**Balancing quality and quaternary care imperative using a high-risk case review committee in adults**

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**Abstract**

**OBJECTIVES:** Quaternary care centres have an imperative to serve as hospitals of last resort and must also meet professional quality targets. We developed a high-risk committee (HRC) to evaluate cases meeting pre-defined predicted risk cut-offs as a part of an overall quality improvement drive.

**METHODS:** We describe the structure, outcomes and effects of the Penn HRC. Using propensity-matching, we investigated whether the committee modifies or screens risk. We used multivariable analysis to examine the impact of unmeasured variables on clinical outcomes in this cohort.

**RESULTS:** Institutional predicted and observed mortality had already been in decline prior to HRC institution in 2017, due to a multi-faceted quality improvement initiative. Between 2017 and 2020, the HRC discussed 205 patients with a median predicted risk of mortality of 10.6%. 89% survived. Overall 30-day survival was 86% for the entire cohort and 89% for operated patients. A matched...
analysis of similar patients prior to and following the HRC showed that the HRC did not directly modify outcomes. Most patients had better than expected survival (observed:expected mortality < 1). Predicted risk did not predict 30-day mortality among this high-risk cohort.

**CONCLUSIONS:** HRCs serve as an important element in quality improvement by encouraging a thoughtful approach and channelling the collective experience of a group of senior surgeons. It may improve patient selection by identifying a cohort with extremely poor survival, while allowing safe operation with acceptable outcomes among a group with very high operative risk.

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### INTRODUCTION

Quaternary academic medical institutions have an obligation to serve as hospitals of last resort and have considerable experience and resources which are of utility in the care of this challenging cohort [1–5]. They also must meet state and societal quality guidelines and are driven to consistent improvement in outcomes. The tension between these has led to a number of developments including a high-risk review committee.

High-risk patients are defined by an elevated Society of Thoracic Surgeons (STS) predicted risk of mortality (PROM) of 5% or greater and are also at elevated risk of STS-defined morbidities. They represent a significant proportion of the total institutional risk relative to the number of patients captured by this definition. As predicted operative risk increases, the risk of futile operation also increases. For these reasons, this cohort should attract the keen interest of institutions. High-risk committees (HRCs) have been formed (along the Penn model) in other institutions and some results recently reported [6]. These studies reflect the nuances of decision-making in cardiac surgery.

Several questions remain: first, what effect do such committees have on institutional risk over time? Second, do these committees simply screen out operative risk or do they modify operative risk (which might occur by several potential mechanisms)? Third, what are the characteristics and outcomes of the patients who are referred to the HRC? Fourth, among the operated cohort what clinical factors predict poor outcomes? The present study addresses these questions through analysis of a prospectively maintained database of these patients as well as our own institutional STS database.

### METHODS

**Ethics statement**

1. Institutional Review Board of the University of Pennsylvania;
2. Approval was granted by above Institutional Review Board; and
3. Need for consent was waived as retrospective chart review.

### ABBREVIATIONS

| Abbreviation | Description          |
|--------------|----------------------|
| AVR          | Aortic valve replacement |
| CABG         | Coronary artery bypass grafting |
| HRC          | High-risk committee |
| O/E ratios   | Ratios of observed proportion of death to expected proportion of death |
| PROM         | Predicted risk of mortality |
| STS          | Society of Thoracic Surgeons |

### Penn high-risk committee

The Penn HRC was formed in 2017 as a part of a general quality improvement drive within the Division of Cardiovascular Surgery. Criteria for referral to the committee included the STS PROM of >5% for coronary artery bypass grafting (CABG), >6% for aortic valve replacement (AVR) or AVR–CABG and >7% for mitral valve repair/mitral valve replacement and mitral valve replacement–CABG. Cases can be referred for elevated risk in the opinion of the surgeon, perceived complexity or perceived futility. We began with ‘STS category cases’ as this was a straightforward way of launching this initiative. The process is standardized by compiling patient information ahead of a 6.45 am virtual meeting, which occurs 1–2 times per week as needed. The meeting is chaired by the Chief and a rotating group of surgeons from each Penn entity including 1 senior surgeon. Referral to the committee was strongly encouraged for any high-risk patient; other non-surgical specialists can also participate as needed but were not a core part of the committee. The cases are presented and following a discussion 3 possible outcomes are determined including: decline surgery, defer surgery for further optimization or investigation or proceed as planned. A prospective database was maintained and patients were followed up. This study was reviewed by the University of Pennsylvania Institutional Review Board and approved (IRB 850427). STS standard definitions were used, including for urgent surgery which is the need for in-patient surgery prior to discharge. Patients referred to the committee were not considered good candidates for transcatheter aortic valve replacement (TAVR).

