

Improved Screening Reduces Transesophageal Study Cancellations at a Large Tertiary Israeli Medical Center

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ABSTRACT **Background:** Cancellation of transesophageal echocardiography (TEE) tests leads to inefficient use of echocardiography laboratory (echo lab) time and wastes resources.

Objectives: To identify the causes of same-day TEE cancellations in hospitalized patients, to formulate a TEE order screening protocol, and to evaluate its efficacy at implementation.

Methods: We performed a prospective analysis of inpatients referred to a single tertiary hospital echo lab for TEE study by inpatient wards. A comprehensive screening protocol emphasizing active participation of all links directly involved in the chain of inpatient TEE referral was developed and implemented. Comparison of pre- and post-implementation of the new screening protocol on two consecutive periods of 6 months on TEE cancellation rates out of total ordered TEEs stratified by cause categories was performed.

Results: In total, 304 inpatient TEE procedures were ordered during the initial observation period; 54(17.8%) were canceled on the same day. The most common cancellation reasons were equally respiratory distress and patient not in fasted state (20.4% of total cancellations and 3.6% of all scheduled TEEs for each cause). Following implementation of the new screening process, total TEEs ordered (192) and cancelled (16) dropped significantly. A decrease in the rate of each cancellation category was observed, with statistical significance achieved for the overall cancellation rate (8.3% vs. 17.8%, $P = 0.003$), but not for the individual cancellation categories in split analysis.

Conclusions: A concerted effort to implement a comprehensive screening questionnaire significantly reduced same-day cancellations of scheduled TEEs.

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TEE, widely ordered by medical professionals, is a resource-intensive procedure that is not always available, and supply often falls short of demand. Availability of inpatient TEE slots is limited by staffing needs (including a qualified echocardiography specialist, a registered nurse, and a cardiac sonography technician for all cases, as well as an anesthesiologist assisting with sedation and cardiorespiratory supervision in selected cases), by the echocardiography machines and TEE probes, and by the competing TEE exam requests at large medical institutions. Same-day TEE cancellation creates logistic and financial burdens associated with extended hospital stay and repetitions of pre-TEE preparations as well as costs of lost time and missed income. It also causes great inconvenience for patients and families.

Previous studies evaluating cancellations among various surgical subspecialties have reported heterogeneous cancellation rates of 2% to 24% for cardiothoracic surgical procedures depending on hospital type, geographical region, patient population, and perioperative management practices [1–7]. Incomplete medical workup, lack of postoperative beds, and administrative matters are common reasons for cancellations, with a majority of surgical cancellations due to administrative reasons and therefore preventable [4].

Despite common experience with TEE cancellations in daily practice, we found only a single publication that evaluated same-day cancellations of TEEs at a single medical center [8]. In that study, among 145 scheduled TEE exams, 41 (28.3%) required same-day cancellations, with the leading causes consisting of sinus rhythm in patients scheduled to undergo TEE and cardioversion (27%), patient non-cooperation (22%), and anesthesia need (10%).

The purpose of our investigation was to prospectively examine same-day cancellation of TEE in-hospital procedures at a large tertiary academic center, with a particular interest toward determining the cancellation rate, identifying the incidence and causes of foreseeable cancellations, and designing a screening protocol that would decrease cancellation rate and test its effectiveness.

Transesophageal echocardiography (TEE) is a key diagnostic imaging procedure that is commonly performed in the inpatient setting. It identifies and manages different known, occult, or iatrogenic conditions such as cardioembolic sources,

PATIENTS AND METHODS

We conducted an analysis of the medical records and echocardiography database of all in-patients who were scheduled for a TEE procedure at our institution during a pre-intervention period of 6 months (January to June 2019) and recorded cancelled procedures and cancellation cause categories out of total scheduled procedures [Table 1]. *TEE deemed unnecessary* refers to cancellation of ordered TEE by the attending echocardiographer after revision of clinical findings to comply with the ASE appropriate use criteria for echocardiography developed by the American College of Cardiology and American Society of Echocardiography [9].

Next, we designed a screening checklist to be completed by the treating healthcare providers based on the main cancellation reasons and current TEE guidelines [10]. As detailed in the checklist shown in Table 2, in-hospital providers involved in the chain of patient care (including treating medical professional, nurse, and ward medical secretary) completed the form and implemented it uniformly before inpatient TEE procedures were approved by our echocardiography laboratory (echo lab) staff. We then reassessed TEE cancellations out of total scheduled procedures during a second post-intervention similar test period of 6 months (July to December 2019). The study was approved by the hospital’s institutional review board.

Descriptive and basic analytical statistics were used to summarize the data. Association between pre- vs. post-intervention period overall cancellation rate and cancellation rate in each sep-

arate cancellation category rate (of all scheduled TEEs during each of the two periods) was determined by 2 × 2 chi-square test with Yates correction for continuity for determination of significance level. *P*-value < 0.05 was considered statistically significant.

