Preliminary Experience with the Procedural Autonomy and Supervision System (PASS)

BY

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>II. METHODS</td>
<td>6</td>
</tr>
<tr>
<td>III. RESULTS</td>
<td>10</td>
</tr>
<tr>
<td>IV. DISCUSSION</td>
<td>13</td>
</tr>
<tr>
<td>V. APPENDICES</td>
<td>31</td>
</tr>
<tr>
<td>VI. REFERENCES</td>
<td>37</td>
</tr>
<tr>
<td>VII. CURRICULUM VITAE</td>
<td>41</td>
</tr>
</tbody>
</table>
LIST OF TABLES

TABLE I. TABLE 1 – SPEARMAN’S CORRELATIONS................................................................. 20
TABLE II. TABLE 2 – PROCEDURE REPORT............................................................................. 21
TABLE III. TABLE 3A – FACULTY OREEM RESULTS: 2012 VS. 2013............................... 22
TABLE IV. TABLE 3B – RESIDENT OREEM RESULTS: 2012 VS. 2013............................. 24
<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Zwisch Scale of Progressive Autonomy</td>
<td>26</td>
</tr>
<tr>
<td>2. PASS Workflow</td>
<td>27</td>
</tr>
<tr>
<td>3. Proportional Zwisch Levels by PGY</td>
<td>28</td>
</tr>
<tr>
<td>4. Proportional Zwisch Levels by Complexity</td>
<td>29</td>
</tr>
<tr>
<td>5. Proportional Zwisch Levels by Prior Experience</td>
<td>30</td>
</tr>
</tbody>
</table>
SUMMARY

Purpose: Surgical residents are expected to be able to independently perform the core surgical procedures by the completion of their training. Existing methods for assessing resident operative performance are cumbersome, interrupt faculty workflow, and are often completed long after the end of the procedure. These issues lead to poor faculty compliance and potential for significant recall bias. To provide a more effective OR assessment system we have developed PASS (Procedural Autonomy and Supervision System). PASS is a smart phone based system that enables faculty to use the Zwisch scale to provide timely assessments of residents’ operative autonomy with every case they perform. The Zwisch scale has 4-levels based on the amount of guidance the attending surgeon must provide to the resident to safely and effectively perform the procedure. Our goal with this study is to demonstrate that PASS with the Zwisch scale is a valid and feasible system for measuring resident operative autonomy without negatively impacting the OR environment.

Methods: Prior to implementation, all participating general surgery residents and faculty underwent frame-of-reference training to the Zwisch scale. Once implemented, after every operation in which a resident participated, the system automatically prompted the attending to rate the resident’s level of operative autonomy based on the Zwisch scale. Eight procedures were videotaped and independently rated by 2 additional surgeons. Zwisch ratings between the 3 raters were compared using an intra-class correlation (ICC) coefficient. Videotaped procedures were also scored using two alternative OR performance assessment instruments (OPRS and O-SCORE), against which item correlations were calculated. OR times for procedures performed at least 3 times in both the 6 month periods before and during PASS implementation were compared using an independent t-test. A modified version of the OREEM survey tool (36 items) was used to assess the impact of PASS on the satisfaction of residents and faculty with the OR educational experience. Responses for faculty and residents before and during PASS implementation were compared using an independent t-test.
Results: PASS was implemented for a seven month period by 27 full-time general surgery faculty to assess 1490 operative performances with 31 general surgery residents. During the study period, faculty completed evaluations for 92% of all operations performed with general surgery residents. Zwisch scores were shown to correlate with PGY levels based on sequential pair-wise chi-squared tests: PGY1 vs. PGY2 ($\chi^2=76.2$, df=3, $p<0.001$); PGY2 vs. PGY3 ($\chi^2=23.8$, df=3, $p<0.001$); PGY3 vs. PGY4 ($\chi^2=38.3$, df=3, $p<0.001$); Comparison of PGY4 to PGY5 scores were not significantly different ($\chi^2=1.3$, df=3, $p=0.72$). For the 8 operations reviewed for inter-rater reliability, the ICC coefficient was 0.90 (95% CI 0.72-0.98, $p<0.01$). Correlation of PASS ratings with both OPRS items (each $r>0.90$, all $p<0.01$) and O-SCORE items (each $r>0.86$, all $p<0.01$) was high. Faculty and resident compliance with completing the modified OREEM survey was > 80%. There were no significant differences between the resident or faculty responses obtained before and during PASS implementation. OR times were compared for 40 procedures performed at least 3 times during both time periods evaluated. There were no significant differences in OR times before and during PASS implementation.