### Study inclusion

The present study includes all patients presented to the HRC from 2017 to the study closure (July 2020). In addition, we reviewed our internal STS database entries for a period of 2011–2020 as described for each analysis including the descriptions of STS PROM over time and the matched studies.

### Statistical methods

This is a retrospective review of prospectively gathered data. We had 3 aims in this study:

- **Aim 1:** To understand the overall institutional risk profile over time, the size and impact of the high-risk population on institutional risk profile and the effect of the institution of the HRC on these parameters. To test monotonic trends in proportions over time, Cochran–Armitage (parametric) and Jonckheere–Terpstra (non-parametric) trend tests were applied, as appropriate.

- **Aim 2:** To understand whether the HRC modified operative risk or simply acted as a deterrent to operation, we matched patients presented to the HRC with similar patients operated upon prior
to the HRC’s institution. To examine whether actual patient 30-day mortality was higher than predicted using STS PROM, ratios of observed proportion of death to expected proportion of death (O/E ratios) were calculated. We report O/E ratios for notable survival outcomes. To assess whether the frequency of patient outcomes changed after the initiation of the HRC, patients who underwent surgery after the initiation of the HRC (2017–2020) were matched with patients who underwent surgery before the HRC was implemented (2011–2017). Matching was 1:1 optimal matching and also exactly matched on procedure type. The caliper for matching was 0.25. To examine differences in 30-day mortality, patients were initially matched on STS PROM using one-to-one optimal matching and exactly matched on procedure type (CABG, AVR, AVR + CABG). They were subsequently additionally matched on risk factors including liver disease status, intubation status and transfer status.

When examining differences in additional outcomes, including postoperative stroke, deep sternal wound infection, renal failure, prolonged ventilation and surgical re-exploration, patients were matched on their predicted risk of respective outcome using the greedy algorithm and exactly matched on procedure type. Greedy nearest-neighbor matching: sequentially and without replacement selects the control unit whose propensity score (in this case STS PROM) is closest to that of the given treated unit. ‘Two-to-one’ matching so that for each treated unit, 2 control units were selected. This was due to the fact that the pool of patients to be selected from in the control group was substantially larger than the treatment group and allowed for the selection of multiple patients per each treated patient. Logistic regression of mortality on HRC status was performed to see if there was an increased or decreased risk of mortality depending on HRC review, after patients were matched on other assumed predictors of mortality. Because of the two-to-one matching, match weights were generated and incorporated in subsequent analyses. After matching, O/E ratios were compared between cohorts.

- **Aim 3:** We reviewed the results of the HRC cohort, both those who were operated upon and those who were not. We assessed for factors associated with poor outcomes including 30-day mortality, late mortality (at the last clinical follow-up), poor ventricular function and STS-defined morbidities (prolonged ventilation, renal failure, deep sternal wound infection, cardiac reoperation and stroke). In the surgical HRC cohort, predictors of interest were examined for association with the outcomes of 30-day mortality, late follow-up mortality, cardiac reoperation, postoperative renal failure, postoperative prolonged ventilation, postoperative stroke and postoperative left ventricular ejection fraction (LVEF). Descriptive baseline characteristics are expressed as mean (standard deviation) or n (%). Associations between outcomes and predictors were calculated and reported along with P-values and sample size used. Next, unadjusted bias-corrected logistic regression (LR-Firth) models of binary outcomes were fit for each predictor. Unadjusted ordinary least squares linear regression models were fit for the continuous outcome LVEF. Multivariable LR-Firth and multivariable ordinary least squares models were examined next. All predictors were considered for inclusion in multivariable models, but final reported models removed non-significant and non-confounding predictors. Two final models were reported: 1 model adjusted for the common baseline characteristics of age, sex, weight and height regardless of significance and the second model dropped these baseline characteristics that are non-significant and non-confounding. The distribution of LVEF at late follow-up was visually compared between surgical and non-surgical patients via a boxplot and statistically compared using a Wilcoxon rank-sum test. To examine differences in odds of death between groups of patients, logistic regression models of 30-day mortality and late follow-up mortality on surgery cohort and PROM were fit. Survival time was also compared between groups using Kaplan–Meier survival curves and log-rank tests. An initial comparison was made using the entire sample of HRC patients. A subsequent comparison matched surgical and non-surgical patients on STS PROM using the greedy algorithm. Survival curves were then compared using the log-rank test. Regarding completeness, of the 205 HRC patients, 28 had mortality within 30 days and no follow-up was required, 150 had a follow-up past 30 days of either date of consult or date of surgery (depending on surgery decision) and 27 had no follow-up past 30 days of consult/surgery.

