Supplemental Material

Technical Appendix

We calculated observed bleeding rates for hospitals by dividing the observed number of bleeds by the total number of admissions. The expected number of bleeds for each hospital was determined using the validated CathPCI Registry bleeding model to tabulate the sum of the predicted probabilities of bleeding for each patient at that hospital. Hospital adjusted rates were then obtained by multiplying the ratio of observed to expected number of events by the population bleeding rate. Hospital outlier status for observed rates was defined using the 95% confidence interval (CI) for a hospital's observed bleeding rate divided by the population bleeding rate: hospitals for which the lower 95% CI limit was greater than one were considered to have high outlier status; hospitals for which the upper 95% CI limit was less than one were considered to have low outlier status; and hospitals whose 95% CI included one were considered to be non-outliers. Hospital outlier status for adjusted rate was defined similarly using the 95% CI for a hospital's ratio of observed-to-expected bleeding rates. This approach to identifying quality outliers is described in Method #1 in Glance, et al. Med Care. 2006 Apr;44(4):311-9 and is the current methodology used to assess participating CathPCI Registry hospital performance in site reports. However, standard errors were based on the binomial distribution, rather than Poisson, as the former approach is currently used in the NCDR CathPCI site reports.

We also repeated analyses using random effects modeling, which is increasingly used to compare hospital outcomes. In these analyses, unadjusted hospital bleeding rates were calculated with hospital included as a random effect variable, whereas adjusted bleeding rates were determined after accounting for all variables in the CathPCI Registry bleeding model in addition to hospital. Models incorporating hospital as a random effect allow for formal statistical testing

of whether any observed variation in outcome is due to differences among hospitals (variance parameter estimates greater than zero and with p-values <0.05) versus simple sampling variation. Hospitals were again classified as outliers using similar criteria as in the main analysis, but this time using the 95% CI around the hospital's random intercept. In this approach, described in Method #5 in Glance, et al. Med Care. 2006 Apr;44(4):311-9, the random hospital intercept is a shrunken estimator and represents the log odds of bleeding for each hospital. Hospitals with 95% CI for log odds of bleeding that were greater than 0 were considered upper outliers. Hospitals with 95% CI for log odds of bleeding that were less than 0 were considered lower outliers. All other hospitals were considered to be non-outliers.

Table. Comparison of Adjusted Hospital Outlier Status Defined by Non-random Effects versus Random Effects Models

Outlier Status: Non-random Effects	**Outlier Status: Random-effects**		
	Low Outlier (n=260)	**Non-outlier (n=706)**	**High Outlier (n=326)**
Low outlier (n=349)	260 (100.0%)	89 (12.6%)	0 (0%)
Non-outlier (n=665)	0 (0.0%)	613 (86.8%)	52 (16.0%)
High outlier (n=278)	0 (0.0%)	4 (0.6%)	274 (84.1%)