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Endocrine Surgical Procedures During COVID-19: Patient Prioritization and Time to Surgery

Jae P. Ermer, BS,[a] *Jacqueline M. Soegaard Ballester, MD,*[a] *Beatrice C. Go, BS,*[b] *Benjamin Philipson, PhD,*[b] *Peter E. Gabriel, MD,*[b,c] *Daniel A. Pryma, MD,*[b,d] *Douglas L. Fraker, MD,*[a,b] *Rachel R. Kelz, MD,*[a,b] *and Heather Wachtel, MD*[a,b,*]

[a] *Div. of Endocrine and Oncologic Surgery, Department of Surgery, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania*
[b] *Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania*
[c] *Department of Radiation Oncology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania*
[d] *Div. of Nuclear Medicine Imaging and Therapy, Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania*

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ABSTRACT

Background: We tracked endocrine surgery patients with treatment delays due to COVID-19 to investigate the relationship between physician assigned priority scoring (PAPS), the Medically Necessary, Time Sensitive (MeNTS) scoring system and delay to surgery.
Material & Methods: Patients scheduled for endocrine surgery or clinically evaluated during COVID-19-related elective surgery hold at our institution (2/26/20–5/1/20) were prospectively enrolled. PAPS was assigned based on categories of high, moderate, or low risk, consistent with the American College of Surgeons' priority system. MeNTS scores were calculated. The primary outcome was delay to surgery. Descriptive statistics were performed, and receiver operator characteristic (ROC) curves and area under the curve (AUC) values were calculated for PAPS and MeNTS.
Results: Of 146 patients included, 68% ($n = 100$) were female; the median age was 60 years (IQR:43,67). Mean delay to surgery was significantly shorter ($P = 0.01$) in patients with high PAPS (35 d), compared with moderate (61 d) and low (79 d) PAPS groups. MeNTS scores were provided for 105 patients and were analyzed by diagnosis. Patients with benign thyroid disease ($n = 17$) had a significantly higher MeNTS score than patients with thyroid disease which was malignant/suspicious for malignancy ($n = 44$) patients (51.5 *versus* 47.6, $P = 0.034$). Higher PAPS correlated well with a delay to surgery of <30 d (AUC: 0.72). MeNTS score did not correlate well with delay to surgery <30 d (AUC: 0.52).
Conclusion: PAPS better predicted delay to surgery than MeNTS scores. PAPS may incorporate more complex components of clinical decision-making which are not captured in the MeNTS score.

* Corresponding author. Hospital of the University of Pennsylvania, 3400 Spruce Street, 4 Silverstein Pavilion, Philadelphia, PA 19104. Tel.: 215-662-2341.
E-mail address: heather.wachtel@pennmedicine.upenn.edu (H. Wachtel).
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Introduction

The COVID-19 pandemic has required health systems to meet acute needs during an international health crisis. In the United States, normal medical and surgical care was disrupted starting in February 2020. While some routine medical care was able to be managed with a shift to telemedicine, surgical procedures posed a particular challenge as they require both physical interaction and substantial hospital resources including staff, personal protective equipment, and ventilator use.[1, 2] In March 2020, the United States Surgeon General delivered a formal advisory to halt elective surgeries due to the concern of viral transmission and resource use.[3] This unique situation placed many health systems and providers in the unprecedented circumstance of triaging access to surgery. To provide guidance the American College of Surgeons (ACS) and other professional organizations published general principles on the management of elective operations accounting for institutional resources and clinical acuity.[4] In endocrine surgery specifically, the American Association of Endocrine Surgeons (AAES) and the Society of Surgical Oncology (SSO) published guidance for the management of elective operations amidst the COVID-19 pandemic.[5-7] These guidelines include disease specific management for benign and malignant endocrine surgical procedures.

While some endocrine diseases are indolent and may be medically managed; a subset require timely surgical intervention.[8] When elective surgeries resumed, health systems faced the additional challenge of prioritizing patients for surgery. Several scoring systems were proposed to assist with prioritizing patients for elective surgery. These systems were developed for breast cancer surgery, head and neck surgery, urologic and gynecologic surgery.[8-10]

One critique of some of the published scoring systems is that they fail to account for procedure-related components, such as surgical team size and need for aerosol-generating procedures such as intubation. The Medically Necessary, Time Sensitive (MeNTS) is a scoring system which was developed to incorporate patient, procedural and disease factors.[11] At our institution the MeNTS score was used concurrently with a locally assigned Physician Assigned Priority Score (PAPS), based on the principles published by the ACS.[12, 13] The goal of this study was to analyze the actual treatment delay experienced by endocrine surgery patients due to COVID-19, and to compare performance of MeNTS and PAPS scores in correlating with surgical delays.