Analyses were conducted using SAS 9.4. Normality was assessed visually via histograms and formally using Kolmogorov–Smirnov tests. No issues were identified.

**RESULTS**

The Penn HRC assessed 205 patients from 2017 to 2020. The reason for referral was an STS PROM of over 5% in 86.4% of cases. Non-STS PROM reasons for referral included case complexity, poor coronary targets or concern for futility. Seventy-six percent of patients underwent operation following presentation. STS PROM of the operated cohort was 10.3%, of those operated on following optimization 7.3%, of those declined was 11.9% and of those for whom a decision was deferred for further investigations was 6%.

**Aim 1: institutional risk over time**

Figure 1A shows a plot of the percentage of patients at our institution with an STS PROM over 5% for the period 2011–2020 for all patients, as well as individual analyses for CABG patients, AVR and aortic valve + CAB patients. There was a trend towards reduced percentage of patients with PROM >5% prior to the HRC beginning in 2017; the only operation that showed a significant reduction in the proportion of patients with a PROM over 5% in the HRC era was CAB (P = 0.02). Figure 1B shows the same groups’ average PROM declined in a fashion analogous to Fig. 1A, with overall STS PROM hovering between 4% and 5%. Following HRC institution, the only operation that continued to decline in the average PROM over time was AVR (P = 0.003), possibly due to the expansion of low-risk transcatheter AVR. We next assessed the overall operative risk conferred on the institution by patients with a PROM of >5% (this may vary not only by the number of patients but also the magnitude of their PROM). Supplementary Material, Fig. S1 shows that the operative risk conferred on the institution by high-risk patients declined for each category as well as the overall group following the institution of the HRC.

**Aim 2: impact of the high-risk committee on outcomes—modification or screening?**

Table 1 describes the 205 patients presented to the HRC between 2017 and 2020. While the criteria for referral was 5%, their mean
Figure 1: High risk patient cohorts over time at Penn. (A) Percent of patients with Society of Thoracic Surgeons predicted risk of mortality (PROM) >5% over time coronary artery bypass grafting, aortic valve replacement and aortic valve replacement–coronary artery bypass grafting. (B) Average PROM over time at Penn for all procedures, coronary artery bypass grafting, aortic valve replacement and aortic valve replacement–coronary artery bypass grafting.

Table 1: Characteristics of the high-risk review committee

| Total | N = 205 |
|-------|---------|
| CABG  | 98      |
| AVR   | 15      |
| AVR–CABG | 9 |
| Reoperation | 27 |
| Others | 83      |
| STS PROM | 10.6% (0.4–66%) |
| Non-STS indication | 28/205 (13.6%) |
| Operated | 155 (76%) |
| STS PROM of operated pts | 10.3% (0.6–43%) |
| Optimize | 5 (STS 7.3%) |
| Surgery declined | 50 (STS 11.9%) |
| Decision deferred | 12 patients (6%) |
| 30-Day survival (%) | 89 |
| Operated | 89      |
| Entire cohort | 86 |
| Unoperated | 78      |

AVR: aortic valve replacement; CABG: coronary artery bypass grafting; PROM: predicted risk of mortality; STS: Society of Thoracic Surgeons.

STS PROM was 10.6% (8.79) and ranged from 0.4% to 66% (patients could be referred voluntarily). We next examined the observed:expected mortality for all patients, as well as those undergoing the index operations of AVR, CABG and AVR + CABG. Figure 2A shows that there appeared to be a trend towards improved O:E with most data points occurring below the dotted line indicating an O:E of 1. Figure 2B shows that in a matched analysis, the institution of the HRC had no impact upon the O:E line indicating an O:E of 1.

