Editorial

Surgeon proficiency and outcomes in esophagectomy: a perspective and comment on an analysis of the Swedish Cancer Registry

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Esophageal cancer incidence has been increasing over the past three decades and is now the sixth most common cause of cancer related death and eighth most common cancer overall (1-3). It has an aggressive course and is characterized by a high degree of local-regional and distant recurrence after treatment (4). Esophagectomy with or without neoadjuvant therapy remains the standard of care for treating early stage cancer (5,6).

The recent publication by Markar *et al.* in the Journal of Clinical Oncology evaluates the change in short and long term mortality as surgeons gain proficiency in performing open esophagectomy (7). In a retrospective analysis of the Swedish Cancer Registry of all patients with esophageal cancer treated with curative intent from 1987 to 2010 with follow up until November 2014, 1,821 patients were identified who underwent esophagectomy. These operations were performed by 139 surgeons with a median number of cases performed at 16, interquartile range of six to 46 cases. Only open transthoracic esophageal resection was studied and the outcomes measured were 30-day, 90-day, 1-year, 3-year, and 5-year all cause and disease-specific mortality. Lymph node yield, reoperation, and resection margin status were utilized as performance markers in long-term survival. Risk-adjusted cumulative sum (RA-CUSUM) curves were created to define the proficiency gain curve for each mortality outcome from esophagectomy. The curve increases if the observed mortality or survival exceeds the expected mortality or survival. The expectation was that an inverse relationship would be identified between surgeon experience and patient mortality. Change-points in proficiency were identified as maximal deflection of the curve.

The curves for measuring short and long term mortality showed different inflection points. The change-point for all-cause 30-day mortality was seen at 15 cases with a drop in mortality from 7.9% to 3.1% (P<0.001). At 35 to 59 cases long term mortality outcomes improved, with change points observed for 1-, 3- and 5-year mortality rates, and corresponding to respective decreases in all-cause mortality from 34.9% to 27.7% (P=0.011), 47.4% to 41.5% (P=0.049), and 31.4% to 19.1% (P=0.009). Similar change-points were observed in disease-specific mortality at 1 year and 3 years between 38 to 53 cases, where mortality decreased from 31.8% to 24.7% (P=0.010) for 1 year and 39.4% to 32.8% (P=0.034) for 3 years. There was a continuous increase in lymph node harvest. Incidences of positive resection margins decreased significantly at 17 cases with a reduction from 20.9% to 15.2% (P=0.004), and for reoperation rate at 55 cases, with a reduction from 12.6% to 5.0% (P<0.001).

The study investigates and discusses an easily digested premise: surgical outcomes will improve with experience. As their results indicate, this is initially reflected in early improvements in short-term outcomes and immediate

perioperative morbidity and mortality. As surgeon experience increases, gains in surgical quality and long-term outcomes and mortality continue to accrue. The current study elegantly identifies that longitudinal trends in quality and long-term outcome improvement continue with cumulative experience over extended periods of time, well beyond the "traditional" short-term learning curve.

The authors rightfully acknowledge the challenges this implies for training and mentored accrual of experience for surgical trainees and attending surgeons alike. An increasing focus and demand for achieving defined performance metrics and patient outcomes, coupled with evolving surgical training and time restrictions, have raised significant challenges to the traditional mentored approach to teaching the fundamental art of surgery. This may be particularly true for complex operations, such as esophagectomy, in which the learning curve is known to be long and flat, in comparison to the short and steep curve for less complex cases such as laparoscopic appendectomy or hysterectomy (8). There have been different models proposed to allow adequate training while not compromising quality or increasing morbidity or mortality for the patient. These include a greater reliance on surgical simulation, extended periods of mentored hands on training, and workplace-based assessment of defined competency milestones achieved (9-11). Markar *et al.* propose one such approach with competency based assessment and structured mentorship (7). Regardless, there remains no consensus on the ideal way to train the modern thoracic surgeon in complex operations such as esophagectomy.

One significant limitation of the current study is that the setting of these operations is not reported, whether in academic/university hospitals versus private/community hospitals, or in high volume versus low volume centers. These variables have been found by several authors to significantly impact surgical outcomes (12-14). Verhoef *et al.* found that when esophagectomy was performed in a university, teaching hospital versus a nonteaching hospital, there were significant differences in the 5 year relative survival rate. For patients who underwent surgery, the 5-year relative survival was 49.2% for the university hospital versus 32.6% and 27.3% for teaching non university and nonteaching hospitals, respectively (P=0.0039) (14). A meta-analysis by Low *et al.* showed that esophagectomy at low-volume hospitals was associated with a significant increase in incidence of in-hospital (8.48% *vs.* 2.82%; P<0.0001) and 30-day mortality (2.09% *vs.* 0.73%; P<0.0001). Fuchs *et al.* identified that hospital volume was the only variable that impacted outcomes, with high volume centers (>20 cases/year) showing a protective effect (15). Regardless, formal centralization of high risk cancer surgeries to high volume centers of excellence is variable, with little structured centralization in some countries, such as the United States, versus more rigorous adoption in others, such as England and other European and Asian nations (15,16). This fragmented experience may be part of the reason why a majority of graduating US cardiothoracic surgery trainees reported a relative lack of confidence with complex esophageal operations when surveyed (17).

It is also difficult to gauge the impact of minimally invasive approaches to these operations which have steadily emerged over the course of the current study, but were not included in the patient cohort. Minimally invasive esophagectomy (MIE) has been increasingly adopted with recognized benefits including decreased blood loss, chest tube duration, length of stay, and pulmonary complications, while maintaining comparable oncologic outcomes (18-22). Luketich *et al.*, in an experience from the University of Pittsburgh Medical Center of over 1000 patients with a mortality of 0.9%, reported that MIE can be a safe and effective operation when performed at a high volume center (18). Robotic approaches to these operations have also shown excellent results, such as the experience from Memorial Sloan Kettering in 100 patients with a 90-day mortality of 1% reported by Sarkaria *et al.* (23). It will be important for future registry based population studies, similar to that by Markar *et al.*, to gauge the impact on learning curves and outcomes of these approaches and technologies.

In summary, Markar *et al.* have presented an important study highlighting the ongoing longitudinal improvement in outcomes with extended surgical experience. While there are limitations to the study, it underlines an important need to develop and provide ongoing mentored training programs to allow trainees and surgeons early in their experience with esophagectomy to obtain experience while maintaining short and long term patient outcomes. This may likely be best achieved through centralization of these operations to high-volume centers of excellence with an academic commitment to teaching within a structured, mentored setting. As emerging techniques and technologies gain wider acceptance and usage, such as minimally invasive and robotic approaches to these operations, their impact on patient outcomes and surgeon learning curves will need to be similarly assessed.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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