Conclusions: The Zwisch scale is a reliable and valid measure of operative autonomy that does not appear to have any major disruptive effect on OR times or on residents’ and faculties’ perception of the OR experience. Deployed on an automated smart-phone based system PASS can be used to feasibly record evaluations for the vast majority of operations performed by residents. This information can be used to counsel individual residents, modify programmatic curricula, and potentially inform national training guidelines.
I. INTRODUCTION

There is significant concern that general surgical residency training programs are not adequately preparing residents for independent surgical practice (1,2). Recent changes in surgery and in surgical training have influenced residents' access to educational opportunities in the operating room (3,4). While reports on the overall procedural exposure during residency vary (5,6), residents have limited exposure to many common surgical procedures considered to be essential to independent general surgical practice (7-9). A significant portion of general surgery residents do not feel they are adequately prepared for independent practice and do not feel they are competent to perform many procedures that are considered to be relevant in general surgical practice (10,11). As a consequence, most general surgery graduates now seek additional training in surgical fellowship programs before entering practice (11,12). Fellowship program directors have also expressed concerns that general surgery graduates are often unable to perform basic surgical procedures competently and independently (13).

Factors that are perceived to be significant impediments to effective operative teaching and assessment include: 1) patient safety concerns and time pressures make it difficult to both teach effectively in the OR and/or complete performance assessment forms, 2) uncertainty about the residents' current operative developmental status with the procedure being performed making it difficult to know where to focus teaching efforts, 3) lack of clear and consistent operative development milestones make it difficult to coordinate teaching efforts among faculty.

For the purposes of this discussion operative autonomy will be defined as the ability to independently perform a surgical procedure safely, competently, and effectively. This includes correctly planning the procedure, anticipating potential complications, and improvising when unanticipated circumstances arise which requires the ability to recognize circumstances where other surgical or non-surgical expertise is needed to provide optimal care for the patient. Progression to operative autonomy
is arguably the single most important criteria for determining whether a surgical resident has successfully completed their training and are ready to enter independent clinical practice. For general surgery residents it is expected that operative autonomy or “specific procedural competency” be achieved for core procedures as defined in the national SCORE curriculum (9,14).

Currently, for a general surgery resident to be eligible for their qualifying exam, they must provide evidence of their overall operative competence based primarily on: 1) their self-logged procedural numbers, 2) aggregate faculty assessments of their operative performance based on collective recall. Regarding procedural numbers, the ACGME and ABS have established minimal requirements for each of 19 defined procedural categories (i.e. laparoscopic basic, vascular, alimentary tract, endocrine, etc) which all residents must achieve to be eligible for taking their qualifying exam. Residents are directed to log each procedure they participated in if they played a significant role in performing a key portion of it. However, no formal faculty evaluation of the residents’ operative performance or the level of autonomy they achieved in each of their logged procedures is currently required, creating the potential for residents to log the required numbers of cases without actually being able to perform the operation safely, competently and independently. While aggregate faculty assessments address operative performance, this process is not standardized and is commonly incorporated into a periodic, retrospective review of the resident’s overall performance of which operating room performance is only a part. Furthermore, this retrospective evaluation process, typically performed months later, is highly vulnerable to distortions in faculty recall over time and to the influence of other intervening feedback pertaining to the resident.