We performed univariate and multivariable analyses to study the impact of specific preoperative factors associated with important clinical outcomes. The only factor associated with 30-day mortality was a low total albumin (P = 0.001), as expected. Prolonged ventilation was predicted by baseline EF (P = 0.02). Postoperative renal failure was predicted by baseline creatinine (P = 0.001), as expected. Prolonged ventilation was predicted by baseline creatinine (P = 0.01), baseline diabetes (0.01), renal failure (P = 0.01) and inotropes within 48 hours (P = 0.006). Postoperative stroke was predicted by preoperative albumin (P = 0.01) and current smoking status (P = 0.04).

Aim 3: results of the high-risk committee cohort

Table 4 shows the demographic details of the HRC cohort and Supplemental Material, Table S9 shows the operative details of those who underwent surgery, showing that the most common operation performed was CABG. Supplementary Material, Fig. S1 shows the fate of all HRC patients. Of the 7 patients with a delayed surgery decision, 6 of them had surgery delayed the following number of days from their HRC consult: 7, 27, 56, 74, 78 and 104. One patient was delayed with no eventual surgery time recorded by the time of data collection. The high-risk nature of this group is evident in the fact that over 30% of patients required some form of temporary mechanical circulatory support in the immediate postoperative period. The 30-day mortality was 11.6% and the mortality at latest follow-up was 25%, at an average of 326 (302) days postoperatively (Supplemental Material, Table S1A). Figure 3 shows a Kaplan–Meier analysis of survival from the time of presentation to the HRC to the time of death for the operated and unoperated cohorts. This shows that the operated cohort had higher survival than the non-operated cohort (P = 0.0185). We then examined the fate of the left ventricle and found that there was improved ventricular function in patients alive at late follow-up (Fig. 4A). LVEDD generally declined in both groups (Fig. 4B).

We performed univariate and multivariable analyses to study the impact of specific preoperative factors associated with important clinical outcomes. The only factor associated with 30-day mortality was a low total albumin (P = 0.02). Notably, STS PROM did not predict 30-day mortality among this high-risk cohort. Factors influencing late mortality among the operated cohort of high-risk patients were age (P = 0.04), total albumin (P = 0.0005), diabetes (P = 0.01) and previous cardiac intervention (P = 0.009). Cardiac reoperation was predicted by weight (P = 0.02) and baseline EF (P = 0.02). Postoperative renal failure was predicted by baseline creatinine (P = 0.001), as expected. Prolonged ventilation was predicted by creatinine (P = 0.01), baseline diabetes (0.01), renal failure (P = 0.01) and inotropes within 48 hours (P = 0.006). Postoperative stroke was predicted by preoperative albumin (P = 0.01) and current smoking status (P = 0.04).
DISCUSSION

In the present study, we describe the format, conduct and results of the Penn HRC. We find that institutional risk was in decline prior to institution of the HRC, which appears to have specifically reduced the proportion of patients undergoing CAB with an STS PROM of >5%. Overall institutional risk declined, as did the total operative risk conferred by the population of patients with a PROM over 5%. In a matched analysis with similar patients prior to the HRC, we did not find evidence that it modified outcomes directly. This matched pre-HRC cohort acts as a control group to study the influence of the HRC directly, which we feel that significantly enhances the rigour of the present study. Importantly, PROM did not predict 30-day mortality in this group, possibly due to unmeasured factors (Supplementary Material, Table S10). We also describe factors associated with important clinical outcomes.

In contradistinction to the Pittsburgh group [6], we operated on the majority of patients presented to the Penn HRC, despite the STS PROM of this cohort being double that described by the aforementioned group. Importantly, the HRC was never intended to reduce high-risk operation but to reduce futile operation and

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Table 2: Observed to expected deaths pre-high-risk review committee matched to high-risk review committee along Society of Thoracic Surgeons predicted risk of mortality strata

|                | Pre-HRC (2011–2016) | HRC (2017–2020) |
|----------------|---------------------|-----------------|
|                | Total N | Deaths N | O/E ratio | Total N | Deaths N | O/E ratio |
| Estimated frequency of death (PROM) |            |            |            |            |            |            |
| <5% chance | 31 | 1 | 3.23 | 1.09 | 31 | 3 | 9.68 | 3.27 |
| 5% to <7% chance | 14 | 2 | 14.29 | 2.36 | 15 | 3 | 20.00 | 3.27 |
| 7% to <11% chance | 17 | 2 | 11.76 | 1.34 | 16 | 0 | 0.00 | 0.00 |
| 11% or greater chance | 15 | 2 | 13.33 | 0.76 | 15 | 3 | 20.00 | 1.08 |
| All | 77 | 7 | 11.69 | 1.50 |

Subjects in the HRC cohort were matched with subjects from the pre-HRC cohort based on the STS risk. Match type was one to one.

