Introduction:
The volume-outcome relationship in TJA has become the focus of payer-driven proposals to regionalize care. Many national policy initiatives are focusing on improving quality by encouraging adherence to process of care “quality” measures. The purpose of this study was to evaluate the independent contributions of surgeon volume, hospital volume, and adherence to quality measures on patient outcomes in TJA. Our hypothesis was that surgeon volume, hospital volume, and adherence to process measures all have independent contributions to patient outcomes in TJA.

Methods:
Data were analyzed from 182,146 consecutive primary TJA patients from 3421 physicians at 312 hospitals participating in Perspective (Premier Inc., Charlotte, North Carolina), a database developed for measuring quality and health care utilization. In addition to standard hospital discharge file data, Perspective contains a date-stamped log of all materials (e.g. scripts, compression devices) used to prevent thromboembolism, and medications (e.g. beta-blockers) charged for during hospitalization. Perspective sites are located in all regions of the United States and are representative of the US hospital population.

Patients were initially eligible for our analysis if they were admitted between 10/1/2003 and 9/30/2005 and were 18 years of age or older. Patients in this cohort who underwent total joint arthroplasty were then identified using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes. Specifically, patients with a principal procedure of 81.51 were classified as having total hip replacement, and patients with a principal procedure of 81.54 were classified as having total knee replacement.

Adherence to process of care measures was defined by whether or not patients received appropriate perioperative beta-blockade, antibiotics and VTE prophylaxis. Patient outcomes included mortality, LOS, discharge disposition, complications, readmissions, and reoperations within the first 30 days. Hierarchical models were used to estimate effects of procedure volume and adherence to process of care measures on individual and combined surgical outcomes. Results:

58% of patients did not miss any of the four process of care measures, while 33% of patients missed one measure, 6% missed two measures, and only 6% of patients missed three or more measures. The average LOS was 3.9 days, and 53% of patients were discharged directly home from the hospital. 4% of patients were readmitted within 30 days of discharge, 3.1% of patients underwent a reoperation during the index hospitalization or during readmission, and 3.0% experienced a surgical complication. The mortality rate was 0.1% at 30 days, 7% of patients experienced one of these unfavorable outcomes (death, readmission, reoperation, or surgical complication).

After adjustment for patient and hospital characteristics and for clustering at the hospital and surgeon level, higher surgeon volume was associated with lower risk of complications, readmission, or reoperation, shorter LOS, and higher likelihood of being discharged home. Higher hospital volume was associated with lower risk of mortality and readmission and higher likelihood of being discharged home. Certain missed individual process of care measures were associated with a higher risk of an adverse clinical outcome or increased length of stay. In particular, missed adherence to the antibiotic-related process measures (administration of pre-procedure prophylactic antibiotics and discontinuation of antibiotics within 24 hours) was associated with a higher likelihood of having an adverse clinical outcome and an increased LOS. However, failure to administer beta-blockers in appropriately indicated patients was not associated with adverse patient outcomes or increased LOS.

We then calculated adjusted rates of our combined negative outcome according to the total number of missed process of care measures and hospital or surgeon volume. Although higher volume hospitals and surgeons had consistently lower adjusted rates of adverse outcomes, a higher number of missed process of care measures was associated with worse clinical outcomes irrespective of hospital or surgeon procedure volume. In fact, the absolute differences in adverse outcome rates from lowest to highest surgeon volume (for example) were between 1 and 1.5%. In contrast, missing just 1 process of care measure produced 1-1.2% excess in combined negative outcomes, and 2 or more missed measures produced 1.8-2.0% excess in adverse outcomes.

Discussion:
In this observational cohort of patients undergoing elective primary hip and knee replacement surgery, we observed an association between greater hospital and surgeon procedure volume and shorter length of hospital stay, a higher likelihood of being discharged directly home, fewer surgical complications, fewer readmissions and reoperations within 30 days, and lower mortality. We also observed a strong correlation between overall process of care standardization and patient outcomes, despite inconsistent correlation between adherence to individual processes of care and patient outcomes.

Our data suggest that although adherence to individual process of care measures are inconsistently correlated with improvement in TJA, maximizing adherence to all process of care measures is strongly correlated with improved clinical outcomes and more efficient resource use, independent of hospital or procedure volumes.

A highly coordinated care delivery system — which in our study is indicated by a hospital or surgeon not missing any process of care measure — is thought to be a measure of a health care systems’ ability to deliver reliable, high quality care. This is in contrast to measuring individual care delivery processes, responsibility for which may be divided across members of a care team, and which have inconsistent associations with patient outcomes. Our findings of a strong association between no process of care measures missed and improved clinical outcomes and decreased LOS support the value of process standardization in TJA. Over the past 30 years, standardized TJA clinical care pathways have been developed and refined as tools for improving the quality and efficiency of peri-operative care. One of the key elements of TJA clinical care pathways is adherence to processes of care derived from evidence-based clinical practice guidelines, such as the process measures we analyzed in our study. Our results suggest that standardization of care via clinical care pathways is most effective when adherence to the pathway is greatest, that care pathways can improve patient outcomes independent of surgeon and hospital outcomes, and that process standardization most magnificently benefits related to hospital or surgeon procedure volumes.

Despite its novel findings, our study also has important limitations. Because we relied on administrative claims data, rather than chart abstraction, it is possible that we missed certain clinically relevant complications. Also, the process of care measures we used parallel but do not entirely replicate chart-abstracted process measures. However, it is important to note that the key medications used in our study were based on charges collected automatically by hospitals as part of their business activities, and previous investigators have reported strong associations between medication use detected by charges and patient outcomes using a similar approach with the Premier dataset. Moreover, the rates of VTE prophylaxis, antibiotic prophylaxis and beta-blocker use are consistent with those that have been reported in other studies based on clinical data, therein arguing against substantial omissions or data inaccuracy within the Premier dataset. Another limitation of our study is that we were unable to include all SCIP measures in our analysis, since certain process of care measures, such as hair removal, are not well documented in the administrative record. Furthermore, we were only able to evaluate short-term (30 days) post-operative outcomes, and were unable to measure patient reported pain and functional outcomes.

In summary, our data suggest that although higher surgeon and hospital procedure volumes are unquestionably correlated with improved patient outcomes in TJA, maximizing adherence to process of care measures is also strongly associated with better patient outcomes and more efficient resource utilization. Therefore, we believe that process standardization could help optimize quality and efficiency in TJA, independent of hospital or surgeon procedure volume.