Methods

Study design & cohort

Patients scheduled for endocrine surgery (adrenal, parathyroid or thyroid surgery) or clinically evaluated for endocrine surgical disorders during the COVID-19 related elective surgery hold at the Hospital of the University of Pennsylvania (2/26/20–5/1/20) were prospectively entered into a quality-assurance database which was automatically updated daily from the electronic medical record. During this period, all operative cases were cancelled except those which were deemed urgent by the attending surgeon; these urgent cases were considered to have experienced no delay to surgery and were therefore excluded from the final analysis. Patients initially evaluated during the period when no elective surgery was performed had a single scheduled operative date and therefore were considered to have no delay to surgery. Patients with a date of surgery that was rescheduled were included in delay to surgery calculations.

Demographic and clinical variables included age, sex, self-reported race, diagnosis, procedure, PAPS and MeNTS score. The final study population consisted of 146 unique patients. Four patients had two procedures for a total of 150 procedures. Of the cohort, 105 patients had a COVID-related surgical delay and 105 patients had a MeNTS score. A total of 41 patients experienced no delay to surgery. To evaluate patient comorbid disease, a modified Elixhauser Comorbidity Index was calculated for all patients using ICD10 codes for 31 defined comorbidities.[14] This study was reviewed by the Institutional Review Board of the University of Pennsylvania and deemed exempt (IRB#: 844032)

Definitions and outcomes

Our primary outcome was delay to surgery. Surgical delay was defined as the time from initial surgery to rescheduled surgery. Patients were stratified by 30 or 60 d delayed. Subjects were categorized by disease process and diagnosis. Benign thyroid conditions included Graves' disease, and biopsied benign thyroid nodules. Malignant thyroid disease included thyroid nodules suspicious for cancer and confirmed malignancy.

Scoring systems

Physician Assigned Priority Score (PAPS) was determined by the care providing physician based on categories of high, moderate, or low risk, consistent with the Elective Surgery Acuity Scale published by the American College of Surgeons.[4] The elective surgery acuity scale is composed of three tiers with two subtypes for each tier. Tier one is defined as outpatient surgery for nonlife-threatening illness, tier two is defined by patients with non-life-threatening illness that has potential future morbidity and mortality and tier three is for high acuity cases. The PAPS score consolidated tiers to low, moderate and high risk without the retention of subtypes. MeNTS score was calculated as described by Prachand et al[11]. The MeNTS systems includes procedure, disease and patient factors. Procedure factors are scored from 1 to 5, with higher scores suggesting longer operating room (OR) times, length of stay, and greater probability of postoperative intensive-care unit (ICU) care and intubation (Supplementary Table S1).[11] Disease factors focus on the impact of 2- and 6-w delay in treatment and the potential effects on patient outcomes. Lower MeNTS scores suggest favorable surgical risk, minimal risk to personnel, and low resource utilization. A higher score suggests a greater risk for the patient, a higher utilization of resources, and a higher possibility of viral exposure to health care providers[11].

Table 1 – Demographic characteristics and planned procedures for study cohort ($n = 146$).

	Surgical Cohort ($n = 146$)
Median age, years (IQR)	60 (43, 67)
Sex	
Male (%)	46 (32%)
Female (%)	100 (68%)
Race	
African American (%)	23 (16%)
Caucasian (%)	112 (77%)
Other/Unknown (%)	11 (7%)
Procedures ($n = 150$)	
Thyroidectomy (%)	79 (52%)
Parathyroidectomy (%)	52 (35%)
Neck Dissection (%)	9 (6%)
Adrenalectomy (%)	6 (4%)
Other (%)	4 (3%)

Institution-specific rescheduling of elective surgeries

PAPS and MeNTS scores were both utilized to prioritize subjects for surgery, as no data was available to support the advantage of one over the other. Scheduling of elective surgical procedures resumed on May 1, 2020 at our institution, initially at 50% capacity. Surgical capacity was increased over a 6-w period, after which normal surgical block time was restored. Subjects with high MeNTS scores were not permitted to undergo elective surgery in the initial phase of rescheduling. Urgent and emergent surgical procedures continued throughout the study period.

