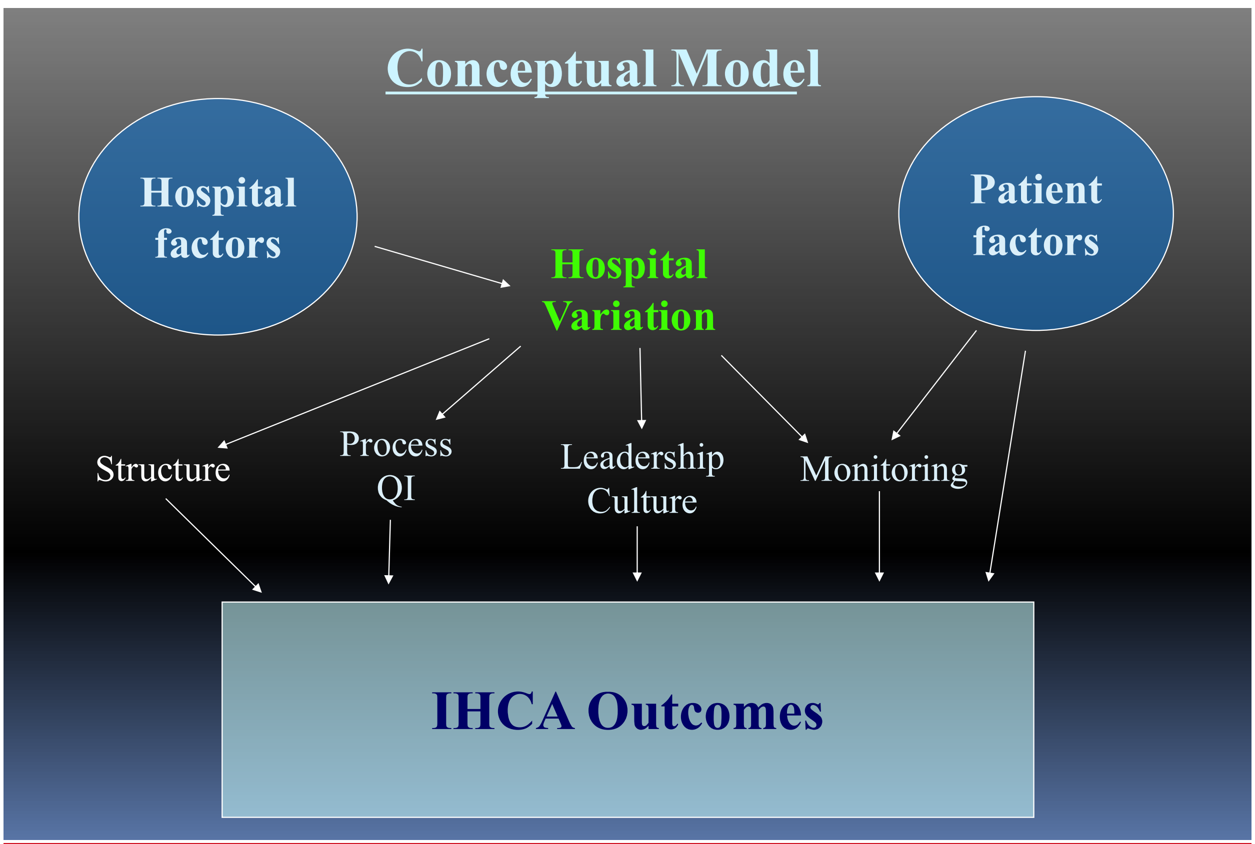
A hospital's risk-standardized rate of survival for IHCA should ensure that differences in case-mix are accounted for. Hospitals which care for sicker patients who have an IHCA, on average, will have lower unadjusted survival rates. Accounting for differences in comorbidity burden and illness severity allows for a fairer "apples-to-apples" comparison. Therefore, differences across hospitals in their risk-standardized survival rates for IHCA will more likely reflect differences in resuscitation response and care quality.

In the figure below, we note that patient factors (comorbidities, illness severity) can influence a hospital's survival rate for IHCA. The proposed Risk-standardized survival rate for IHCA seeks to address this by adjusting for differences in patient factors and case-mix across hospitals. **What remains is what hospitals do to respond to IHCA.** In our mixed-methods study to identify best practices at hospitals with the highest survival rates for IHCA,[1] we found that hospital variation was explained, in large part, by how hospitals structure resuscitation teams and response, the quality improvement initiatives which they undertook, the important role of leadership and hospital culture in building excellence in resuscitation care, and a hospital's ability to monitor for clinical deterioration among patients and detect gaps in the quality of resuscitation care.



To develop the risk-standardized survival measure for IHCA, there was an extensive process to ensure the face and content validity of the measure. After settling on the candidate variables for the model through input from experts in the field, categorical variables were summarized as frequencies and percentages and compared with Pearson chi-squared tests. Continuous variables were summarized as medians (interquartile range) and compared using Wilcoxon rank-sum tests.

The study population was then randomly split into a development sample consisting of 70% of patients with IHCA and a validation sample consisting of the remaining 30% of patients with IHCA. A range of baseline patient characteristics and cardiac arrest variables were considered candidate variables. These variables included age and sex, location of the cardiac arrest, initial rhythm of the IHCA, baseline comorbidities, clinical conditions present within 24 hours of the IHCA (e.g., respiratory insufficiency, hypotension) and interventions in place at the time of the IHCA (e.g., mechanical ventilation, continuous intravenous vasopressor). Candidate variables had less than 0.1% missing data We used multivariable hierarchical logistic regression with hospital site as a random effect and included all candidate variables to develop an initial "full" model predicting survival to hospital discharge.

To limit the burden of data collection, a more parsimonious model for clinical use was then developed by only using those variables with the strongest association. Variables in the full model were ranked in terms by their model contribution (e.g., F statistic), and predictor variables with the least contribution to the model were sequentially removed until the model had only 99% of the predictiveness of the initial full model. The remaining variables constituted the "reduced" RSSR model.

The C-statistic was used to describe the discrimination of the full and reduced models and compared. A c-statistic >0.700 signifies a risk model with good discrimination. Calibration plots were used to access goodness of fit. A p-value <0.05 was considered statistically significant. All statistical tests were two-sided. All statistical analyses were performed using SAS software (version 9.3, SAS Institute, Cary, NC).

We do not believe that social (e.g., race) and economic factors should be included in risk-adjusting outcomes for in-hospital survival for IHCA. This is predicated on the feasibility (and current unavailability) of many patient-level social and economic factors. That being the case, we feel that the consequence of adverse social factors (e.g., leading to greater rates of renal insufficiency, sepsis) would be directly captured by our rich clinical data, and that the short duration of follow-up (in-hospital survival), would negate potential barriers to healthcare access and treatment that might be more relevant when examining the association between social and economic factors and longer-term post-discharge outcomes. Accordingly, we believe that inclusion of social risk factors would not likely improve this model of in-hospital risk-standardized survival rate. Please also see our comment on not including race, a social construct, in the risk model in 4.2.2.

1. Nallamothu BK, Guetterman TC, Harrod M, Kellenberg JE, Lehrich JL, Kronick SL, Krein SL, Iwashyna TJ, Saint S, Chan PS. How Do Resuscitation Teams at Top-Performing Hospitals for In-Hospital Cardiac Arrest Succeed? A Qualitative Study. *Circulation.* 2018;138(2):154-163.