RESULTS

A total of 304 inpatient TEE procedures were ordered during the initial 6-month period, of which 54 (17.8%) were cancelled on the same day. As shown in Table 1 and Figure 1, the most common reasons for cancellation were equally respiratory distress and patient not in fasted state (each of them constituting 20.4% of total cancellations and 3.6% of all scheduled TEEs). After implementation of the screening checklist, we observed a reduction in the overall cancellation rates (8.3% in the second period vs. 17.8% in the first period, *P* = 0.003). Non-statistically significant reductions were observed in the cancellation rates in each separate category [Table 1]. The most common cancellation reasons following the improved screening checklist implementation was patient not in fasted state (constituting 25% of total cancellations and 2.1% of all scheduled TEEs) and inability to provide consent and hemodynamic instability (each of them constituting equally 18.7% of total cancellations and 1.6% of all scheduled TEEs).

Figure 1. Pie chart distribution of the different cancellation categories, percentage rates out of total ordered TEEs during the first and second 6-month observation periods

TEE = transesophageal echocardiography

Table 1. Cancellation cause categories of same day TEEs out of total ordered TEEs during initial 6-month period and during a second 6-month period following implementation of an improved screening

| Cancellation cause category | Initial period, n=54/304 | Second period, n=16/192 | <i>P</i> -value |
|------------------------------|--------------------------|-------------------------|-----------------|
| Not fasted state | 11 (3.6%) | 4 (2.1%) | 0.42 |
| Respiratory distress | 11 (3.6%) | 2 (1%) | 0.09 |
| Hemodynamic instability | 9 (3%) | 3 (1.6%) | 0.38 |
| Inability to provide consent | 8 (2.6%) | 3 (1.6%) | 0.54 |
| Bleeding diathesis | 5 (1.6%) | 1 (0.5%) | 0.41 |
| Esophageal problem | 5 (1.6%) | 1 (0.5%) | 0.41 |
| TEE deemed unnecessary | 5 (1.6%) | 2 (1%) | 0.71 |
| Cancellation for any cause | 54 (17.8%) | 16 (8.3%) | 0.003 |

P-values represent comparison of each cancellation cause category rate of total TEEs ordered between the two periods
 Bold signifies significance (*P*-value < 0.05)

TEE = transesophageal echocardiography

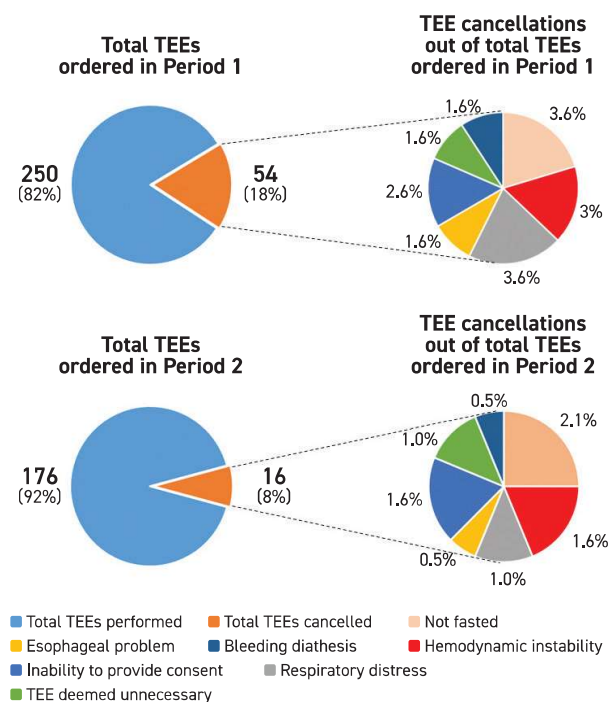


Table 2. TEE referral checklist, which was completed by the ordering medical professionals

| Treating Physician Section Checklist | |
|---|---|
| Swallowing problems | Yes/No |
| Known esophageal problem | Yes/No If positive, detail (esophageal obstruction, varices, esophagitis, space occupying lesion, prior esophageal, or stomach surgery) and provide relevant gastroenterologist assessment |
| Respiratory distress | Yes/No If positive, detail: Saturation < 90% at room air oxygen Obstructive sleep apnea/CPAP device Impaired consciousness state Severe COPD |
| Anticoagulation therapy | Yes/No If positive, detail |
| Required blood tests | Hemoglobin Platelets Creatinine INR |
| Patient capable of providing informed consent | YES/No/appointed guardian |
| Cervical flexion impairment | Yes/No If positive, detail |
| Pre-TEE instructions provided | YES/No |
| Treating Nurse Section Checklist: to be completed on the day of scheduled TEE | |
| Patient identification | |
| 6-hour fasting state | |
| Peripheral IV line inserted | |
| Vital signs before patient transfer | Pulse: Blood pressure: Room air oxygen saturation: |
| Medical Secretary Section Checklist | |
| Patient transfer stretcher and oxygen balloon ordered | |
| Patient identification labels | |