A longitudinal assessment of a resident’s operative performance completed immediately after each operation would enable timely monitoring of his or her chronological progression and would provide more reliable, real-time data to guide both the teacher and the learner. A literature search was conducted using PubMed and Web of Science data bases to identify studies that explored the validity of
methods for assessing operative surgical skills. The majority of these studies pertained to assessment tools designed for use in a skills lab setting (3,15). While some of these tools were studied in real operating room teaching scenarios (16-20) none have been widely adapted in surgical residency training. We believe this is primarily because most surgical faculty members consider the time required to complete these evaluations as disruptive to the normal workflow of their busy surgical practice. Therefore while some of these tools have been used to provide cross-sectional data pertaining to aspects of residents’ OR performance, they have not been able to provide real-time, ongoing assessment of a residents’ progression to operative competence and independence. Recently the American Board of Surgery has mandated that programs must complete at least six formal operative performance assessments for each resident before they will be eligible to sit the qualifying exam. While this will be a valuable step forward, the complexity of many of the published assessment tools will significantly limit the percentage of procedures that get formally assessed. As the burden of required assessments increases, their quality may diminish as assessments are performed selectively based on convenience or completed late when memory decay threatens their accuracy.

To optimize the effectiveness of the intra-operative educational experience and produce general surgery residents who are competent and independent in the operating room we embedded a simple operative assessment scale to monitor residents’ progressive stages of operative autonomy into a mobile (smartphone) instrument. The Zwisch scale (21), named after Dr. Jay Zwischenberger who first conceptualized it, provides a metric for intraoperative teaching and learning based on the teachers’ gradual relinquishment of operative control in response to the learners’ progressive demonstration of operative competence and independence (Figure 1 - Zwisch Scale of Progressive Autonomy).

Upon termination of each surgical procedure, the Procedural Autonomy and Supervision System (PASS) automatically sends an electronic text prompt to the smartphone of the surgeon who performed the procedure. This “prompt” reminds the surgeon to rate the resident’s operative performance for the
procedure they just performed together by assigning one of the four stages of the Zwisch scale (Figure 2- PASS Workflow). Once the Zwisch level is selected the surgeon will also be asked to rate the level of difficulty of the procedure in comparison to all previous experiences with that same procedure, or comparable procedures. An additional option that will be ultimately incorporated will be a separate dictation system that will enable provision of more detailed feedback about the residents' performance. Therefore, an operative performance assessment can be completed immediately after the procedure is completed by pushing a few buttons on a hand-held device while walking away from the operating room. The Zwisch level and other variables selected are deposited in a database that will accumulate assessment data for all operative procedures performed involving faculty surgeons and residents. This data will be organized into simple graphic profiles that will summarize the residents' Zwisch levels achieved overall with all procedures, for specific individual procedures, and for operative procedures performed with specific surgical faculty.

To preserve confidentiality, these personalized Zwisch level profiles are accessible only to the resident, the surgical education staff, and surgical faculty with whom they will be operating. These operative performance profiles will provide valuable information for faculty who are planning their next operation with a specific resident by defining the level of operative autonomy they have achieved to date and thereby providing insight as to what should be the educational focus of the upcoming surgical procedure. We believe this feature will help to facilitate regular usage of the assessment tool which will help to generate valuable data based on comprehensive, real-time monitoring of residents' progress towards operative autonomy. This data can be made available to both teachers and learners and utilized to define the learner's educational needs and thereby determine the educational priorities in tailoring an individualized operative curriculum. In addition to providing valuable information about resident performance, the data collected can also be used to monitor the effectiveness of surgical faculty teaching based on their willingness and ability to guide residents to progressively higher levels of
autonomy. Finally if the PASS system is adapted nationally it could be used to establish performance norms and standards for residents, faculty teachers, and residency programs.

The problem to be addressed is that currently available tools for assessing OR performance are not effective because they are too cumbersome to facilitate use with every procedure and they do not focus on progressive autonomy. The goal of this study was to provide evidence for the feasibility and validity of PASS through answering the following questions related to response process, relationships with other variables, and consequences (22):

1) How often and how soon will faculty complete assigned resident OR performance evaluations?
2) How are Zwisch scale scores associated with: a) Trainee experience (i.e. PGY level, procedural numbers); b) Case complexity; and c) other well-known more intensive measures of operative performance?
3) Will PASS improve resident and faculty satisfaction with the educational experience in the OR?
4) Will PASS influence average OR times for cases involving both faculty and residents?