HRC: high-risk review committee; O/E ratio: ratios of observed proportion of death to expected proportion of death; PROM: predicted risk of mortality.

Table 3: Observed to expected deaths pre-high-risk review committee matched to high-risk review committee by procedure

| Procedure type | Pre-HRC | HRC |
|----------------|---------|-----|
|                | N | Av PROM (%) | Deaths n | % | O/E ratio estimate | N | Average PROM (%) | Deaths n | % | O/E ratio estimate |
| CAB only | 62 | 7.09 | 6 | 9.68 | 1.37 | 62 | 7.11 | 7 | 11.29 | 1.59 |
| AV replacement | 10 | 10.46 | 1 | 0.96 | 0.96 | 10 | 11.51 | 0 | 0.00 | 0.00 |
| AV replacement + CAB | 5 | 9.10 | 0 | 0.00 | 0.00 | 5 | 9.23 | 2 | 40.00 | 4.33 |
| All | 77 | 7.66 | 7 | 9.09 | 1.19 | 77 | 7.82 | 9 | 11.69 | 1.50 |

Subjects in the HRC cohort were matched with subjects from the pre-HRC cohort based on the procedure type (CABG, AVR, AVR/CABG). Match type was one to one.

AVR: aortic valve replacement; CABG: Coronary artery bypass grafting; HRC: high-risk review committee; PROM: Predicted risk of mortality.
improve outcomes by consolidating the experience of several surgeons in decision-making about preoperative optimization and operative strategy. The fact that the matched analysis did not show an improvement in quantitative outcomes does not suggest that these desired outcomes were not achieved qualitatively. Indeed, there are other factors not assessed, such as frailty, which may have impacted the effect of a nuanced discussion of high-risk cases. Interestingly, ‘late’ outcome (which in this study was ~1 year) was worse for the non-operated cohort. This may suggest that the HRC identified futile operation, as the risk of death was higher despite no conferred operative risk.

There are several reasons to suppose that decision by committee is superior to individual surgeon decision-making. First, by formalizing the process in this way, measuring outcomes and tracking them over time we harness the power of the Hawthorne effect to actuate change [7, 8]. Second, considerable data suggest that the ‘wisdom of the crowd’ in decision-making often exceeds that of individual experts. A recent analysis of neurosurgeons’ assessment of the resectability of glioblastoma found that while individual surgeon opinion varied widely, responses of the entire group correlated with objective measures of resectability—in other words, group decision-making was better than that of the individual [9]. Third, the HRC may be a conduit for the ‘nudge effect’ which was described by Nobel-laureate Richard Thaler as the powerful impact of small suggestive influences on outcomes. It is possible that the presence of the HRC acts as a barrier to futile operation. In these ways, while addition of the HRC did not itself directly modify outcomes, it was an important addition to our department. Partly this may be due to limitations on the number of subjects, but we still believe it to be of great benefit. It would be interesting to address in future studies different models of an HRC, including where all cases are presented, or where the HRC has different thresholds for discussion or includes a multi-disciplinary component. These may be the target of future studies.

**Limitations**

One significant limitation is that we did not directly study the decision-making process itself, which may be a worthy topic of another study. Importantly, when cases were presented by more junior faculty, the committee likely acted in more of an advisory than discursive role—surgeon experience was not directly addressed by our study. Our study is also limited by its small number, limited follow-up period and lack of prospective randomization to HRC or individual decision-making—future studies

