|---|---|
| S1117: No | ✓ | ✗ | ✓ |
| S0106: Yes | ✓ | ✓ | ✗ |

✓ Correct Decision ✗ Incorrect Decision

## Conclusion

RECeUS accurately classifies when a cure model is or is not appropriate in simulations and data examples