We hypothesized PASS use will be associated with high faculty compliance with timely completion of evaluations by surgical faculty, that use of PASS will improve satisfaction in the OR for both resident and faculty without significantly prolonging operative times, and that Zwisch scores will correlate with operative performance rated using other established (16, 23) instruments.
II. METHODS

We obtained baseline data regarding both resident and faculty satisfaction with the educational experience in the OR and the mean OR times for procedures performed commonly on each surgical service participating in the study. OR satisfaction was determined by surveying both faculty and categorical general surgery residents using modified versions of the OREEM (Operating Room Educational Environment Measure) tool (24). Both faculty and resident versions were piloted with former residents (n=6) who had completed their residency training within the last two years. All clinically active general surgery residents (PGY1-PGY5) who were on operative services at Northwestern Memorial Hospital (NMH) during the defined study period (N=31) were included in the survey analyses. Faculty included in the survey analyses were all active, full-time general surgery teaching faculty in the Feinberg School of Medicine’s Department of Surgery at Northwestern University who agreed to use PASS and who would be performing surgical procedures with categorical surgical residents at NMH during the proposed study period (N=27). Baseline data pertaining to mean OR times was obtained from the electronic medical record (EMR) at NMH for all procedures performed at least three times by participating general surgery faculty with surgery residents from a seven month time period identical to the PASS implementation period from the preceding year (i.e. Dec 1, 2011–June 30, 2012).

Prior to implementation of PASS, all categorical general surgery residents and participating general surgery faculty underwent frame-of-reference training to calibrate their understanding of each phase of the Zwisch scale. This included a review of the four Zwisch level definitions and viewing of video vignettes dramatizing each. Subsequently all participants were tested on their ability to recognize and distinguish the stages by sequential review of 8 short videotapes obtained from actual surgical procedures and independent assignment of a specific Zwisch level to each based on the level of help they believe was provided by the faculty. Answers were collected using and audience response system
and tabulated to display the frequency by which each Zwisch level was selected by the entire group for each videotaped procedure. These results were reviewed and discussed with each responding group. Excellent inter-rater reliability was demonstrated among faculty with a mean correlation of 0.90 (SD 0.12). Additionally, PASS was beta-tested with five faculty general surgeons at Northwestern Memorial Hospital for a period of one month to identify unanticipated problems and/or technical glitches.

Following frame of reference training with the Zwisch scale and beta-testing with PASS, PASS was implemented with all participating surgical faculty and residents. Data collection was initiated on Dec 1, 2012. With study initiation all participating surgeons began receiving electronic prompts immediately upon completion of every operation they performed with a categorical general surgery resident. Faculty were asked to indicate the Zwisch level and the relative difficulty of the procedure they had just performed compared to all other procedures of the same type they had performed previously, or compared to other similar procedures. Data collection continued until June 30, 2013.

To establish inter-rater reliability, eight of the procedures performed during this time period were videotaped and independently rated by two attending surgeons and a resident who had undergone frame of reference training and who were blinded to the Zwisch level assigned by the primary surgeon. Zwisch ratings between the three raters were compared using an intra-class correlation (ICC) coefficient. To further establish validity these eight videotaped procedures were also scored by two additional surgeons using two alternative and previously published OR performance assessment instruments, the Operative Performance Rating System (OPRS)(16) and the Ottawa Surgical Competency Operating Room Evaluation (O-SCORE)(23), against which relevant individual item correlations were calculated using Spearman’s rank correlation coefficient. The decision to utilize eight videotaped procedures for determining inter-rater reliability with Zwisch and correlation of Zwisch scores with relevant components of other validated OR performance assessment instruments was based on a preliminary power analysis which demonstrated that with 8 video comparisons correlation would
have to be at least 0.82 to be considered significantly different from 0 at 5% with 80% power. Based on the high faculty inter-rater correlation (0.90) demonstrated during our faculty development process, we opted to use 8 videos for this analysis.