COPD = chronic obstructive pulmonary disease, CPAP = continuous positive airway pressure, INR = international normalized ratio, IV = intravenous, TEE = transesophageal echocardiography

DISCUSSION

Cancellation of scheduled TEEs has a significant impact on patient health, resources, cost, and quality of care. Every effort should be made to minimize cancellations. We found that same-

day cancellations rates of inpatient TEEs at our large tertiary center institution during an initial period of 6 months were high at 17.8%, and that causes related to the competency of treating medical team (patient not in fasted state, unable to provide consent, and TEE deemed as unnecessary by the attending echocardiographer) constituted a large portion (44%) of these cancellations. The remediation process involved developing a comprehensive TEE screening questionnaire to address all identified causes of TEE cancellations as well as adoption, implementation, and assimilation of this screening process among staff in the hospital wards, thus emphasizing active participation of all links directly involved in the chain of the inpatient care team (including the treating medical house officer, nurse, and medical secretary). Following implementation of this process, the overall rate of cancelled TEEs was significantly reduced from 17.8% pre-intervention to 8.3% post-observation. The total number of ordered TEEs dropped by 37%. Of note, this significant reduction in TEE orders was not influenced by the well-recognized effect of the coronavirus disease 2019 (COVID-19) because the second observation period terminated shortly before the outbreak in Israel (the second half of 2019).

A similar smaller scale and shorter period study was conducted in a single tertiary hospital in Chicago by Yu et al. [8]. That team looked at same-day cancellations of scheduled TEE studies. In contrast to our study, that study did not selectively target inpatient TEEs and thus represents a more heterogeneous referral population, including outpatients (39%) in addition to inpatients (61%). This difference in the study population explains the higher cancellation rate observed by Yu et al. [8] (28.3% vs. ours at 17.8%). It also precludes evaluation of the utility of implementation of a screening questionnaire targeted at the treating healthcare provider level, placing the onus of remediation solely on the echo lab team. Indeed, that study showed reduction in cancellation rates through improved pre-procedure chart review by nurses a day prior to TEE.

LIMITATIONS

The data collected in our study are from a single, large academic tertiary medical center and therefore may not be applicable to smaller academic medical centers or community hospitals. In addition, the subjectivity involved in assessing appropriateness is well documented [11]. Our study did not ascertain appropriateness criteria [9,12] and based educational intervention on the inpatient TEEs by medical professionals. The relative portion of inappropriate/unnecessary TEE orders in our hospital was relatively small at baseline (1.3% of all ordered TEEs). A potential confounder unaccounted for is the point-of-care availability of an on-site anesthesiologist who can influence TEE cancellation rates due to respiratory distress and hemodynamic instability. Unfortunately, we do not have solid information on cancelled inpatient TEE cases that could have been avoided if an anesthesiologist had been

recruited, but since there was no difference in the distribution of prescheduled TEE slots with anesthesiologist coverage throughout the entire time span of 2019. This factor is unlikely to have influenced our findings. As expected, implementation of a tight screening process resulted in a decrease in cancelled TEE procedures for each cause category during the second observation period, but the small numbers of cancellations in the separate categories compared with the large number of performed TEE studies most likely precluded statistical significance assessment in each individual category chi-square analysis. All checklists were completed on the same day that TEEs were ordered, but we do not have documentation of the precise time difference between the checklist filling time and the TEE study time, during which the hemodynamic and respiratory status of the patients may have changed.

Last, for the purpose of precise determination of our intervention success elements, it would have been desirable to document TEE orders that were cancelled before the stage of TEE order submission by the inpatient team due to implementation of the questionnaire sections aimed to increase competency and thus unknown to us, but this is impractical as it carries a significant potential confounder bias.

CONCLUSIONS

A concerted team effort through the implementation of a comprehensive screening questionnaire significantly reduced same-day cancellations of scheduled TEEs, emphasizing active participation of all links directly involved in the chain of inpatient healthcare provider team.

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When you turn the corner / And you run into yourself / Then you know that you have turned / All the corners that are left.

Langston Hughes (1902–1967), American poet, social activist, novelist, playwright, and columnist

**All government—indeed, every human benefit and enjoyment, every virtue,
 and every prudent act—is founded on compromise and barter.**

Lord Acton (John Emerich Edward Dalberg-Acton) (1834–1902), English Catholic historian, politician, and writer