Statistical analysis

Descriptive statistics were performed. Data was assessed for normal distribution using the Shapiro-Wilk test, where $p>0.05$ was considered consistent with a normal distribution. Continuous variables were presented as mean with standard deviation (SD) for normal distribution, and otherwise as median with interquartile range. For parametric group comparisons, one-way ANOVA was used. No non-parametric group comparisons were performed. Receiver Operating Characteristic (ROC) curves were generated to evaluate the specificity and sensitivity of MeNTS and PAPS scores with respect to treatment delay. A P-value of < 0.05 was considered significant. Statistical analysis was performed using STATA 15.1 (Stata Corporation, College Station, TX).

Results

Cohort characteristics

Of the 146 patients included in this study, 68% (n=100) were female (Table 1). The median age was 60 years (IQR: 43,67). The majority of subjects were Caucasian (76%, $n = 112$). Four patients were scheduled for 2 procedures, for a total of 150 procedures. Of 150 procedures, 52% ($n = 79$) were thyroidectomy, 35% ($n = 52$) were parathyroidectomy, 6% ($n = 9$) were neck dissection, 4% ($n = 6$) were adrenalectomy and 3% ($n = 4$) were other. 8 were re-operative procedures, including seven reoperative parathyroid surgeries and 1 re-operative central neck dissection for recurrent papillary thyroid cancer. There was a total of 149 diagnoses for the 146 subjects in the study cohort. The most common diagnosis was thyroid disease ($n = 89$), which was further categorized as malignancy or suspicion for malignancy ($n = 59$), or benign thyroid disease ($n = 30$). Parathyroid disease was the next most common diagnosis ($n = 54$). A minority of patients had adrenal disease ($n = 6$). Three subjects had two diagnoses. All cases were scheduled at the main hospital. Thyroid and parathyroid cases were considered outpatient procedures, while adrenalectomies were considered in-patient admissions.

Forty-one subjects did not experience a delay to surgery. The diagnoses were parathyroid disease (n=14), thyroid disease ($n = 26$), and adrenal disease ($n = 1$).

Table 2 – Mean delay to surgery, in d, by PAPS score.

Priority	Mean, d	Standard deviation	N	P-value
Low	78	54	58	0.01
Moderate	61	42	34	
High	35	39	13	
Total	68	50	105	

Patients by physician assigned priority score

PAPS scores were low in 60% ($n = 88$), moderate in 28% ($n = 41$) and high in 12% ($n = 17$) as shown in Figure 1. Of the total cohort, 105 patients had surgical delays while 41 proceeded with surgery as originally scheduled. Within the subset of subjects with delays, time delay to surgery significantly correlated with PAPS category ($P= 0.01$), as shown in Table 2. The average number of days of surgical delay were 78, 61, and 35, for low, moderate, and high-risk patients, respectively. Within the subset of subjects who did not experience a delay to surgery, the PAPS score was low ($n = 30$) in the majority, with moderate ($n = 7$), and high acuity ($n = 4$) cases constituting the minority.

The mean Elixhauser comorbidity index was 2.2 in low acuity, 1.5 in moderate acuity, and 2.9 in high acuity cases. There was no statistically significant difference between PAPS categories.

Patients by MeNTS score

The entire study cohort was assigned a MeNTS score. 80 subjects had MeNTS scores assigned prospectively with 66 being assigned retrospectively. The mean MeNTS score was 50.5 $\pm$ 5.3. MeNTS varied by diagnosis: in subjects with parathyroid disease ($n = 52$), the mean MeNTS was 50.7 $\pm$ 4.3. Compared with 52.5 $\pm$ 5.8 in benign thyroid disease ($n = 28$), and 48.7 $\pm$ 4.5 in subjects with malignant and/or suspicious thyroid diagnoses ($n = 57$). Three patients had two diagnoses: one with malignant and/or suspicious thyroid and parathyroid disease, one with benign thyroid and parathyroid disease,

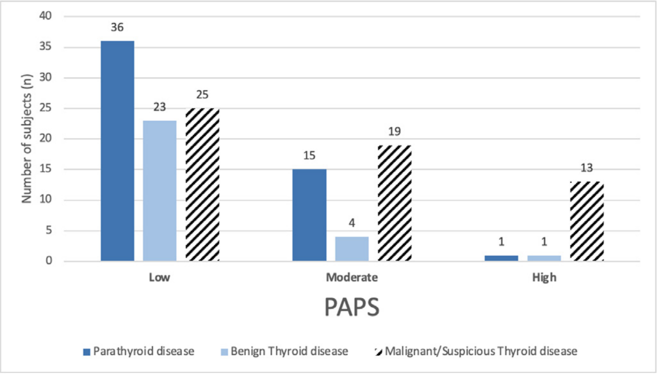

Fig. 1 – Physician assigned priority scores (PAPS) for Parathyroid disease, Benign Thyroid disease and Malignant/Suspicious Thyroid disease (n = 137).