Zwisch scores were also compared between: a) PGY levels (i.e. PGY1 – PGY5); b) levels of procedural difficulty (i.e. Easiest 1/3, Average 1/3, Hardest 1/3) as perceived by faculty based on their previous experience with that procedure if commonly performed, or similar procedures if not commonly performed; and c) the resident’s previous documented experience, as noted in their ACGME electronic operative logbook, with the procedure being performed (i.e. ≤5, >5). These comparisons were performed based on sequential pair-wise chi-squared tests.

During the study period when PASS was deployed, OR times were re-measured to compare with baseline data and determine if use of the PASS system had an impact on OR times. Again, OR times were averaged for all procedures performed between participating general surgery teaching faculty and general surgery residents at least three times during both the study and control time periods. Differences in OR times before the control time period and the time period of PASS implementation were compared and p-values were determined using the independent two-sample t-test. Adjustment for potential bias due to the multiple comparisons was made using the Bonferroni procedure which set statistical significance at a p-value of 0.001.

Also, after completion of the study period the OR satisfaction survey was repeated with the same population of faculty and residents as with the baseline studies. Pre and post study survey completion for both faculty and residents was documented anonymously and survey data was compared from using an independent t-test to compare differences in the results of individual OREEM survey items. A Bonferroni correction was used to adjust for multiple comparisons which set statistical significance at a p-value of 0.001 for both the resident and faculty OREEM surveys.
This study was pre-approved by both the IRBs of Northwestern University's Feinberg School of Medicine and University of Illinois Chicago (Addendum 2, 3). With all data collection patient confidentiality was preserved. Data collected pertaining to OR environment was de-identified and aggregated. All data pertaining to individual resident performance was kept confidential and accessible only to the principal investigators and study coordinators.
III. RESULTS

Between Dec 1, 2012 and June 30, 2013 participating full-time general surgery faculty (n=27) at Northwestern Memorial Hospital assessed 1490 operative performances (127 different procedures) from 31 general surgery residents using the Zwisch scale on PASS. A breakdown of the general surgery residents evaluated during this study period includes 10 PGY1s, 5 PGY2s, 5 PGY3s, 5 PGY4s and 6 PGY5s. During this period participating general surgery teaching faculty completed evaluations for 92% of all operative procedures performed with general surgery residents. Response times for all faculty surgeons completing PASS evaluations during all time periods were based on the time elapsed between the time the operation was terminated to the time the PASS smart-phone evaluation was completed by the faculty surgeon. The median response time was 1.3 hours with 54% of PASS evaluations completed within 2 hours and 77% completed within 24 hours.

Inter-rater reliability for the Zwisch scores assigned by the operating attending, the blinded resident and faculty attending was shown to be high with an ICC coefficient of 0.90 (95% CI 0.72-0.98, p<0.01). Correlations between the Zwisch ratings and individual OPRS and O-SCORE scale items are shown in Table 1. The Zwisch ratings given by the operating attending correlated highly with relevant, individual OPRS (r>0.90 and p<0.010 for all comparisons) and O-SCORE (r>0.86 and p<0.01 for all comparisons) item scores assigned by the expert video raters who were blinded to the Zwisch score assigned by the operating attending. For the OPRS items that specifically measure guidance the correlation with the Zwisch level is -0.92 (p<0.01), where the negative sign indicates that the scales are inverted (TABLE 1 - SPEARMAN’S CORRELATIONS).

Zwisch scores were generally shown to correlate with PGY levels based on sequential pair-wise chi-squared tests: PGY1 vs. PGY2 ($\chi^2=106.9$, df=3, p<0.001); PGY2 vs. PGY3 ($\chi^2=22.2$, df=3, p<0.001); PGY3 vs. PGY4 ($\chi^2=56.4$, df=3, p<0.001). Comparison of PGY4 to PGY5 scores were not significantly
different ($X^2=4.5$, df=3, $p=0.21$). No PGY1s achieved a Zwisch level of 4 (i.e. “Supervision Only”) while, interestingly, only 23.2% of the PGY 5’s operative performances were scored at level 4 (Figure 3 - Proportional Zwisch Levels by PGY).

