

Volume–outcome relationships in breast cancer

K. Hiotis, K. A. Skinner

Division of Surgical Oncology, New York University School of Medicine, New York, NY, USA.

Abstract A significant effect of hospital case volume on perioperative mortality has been documented for a variety of malignancies that require technically challenging operative procedures and complex perioperative management. The effect of case volume on outcome is less clear for the more common cancers, such as breast and colon cancers, that are less technically challenging and require little in the way of specialized care in the postoperative period. For these cancers perioperative mortality is minimal and one must look at other end points such as long-term survival and functional results. The literature demonstrating improved outcomes in terms of mammographical sensitivity, breast-conservation rates, specimen to tumour volume ratios in breast-conserving surgery, sentinel node biopsy success rates, and 5-year survival is reviewed.

Keywords: Breast cancer; Case volume; Perioperative mortality; Treatment outcomes

Breast cancer detection

Mammography remains the procedure of choice for breast cancer detection, with a sensitivity approaching 90%. However, the sensitivity and specificity of mammography for breast cancer detection varies widely between radiologists. Esserman *et al.* evaluated the sensitivity of mammographical interpretation by individual radiologists in the USA using a standardized set of 60 films with known long-term follow-up. Interpretations of the test films by radiologists who read over 300 mammograms per month had a sensitivity of 75.6% at a specificity of 90% compared to 64.8% with radiologists who read 100 or fewer mammograms per year ($P < 0.01$) [1]. Thus, high-volume radiologists are more likely to detect a breast cancer on screening mammography. As early detection of cancers on screening mammography leads to improved outcomes, the increased sensitivity with

increased mammogram volume should translate to improved breast cancer survival.

Surgical management

Case volume has also been shown to significantly impact surgical management of breast cancer. Breast-conservation utilization has been shown to increase significantly with increasing hospital and surgeon case volume. In a population-based study of 29 666 patients undergoing surgery for breast cancer in Los Angeles County between 1990 and 1994, surgeons who performed over 15 breast cancer surgeries per year were shown to be 1.66 (95% confidence interval (CI) 1.54–1.79) times more likely to use breast-conserving surgery than those performing five or fewer cases per year ($P < 0.0001$), when controlled for patient, tumour, and hospital factors. Similarly, patients treated at hospitals that performed over 125 breast cancer surgeries per year were 1.31 (95% CI 1.21–1.41) times more likely to receive breast-conserving surgery than those treated at facilities performing 35 or fewer procedures ($P < 0.001$), when controlled for patient, tumour, and surgeon characteristics [2]. The use of breast-conservation surgery and

Correspondence to: Kristin A. Skinner, MD, Chief, Division of Surgical Oncology, New York University School of Medicine, 550 First Avenue, HCC-6H, New York, NY 10016, USA. E-mail: kristin.skinner@med.nyu.edu; Tel: +1 212 263 5192; Fax: +1 212 263 5045

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the ability of patients to have choices in their treatment have been shown to be beneficial both emotionally and psychologically in breast cancer patients [3,4]. By increasing utilization of breast conservation, then case volume directly impacts patient's quality of life.

In patients receiving breast-conserving surgery, Staradub *et al.* proposed specimen to tumour volume ratio (STVR), a measure of resection volume, normalized for tumour size, as an objective surrogate measure of cosmetic outcome. They reported that the SVTR is significantly lower when the patient is treated by a higher-volume surgeon, without an increase in margin involvement. In other words, higher-volume surgeons are more likely to adequately resect the cancers while minimizing the volume loss [5]. This finding suggests that higher-volume surgeons provide better cosmesis without sacrificing oncological safety.

Sentinel lymph node biopsy (SLNB) is rapidly becoming accepted as the standard of care for nodal staging in clinically node negative breast cancers. However, the success rate of SLNB is operator dependent and has been shown to be related to surgeon case volume. Dupont *et al.* demonstrated that surgeons who perform over six sentinel node biopsies per month had a 97.8% success rate compared to 86.2% in surgeons performing less than three per month [6]. Surgeon case volume was more important than hospital case volume in predicting the success of sentinel node biopsy [7]. Successful SLNB is felt to be associated with lower arm morbidity; so surgeon case volume directly impacts breast cancer surgical morbidity. Increasing case volume, then leads to increased breast-conservation rates, less volume loss with breast-conserving surgery, and higher SLNB success rates, which should translate into better quality of life, patient satisfaction, and cosmesis with lower procedure-related morbidity.

Long-term survival

Several studies have documented an effect of case volume on survival after breast cancer surgery. Sainsbury *et al.* studied the effect of surgeon case volume on survival among 12 861 patients diagnosed with breast cancer in Yorkshire, UK between 1979 and 1988. Patients treated by surgeons performing more than 30 breast cancer surgeries per year had a 15% reduction in the risk of dying compared to those treated by a surgeon performing fewer than 10 cases per year (relative risk (RR) 0.85, 95% CI 0.79–0.93) [8]. A 15% reduction in the risk of death between high- and low-volume surgeons was again seen among patients treated in Yorkshire, UK between 1989 and 1994 [9]. Roohan *et al.* evaluated the impact of hospital volume on survival among 47 890 women with breast cancer treated in New York state hospitals

between 1984 and 1989. The RR of death at 5 years was 1.60 (95% CI 1.42–1.81) times higher in patients treated in hospitals caring for less than 10 breast cancer patients per year than in patients treated in hospitals treating over 150 such patients, after adjusting for patient and tumour factors [10]. In a population-based study of 29 666 patients undergoing surgery for breast cancer in Los Angeles County between 1990 and 1994, patients treated by surgeons who performed over 15 breast cancer surgeries per year were shown to have a 16% reduction in the risk of death at 5 years (RR 0.84, 95% CI 0.77–0.92) than those treated by surgeons performing five or fewer cases per year ($P < 0.0001$), when controlled for patient, tumour, and hospital factors. Similarly, patients treated at hospitals that performed over 125 breast cancer surgeries per year had a 23% reduction in the risk of death at 5 years (RR 0.77, 95% CI 0.70–0.84) compared to those treated at facilities performing 35 or fewer procedures ($P < 0.001$), when controlled for patient, tumour, and surgeon characteristics. When both hospital and surgeon volume were combined, the effect was even more striking, with a 39% reduction in the risk of dying when treated by high-volume surgeons at high-volume centres, compared to low-volume surgeons at low-volume centres ($P < 0.0001$) [11]. Hospital and surgeon case volume clearly impact 5-year survival after breast cancer surgery. While the magnitude of the effect varies, this volume effect has been documented in several different populations and over several time periods.

Summary

A significant body of literature is accumulating documenting an impact of practitioner and hospital volume on multiple measures of breast cancer outcome, including breast cancer detection, breast-conservation rates, cosmesis, success of minimally invasive nodal staging techniques, and long-term survival. Possible explanations for the volume effects include more appropriate use of adjuvant therapies and support services; however, the effects are most likely related to improved knowledge and skill with practice. The finding of significant volume effects on breast cancer outcomes support a move towards centralization of breast cancer screening and management in high-volume centres with dedicated, high-volume specialists.

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