Table 3 – Mean MeNTS score, by PAPS score.

Priority	Mean MeNTS score	Standard deviation
Low ($n = 46$)	49.63	4.6
Moderate ($n = 25$)	49.91	5
High ($n = 9$)	50.1	9.1
Total	49.8	5.4

and one with benign thyroid and malignant and/or suspicious thyroid disease. Their MeNTS scores were 55, 47, and 56, respectively. MeNTS was significantly different between benign and malignant thyroid diagnoses ($P = 0.006$). Within the subset of patients who did not experience a delay to surgery, the mean MeNTS score was 52.

PAPS and MeNTS were not significantly correlated. When patients were stratified by PAPS category, there was no statistically significant difference in mean MeNTS score between groups ($P= 0.09$). Low-risk patients ($n = 58$) had a mean MeNTS of 49.6 ± 4.6, moderate-risk patients (n=34) had a mean MeNTS of 50 ± 5, and high-risk patients ($n = 13$) had a mean score of 50.1 ± 9, as show in Table 3.

Association between scoring systems and time to surgery

Receiver operator characteristic (ROC) curves were generated, and AUC values were calculated to determine the correlation between PAPS and MeNTS scores and surgical delay, as shown in Figure 2. Higher PAPS correlated well with a <30-d delay to surgery (AUC: 0.72). MeNTS score did not correlate well with a <30-d delay to surgery (AUC: 0.52). Neither PAPS (AUC: 0.59) nor MeNTS (AUC: 0.40) correlated well with a <60-d delay to surgery.

Discussion

Elective surgical delays related to COVID-19 created an unprecedented situation requiring first procedure triage, and then prioritization of procedure rescheduling. Several scoring systems have been developed to capture patient and procedure characteristics to guide these challenging management decisions.[8-12, 15, 16] Due to the rapidly evolving public health crisis, these scoring systems were of necessity developed and implemented without external validation. In this study, we evaluate the performance of the published MeNTS scoring system as compared with an institutional physician-assigned priority categorization.

In our cohort, we show that the MeNTS score did not correlate with delay to surgery, while PAPS score was significantly associated with a less than 30-d delay to surgery. These data suggest that the MeNTS score may not capture clinical nuances which are incorporated intuitively by providers. Endocrine surgery procedures in particular

Although the MeNTS system is a well-intentioned and thoughtful assessment of patient, disease and procedure factors, the complexity of clinical care may exceed the capacity of a single scoring system. A similar observation has been made in gynecologic and urologic surgery, where the broad MeNTS system did not well-discriminate urgent cases and performed less well than compared to a modified surgical acuity scale or individual surgeon prioritization.[15, 16] Prioritization systems that better discriminate urgent cases are being developed in individual specialties. Smith *et al*. created a tool to score breast cancer surgeries which includes factors based on genetic testing, and tumor oncotype and characteristics.[9] A study from the University of Toronto, proposes the SPARTAN-HN scoring system for head and neck cancer patients which correlated well with expert rankings.[10] However, in this publication and others, case-by-case review was still recommended. Our findings and prior research suggest that although the MeNTS score may provide some objective data to assist in case rescheduling, it incompletely captures clinical, social and resource nuances which are best incorporated by an experienced clinician familiar with the patient's care. Simpler systems incorporating the principles of the American College of Surgeons' Elective Surgery Acuity Scale may better incorporate clinical considerations. Further validation of this approach is required.