Similarly, increasing operative complexity is associated with more guidance being provided to the resident based on sequential pairwise chi-squared tests: Easiest 1/3 vs. Average ($X^2=51.3$, df=3, $p<0.001$) and Average 1/3 vs. Hardest 1/3 ($X^2=87.0$, df=3, $p<0.001$). Residents were provided with minimal guidance (“Supervision Only”) in just 4.1% of operations deemed to be in the “Hardest 1/3” category. These results are summarized in Figure 4 - Proportional Zwisch Levels by Complexity.

ACGME case log data was used to calculate how many times a resident had performed a procedure of a given type prior to receiving a Zwisch evaluation for a procedure of the same type. When a resident had previously performed 5 or less prior operations of the same type (with any attending), the median Zwisch level was “Active Help”. If a resident had performed more than 5 prior operations of the same type the median Zwisch level was “Passive Help” ($X^2=46.0$, df=3, $p<0.001$). Both distributions demonstrate a similar variability with an inter-quartile range of one Zwisch level (Figure 5 - Proportional Zwisch Levels by Prior Experience).

OR times were compared for all procedures (n=40) that were performed at least 3 times by participating general surgery faculty with general surgical residents during both the control time period and the study time period (TABLE 2 – PROCEDURE REPORT). Procedures were also separated based on whether they were performed in our main hospital ORs (Feinberg) or our ambulatory surgery facility (Olson) to ensure that any differences detected were not related to functional differences inherent to these OR systems. With Bonferroni correction no significant differences between control and study periods were shown to exist when comparing overall OR times or OR times for specific individual procedures.
Faculty and residence compliance with completing the OREEM survey was high both before (Faculty 81%; Residents 96%) and after (Faculty 96%; Resident 80%) introduction of PASS.

After Bonferroni correction, no significant differences were identified between OR satisfaction surveys performed before or after implementation of PASS for either residents or faculty (TABLE 3A – FACULTY OREEM RESULTS: 2012 VS. 2013 & TABLE 3B – RESIDENT OREEM RESULTS: 2012 VS. 2013).
IV. DISCUSSION

In medical education increasing attention has been directed towards defining those activities for which physicians need to be competent in order to appropriately serve their patients. These entrustable professional activities (EPAs)(25,26) need to be the primary focus of medical education. Operative procedures are specific, highly complex EPAs that surgeons must learn to perform safely and competently before they can function independently in clinical practice. Historically surgeons were trained to perform operative procedures using Halstedian principles (27,28) and resident trainees were exposed to a broad variety of operative experiences and granted significant independence in the operating room to cultivate a skill set that fostered the development of operative autonomy. “See one, do one, teach one” was the traditional mantra for surgical training. However, recent changes in healthcare, particularly increased scrutiny on patient outcomes and increased pressures to perform more procedures, have created an environment where surgeons have significant disincentives for granting operative autonomy to their slower and less experienced trainees. Recent concerns about the finished product of a general surgery residency training experience (1,2,4,8) have prompted surgical educators as well as major surgical societies and governing bodies to re-evaluate current training practices and consider new and innovative strategies to enhance teaching and learning in the current environment, particularly in the operating room.

In evaluating residents’ progression towards operative autonomy single procedural based assessments (29) with direct observation (30) have several potential advantages over periodic evaluations based on collective recall. First, if the assessments are performed immediately after the procedure concerns about accuracy are greatly reduced as memory decay will not be an issue (31,32). Second, if accurate assessments are performed with a high percentage of procedures involving faculty and residents, the sample size is increased thereby facilitating a broader performance comparisons.
including between different procedures, different residents, different faculty teachers, and different programs (33). The cumulative data created by this evaluation process can be useful in many other ways at the program level. The data can be used to help make data driven decisions about specific operative milestones and to identify those residents who are lagging behind their cohorts so that remediation strategies or clinical curriculum changes can be implemented. If collected nationally this data could be used to establish norms and standards to guide national leaders in surgical education in trainee assessment and certification and in developing strategies and policies to improve surgical training in the country.

