Association Between Hospital and Surgeon Radical Prostatectomy Volume and Patient Outcomes: A Systematic Review

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Purpose: We examined the association between hospital and surgeon volume, and patient outcomes after radical prostatectomy.

Materials and Methods: Databases were searched from 1980 to November 2007 to identify controlled studies published in English. Information on study design, hospital and surgeon annual radical prostatectomy volume, hospital status and patient outcome rates were abstracted using a standardized protocol. Data were pooled with random effects models.

Results: A total of 17 original investigations reported patient outcomes in categories of hospital and/or surgeon annual number of radical prostatectomies, and met inclusion criteria. Hospitals with volumes above the mean (43 radical prostatectomies per year) had lower surgery related mortality (rate of difference 0.62, 95% CI 0.47–0.81) and morbidity (rate difference −9.7%, 95% CI −15.8, −3.6). Teaching hospitals had an 18% (95% CI −26, −9) lower rate of surgery related complications. Surgeon volume was not significantly associated with surgery related mortality or positive surgical margins. However, the rate of late urinary complications was 2.4% lower (95% CI −5, −0.1) and the rate of long-term incontinence was 1.2% lower (95% CI −2.5, −0.1) for each 10 additional radical prostatectomies performed by the surgeon annually. Length of stay was lower, corresponding to surgeon volume.

Conclusions: Higher provider volumes are associated with better outcomes after radical prostatectomy. Greater understanding of factors leading to this volume-outcome relationship, and the potential benefits and harms of increased regionalization is needed.

Key Words: prostate; prostatectomy; physician's practice patterns; outcome and process assessment (health care); professional competence

Prostate cancer is the most common nondermatological cancer in men.[1] It is the second most expensive cancer organ site for Medicare with an $8 billion annual expenditure.[2] RP is the most common treatment for localized prostate cancer with approximately 60,000 RPs performed annually.[3] Variations in screening,[4] mortality,[5] treatment use and patient outcomes[6–8] suggest the possibility for quality of care improvements in men with localized prostate cancer. The volume of RPs performed annually by individual surgeons and hospitals is a proposed prostate cancer quality care indicator.[7,9] To our knowledge valid quantitative estimates of the association between and patient outcomes and provider volume of RPs have not been evaluated. Evidence based hospital referral volume thresholds have been examined for several surgical procedures with similar complexity, including colorectal resections and cystectomy,[9–11] but not for RP. Conceptually one might expect that some outcomes would be more likely to reflect surgical volume and (related) skill, while others would more likely be related to hospital volume and (concomitantly) better organized perioperative care.[9]

We performed a systematic review of the association between surgeon and hospital RP volumes, and patient outcomes. Our review was derived from a report done for the Agency for Healthcare Research and Quality to examine the comparative effectiveness of therapies for clinically localized prostate cancer (Appendix 1).

METHODS

Selection of Studies

We performed the review according to the recommendations for Meta-analysis of Observational Studies in Epidemiology.[12] We included studies if they evaluated the associative hypothesis between provider characteristics and patient outcomes, and had a control group. We excluded studies not published in English, with no information regarding provider characteristics or with no control comparisons.

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Literature Search Strategy

We searched for original epidemiological studies published in English from 1980 to November 2007 in MEDLINE®, The Cochrane Library, the Centers for Disease Control website, the Catalog of U.S. Government Publications, the LexisNexis® Government Periodicals Index, Digital Dissertations and the Agency for Healthcare Research and Quality.

Synthesis of Evidence

We evaluated studies and extracted data following a prespecified protocol.[13] We compared the periods when patient events occurred with databases that the investigators obtained to select participants to avoid including the same patients in the analysis more than once. We scored study quality from 0—poorest to 5—highest (Appendix 1).

We assessed the association between provider/hospital characteristics and clinical outcomes, including surgery related mortality; postoperative complications; failure of cancer control; disease related adverse events; treatment related adverse events, including urinary and fecal incontinence; positive surgical margins; length of hospital stay; hospital costs; and the hospital readmission rate.[14] Hospital and surgeon volumes were based on the annual number of RPs. We examined the strength and direction of the associations to determine whether they depended on year of publication, data source, sampling strategy, statistical adjustment for patient age, race or comorbidities, or tumor characteristics.