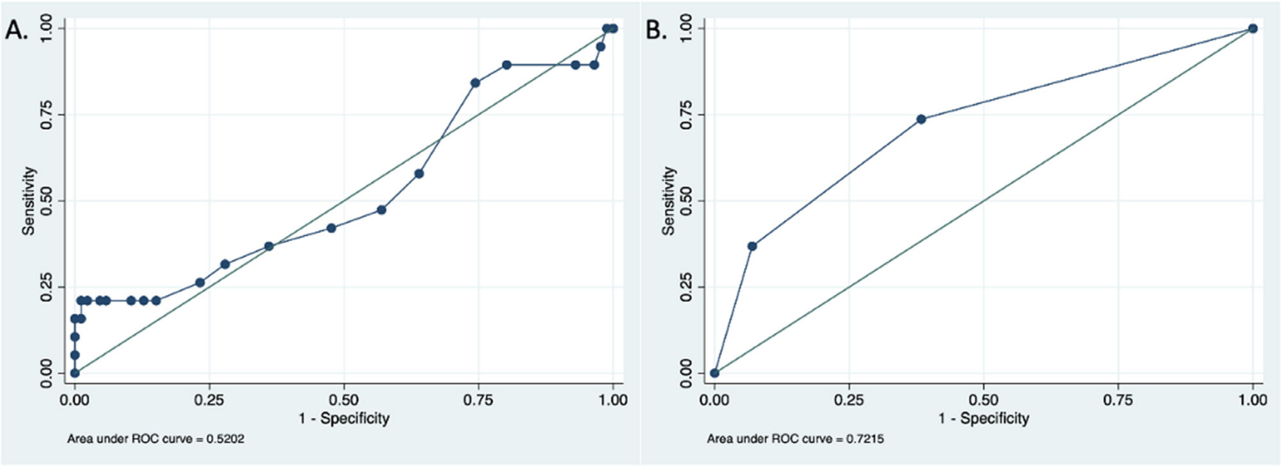

Fig. 2 – Association between scoring systems and surgical delay of <30 d. (A) ROC curves of MeNTS score for surgical delay; AUC = 0.5202. and (B) ROC curve of Physician assigned priority score (PAPS) for surgical delay; AUC = 0.7215.

Resource triage and prioritization are unfortunately not new themes in medicine. Triage of care is an ongoing challenge in trauma surgery and battlefield medicine, and protocols are established for massive casualties and conflict situations.[17-19] Prioritization of elective care in the setting of limited resources presents an ethical and moral challenge in transplant surgery, where organ allocation requires a complex point system and national network of providers to ensure parity.[20, 21] During an unprecedented international health emergency, these past experiences may inform preparedness standards and decision making into domestic health systems. With ongoing uncertainty regarding future case numbers and recurrent pandemic “waves” it is of paramount importance that the standardized systems can be developed to ensure both safe and equitable healthcare for surgical patients.

This study is limited by the small cohort size and short duration of follow up. Although we examined multiple clinical and demographic covariates, this study did not capture non-clinical factors which may have influenced surgical timing. Notable among these was health care avoidance, as many patients declined to reschedule surgery when elective surgery initially resumed. Although we utilized the well-validated modified Elixhauser comorbidity index to evaluate comorbid patient disease, this study may also have failed to capture nuances of comorbid medical conditions due to the inherent limitations of using electronic health record coding data. The Elixhauser comorbidity index was not specifically designed for Endocrine Surgery patients which may also limit this approach. Additionally, the study site is a large tertiary care system with extensive clinical and information technology resources, and therefore results may not be generalizable. By leveraging the electronic medical record in this study, we were able to prospectively capture all patients undergoing endocrine surgery procedures, and automatically update data electronically through the study period. Ultimately, the goal of prioritizing care is to optimize patient outcomes, and therefore future research is needed to determine outcomes in the cohort of patients who experienced delays in care due to COVID-19. Future studies of this cohort will track long-term follow up data, including oncologic outcomes for subjects with cancer diagnoses.

Conclusion

Scoring systems developed to prioritize elective surgery during the COVID-19 public health crisis were implemented without external validation. At our institution the MeNTS scoring system did not predict COVID-related surgical delay. As America’s health system prepares for subsequent viral “waves,” development of robust systems for prioritizing surgical care is of paramount importance. We suggest that a three-tiered system based on the principles of the American College of Surgeons’ Elective Surgery Acuity Scale be utilized to prioritize surgical care in the event of future health care crises.

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Author contributions: JPE, PG, DAP, DLF, RRK, and HW designed the methodology and analysis for this study. JPE, BCG, and BP acquired the data for analysis. JPE, JSB and HW performed the statistical analysis and everyone has contributed to writing this manuscript.

Disclosure

The authors have no disclosures

Supplementary Materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jss.2021.07.006.

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