Given the difficulties associated with acquiring detailed resident evaluations with every procedure there are two potential options that would simplify the process and facilitate the collection of effective data. One strategy is periodic collection of detailed operative performance data for individual procedures. With this approach detailed operative performance data could be collected periodically as directed by surgical education leadership who would try to ensure that data collection was appropriate and adequate to accurately monitor operative performances with individual residents and with the program as a whole. If surgical faculty members are only required to perform more detailed evaluation of a resident’s operative performance periodically at predefined intervals, compliance may improve. However, even if improved compliance rates are achieved with this approach there may still be ongoing problems with the timeliness of completion of these complex forms since few surgeons will sit down between procedures to fill out an evaluation form with multiple items. Also, significant concerns about sampling errors would exist as faculty surgeons may be more inclined to selectively complete assessment forms when most convenient i.e. only with simple procedures that are easier to evaluate or with procedures that occur on days that are less busy.

Alternatively the evaluation process could be simplified by collecting only the most essential, summative, evaluation data using a process that takes only seconds to complete. Of course, when data
collection is minimized to this extent it is important to define which data is the most crucial. Since the ultimate goal of improving each individual operative skill with surgical residents is to transform them into surgeons who can independently perform entire surgical procedures safely, competently, and effectively, we believe operative autonomy is the single most valuable parameter to monitor. Operative autonomy provides a valuable summative assessment of all aspects of a resident’s operative performance (i.e. knowledge, skills, judgment, teamwork, etc.).

PASS was created with the goal of improving the value of operative performance evaluation data by optimizing compliance and increasing overall data collection. In our series there was 92% compliance with faculty completing evaluations for all operative procedures they performed with residents. In focus group discussions we found that most of the non-compliance encountered was related to faculty misconceptions about medico-legal issues associated with using PASS. Additional studies will be needed to determine if comparable compliance can be achieved at other centers and whether this compliance is sustainable over time. We believe that both the high compliance and timely responses demonstrated with the PASS system provide a major advantage for evaluating operative autonomy. In our series the median response time was less than two hours and 77% of evaluations were completed in less than 48 hours. While these results seem quite respectable we believe that, given how easy PASS is to use, that they should actually be much better. In retrospective study group analyses the majority of delays in response time correlated with periods where technical glitches encountered with the PASS system precluded timely responses. While technical problems may continue to be an issue with PASS, they will likely be reduced in the future as experience with this system increases. This timely compliance seen with PASS greatly enhances the value of the evaluation data by providing data more representative of residents’ overall operative. Timely completion of evaluations helps to reduce inaccuracies and biases in evaluation of operative performances (34-36). Ongoing collection of data pertaining to all or most of a resident’s operative experiences creates a dynamic and accessible pool of
data that can be used to monitor their progression toward operative autonomy, allow comparisons with other residents and guide remediation efforts.

Given the recent concerns raised about residents’ not being able to operate independently by the end of their training (1,8,10,11,13), autonomy is arguably the single-most critical parameter to monitor. However, concerns regarding using operative autonomy as a primary focus for surgical education have been raised. Some feel that this parameter does not correlate with surgical performance as there will be variability amongst surgical faculty members regarding the threshold criteria they use for granting additional autonomy to their residents. While additional studies may be required to better define the correlation between operative autonomy and operative performance, in our series there was strong correlation between the Zwisch scale and interoperative performance items from other validated OR assessment instruments (37) (Figure 1: Zwisch scale of progressive autonomy). Nevertheless, we have considered adding a single global performance evaluation parameter to our PASS system so that we can collect ongoing data to see if the performance evaluation levels assigned consistently correlate with the level of autonomy achieved.