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**Table 4: Patient characteristics of high-risk review committee patients**

| Value | N obs |
|-------|-------|
| **Demographics** | |
| Age (years), mean (SD) | 68.9 (1.28) | 128 |
| Height (cm), mean (SD) | 169.0 (11.49) | 128 |
| Weight (kg), mean (SD) | 83.5 (26.32) | 128 |
| Male, n (%) | 66 (51.16) | 128 |
| Liver indicators, mean (SD) | |
| Albumin (g/dl) | 3.3 (0.57) | 121 |
| Bilirubin (mg/dl) | 0.8 (0.75) | 125 |
| MELD score | 13.7 (6.48) | 125 |
| Liver disease | 19 (14.84) | |
| **Chronic health conditions** | |
| Creatinine, mean (SD) | 2.4 (2.45) | 128 |
| Cerebrovascular disease, n (%) | 58 (45.31) | 128 |
| Chronic lung disease, n (%) | 44 (34.38) | 128 |
| Diabetes, n (%) | 70 (54.69) | 128 |
| Hypertension, n (%) | 113 (88.28) | 128 |
| Peripheral arterial disease, n (%) | 34 (26.56) | 128 |
| Renal failure dialysis, n (%) | 32 (25.00) | 128 |
| Current smoker, n (%) | 20 (15.75) | 127 |
| Former smoker, n (%) | 56 (44.09) | 127 |
| **Cardiac indicators** | |
| Baseline EF, mean (SD) | 50.0 (16.87) | 128 |
| Cardiogenic shock, mean (SD) | 6 (4.55) | 132 |
| Heart failure (within 2 weeks), mean (SD) | 100 (78.74) | 128 |
| Inotropes within 48 h, n (%) | 18 (14.06) | 128 |
| Previous cardiac intervention, n (%) | 64 (50.00) | 128 |
| Transferred, n (%) | 26 (19.70) | 132 |
| **Procedural indicators** | |
| Length of stay (days), mean (SD) | 7.3 (7.08) | 128 |
| PROM (%), mean (SD) | 10.3 (7.78) | 150 |
| Intubated prior to entering OR, n (%) | 14 (10.94) | 128 |
| Emergency surgery, n (%) | 4 (3.13) | 128 |
| Urgent surgery, n (%) | 98 (76.56) | 128 |

PROM: predicted risk of mortality; SD: standard deviation.

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**Figure 3**: Survival following presentation to the high-risk review committee according to decision.
with increased numbers may be more suitable for identifying specific factors conferring high risk in this population, an potentially avoiding a type II error. The addition of non-surgical colleagues is another option to consider in the future, including critical care and cardiology. Importantly, this study only includes patients whose only option is surgical intervention and does not capture the impact of transcatheter therapy, and it is highly likely that some high-risk patients were preferentially offered transcatheter therapy prior to presentation to the committee. The HRC operates by self-referral, which is a potential bias; however, it is the institutional policy of the division that all cases meeting the STS-defined thresholds should be presented. Rarely, the STS PROM may be recalculated and make a patient reach the eligibility criteria for HRC referral. An additional limitation is that the propensity matching could not account for all possible differences between groups and because not all covariates that may affect outcome were included in matching.

CONCLUSION

We report the construction, results and impact of the Penn HRC with an experience of 205 patients with a very high STS PROM. Importantly, we perform a matched analysis to study the impact of the HRC itself. We did not find objective evidence of HRC modification of outcomes. However, for several reasons explained above, we feel that institutional HRCs serve as an essential forum for the discussion of challenging patients, identifying futility and allowing safe operation on a very high-risk group with good outcomes. HRCs have an important role as a part of a continual quality improvement program. Further studies will benefit from a larger cohort and longer follow-up period.

SUPPLEMENTARY MATERIAL

Supplementary material is available at ICVTS online.

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Conflict of interest: none declared.

Data availability

The data underlying this article cannot be shared publicly due to patient confidentiality. The data will be shared on reasonable request to the corresponding author.

Author contributions

Michael Ibrahim: Investigation; Methodology; Project administration; Resources; Software; Writing—original draft; Writing—review & editing. Andrew Acker: Formal analysis; Software; Writing—original draft; Writing—review & editing. Steve Weiss: Conceptualization; Data curation; Formal analysis; Investigation; Kendall Lawrence: Data curation; Formal analysis; Investigation; Methodology; Software; Supervision; Writing—review & editing. Stephanie Ottemiller: Conceptualization; Data curation; Investigation; Visualization. Jeremy McGarvey: Conceptualization; Methodology; Resources; Software. Mark Epler: Conceptualization; Project administration; Resources; Supervision. Matthew Williams: Conceptualization; Data curation; Formal analysis; Writing—review & editing. Wilson Y. Szeto: Resources; Software; Supervision; Validation. Michael Acker: Data curation; Investigation; Supervision; Validation.

Reviewer information

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