We calculated regression coefficients and the SE or 95% CI from reported means and SDs.[13] We used pooled adjusted rates and ORs to estimate the association with hospital and surgeon volumes independent of cancer stage. Meta-analysis was done to test the consistency of the association from at least 2 studies.[15] We calculated the OR weighted by sample size and the 95% CI from fixed and random effects models with a random intercept for each study.[13] We used meta-regression models to analyze interactions with the year of data collection, databases to measure outcomes and adjustment for confounding factors.[13] Calculations were performed using STATA®[16] and SAS® 9.2.[17]

RESULTS

Of the 792 articles identified 17 observational studies of a total of 235,763 men were eligible (table 1). We excluded 775 studies, of which 525 were articles without relevant information on provider characteristics, 166 were reviews or secondary data analyses, 34 were commentaries, 28 were observations of ineligible target populations and the remainder were case reports, editorials, expert opinions, reprints of original reports or articles that reported ineligible outcomes (Appendix 2). Average study quality was 65% of the maximum possible quality score. Of epidemiological investigations that examined associations between hospital RP volumes and patient outcomes[18–24] the highest quality studies were those that measured morbidity and urinary complications after RP.

Most studies analyzed patients selected from existing databases, including the North American Association of Central Cancer Registries (SEER),[18,25] the Nationwide Inpatient Sample Database[19,26] and the Medicare health claims national database.[20–22,27–32] Several single hospital[33–37] and multihospital[23,38,39] studies selected patients at clinics to analyze medical records. One study obtained the Quebec Healthcare Plan database to identify eligible subjects.[23] Few investigators reported a random sampling of study subjects.[19,20,24] Investigators defined volume as an annual average of procedures[18,19] or the total number of procedures during the study period that were performed at each hospital.[20–22] Investigators compared volume measurements from linked SEER and Medicare hospital claims databases, and concluded that the 2 approaches yielded the same results.[18]

Studies that investigated provider volumes adjusted for patient age and comorbidity,[22,25,27,36] race,[18,20,21,27,34] cancer stage and grade,[18,24,34] provider location and teaching status,[20–22,25,38,40] and clustering of patients and providers.[18] Investigators stated that the target population included patients with localized prostate cancer,[41] reported the number of participants with localized cancer,[28,19,24] adjusted for cancer stage and grade[18,20,24,34] or assumed that all patients treated primarily with RP would have localized disease.[40] The investigators adjusted for comorbidities assessed using ICD codes for major confounding diseases[21,27]or comorbidity indexes.[18–20,22,24,25,36]

Hospital Volume Associated Outcomes

Four retrospective cohort studies examined the association between hospital RP volumes and surgery related mortality. Investigators defined surgery related mortality as in-hospital death[19] or postoperative death within 30 to 90 days after surgery.[18,21,22] We combined these 2 measurements. Estimating surgery related mortality based only on in-hospital deaths may be influenced by hospital discharge practices[42] and could bias the association with provider volume.

Investigators reported death rates in different hospital volume categories. We calculated the death rate corresponding to an increase by 10 procedures performed annually at hospitals for a pooled analysis. Three studies adjusted for patient characteristics when estimating the relative risk of surgery related mortality.[19,21,22] Two series demonstrated a significant decrease in mortality with increased volume (fig. 1).[19–22,24] Wennberg et al reported no association but they evaluated men who underwent RP in the mid 1980s.[22] A recent study describing mortality showed a nonsignificant 1% decrease per 10 RPs performed.[18]

Hospitals with 25 to 54 vs more than 55 RPs performed per year had a 1.71 increase (95% CI 1.20, 2.60) in the odds of death according to 1 study of 66,693 patients treated at a total of 1,334 hospitals.[19] Another large study showed a 42% higher relative increase (RR 1.42, 95% CI 1.20, 1.70) in surgery related mortality at hospitals with fewer than 27 procedures performed per year (51st to 75th percentiles) vs more than 36 (greater than 75th percentile).[21] A large cross-sectional analysis indicated a 2.60 to 2.90-fold increase in the in-hospital death rate at hospitals where fewer than 6 vs more than 20 RPs were performed per year (tertiles of volume distribution).[26]

Pooled analysis of 3 cohorts for which the reported mortality risk was reported in categories of hospital volume showed a relative 13% decrease (relative risk 0.87, 95% CI 0.81, 0.94), corresponding to 10 additional RPs performed annually at hospitals (table 2). The relative risk of surgery related mortality at hospitals in the highest quartile (greater than 50 procedures) was almost half that at hospitals in the lowest quartile (fewer than 22) (relative risk 0.51,