Surgical faculty members are highly unlikely to let a resident perform an entire operative procedure independently if they believe the resident’s individual operative knowledge, skills and attitudes are inadequate. Conversely, for the reasons previously addressed, surgical faculty members may be more likely to hold a resident back from performing an operation with autonomy. With PASS, faculty behaviors can also be monitored by comparing autonomy levels achieved by individual residents or by PGY level cohorts performing the same procedure with different surgical faculty, i.e. if a resident is achieving “supervision only” with all but a few faculty members, the operative teaching behaviors of those aberrant faculty members will need to be reviewed.

We believe PASS may provide some additional benefits to surgical training. Because of its focus on operative autonomy we believe PASS may influence behaviors and interactions in the operating room
between the surgeons and residents as both parties seek to develop strategies that will help the resident progress towards greater autonomy with essential procedures. Since faculty will receive a text prompt with every procedure they perform, they will constantly be reminded of the need for resident progression towards operative autonomy with essential procedures. This may serve to change the dynamics in the operating room and increase their focus on accelerating the progression towards operative autonomy with their residents.

Clearly surgery is evolving and general surgery is now less clearly defined than it once was. With increasing and earlier sub-specialization redefining the realm of general surgery, the procedures for which surgical trainees need to achieve full operative autonomy may need to become more individualized for surgical trainees based on their specific sub-specialty training agendas and ultimate career goals.

This study has several limitations. PASS asks raters to score just two items, Zwisch level and case complexity. We used ACGME case log and the resident PGY data to supplement the prospectively collected data. However, there are multiple other possible confounders (time pressures, institutional cultures, etc.) that can influence how much guidance faculty actually provide. We did not measure those confounders given our focus on feasibility which, with increasing system complexity, would necessarily be compromised. Raters were not blinded to the PGY of each resident, knowledge which may have independently biased their Zwisch rating. This limitation could be addressed in future studies by using in-person and video raters who do not know the residents. We also plan to further investigate rater bias in future studies by asking residents to also use Zwisch to assess faculty guidance and evaluate the degree of correlation between faculty and resident Zwisch scores for the same procedure. In addition, these results represent the experience of a single institution. The case mix, the culture around teaching and resident operative autonomy, resident innate abilities, and faculty willingness to complete resident performance assessments may not be generalizable to other surgical training programs. Finally,
all of the statistical methods used assume independent observations while Zwisch scores data are cross-classified since they include scores provided by multiple raters, on multiple learners performing multiple procedures. This is related to the fact that all data collected was de-identified and therefore analyses could not be linked to individual learners or raters. While we have demonstrated significant inter-rater reliability with using the Zwisch scale using our baseline frame of reference training and our subsequent multi-rater analyses of videotaped procedural experiences, the bulk of our data has not been analyzed to control for the potential variability this scenario creates. We fully intend to address this in future studies using this system.

In addition to study limitations, we identified several barriers to the use of PASS outside the study environment. First, the technical aspects of setting up and maintaining PASS to achieve the functionality described here are complex and require involvement by individuals with experience in software development and database management. Second, while both high and timely compliance with completing evaluations were demonstrated in this study it is possible that this compliance could wane with time outside of a formal study. Finally, the Zwisch scale does not assess specific individual aspects of operative performance. We are actively working to address this situation in the next version of our software by providing a dictation feature which will enable faculty to provide specific verbal (formative) feedback for the resident in a manner that is quick and intuitive. This dictated feedback would be immediately accessible to the resident. Another option is to supplement PASS with selective utilization of other more complex assessment instruments (e.g. OPRS and O-SCORE) which will help to “drill down” on residents who are performance outliers.

A critical goal of surgical training is to develop trainees into surgeons who can independently perform surgical procedures safely and effectively. We believe this can best be achieved by focusing on operative autonomy with essential procedures as a primary goal for trainees, monitoring their
progression towards that goal, and developing strategies to enhance that progression. We believe PASS will be very effective in facilitating these goals.
TABLE 1 – SPEARMAN’S CORRELATIONS

Spearman’s correlations between Zwisch ratings assigned by the operating surgeon and individual Operative Performance Rating System (OPRS) and Ottawa Surgical Competency Operating Room Evaluation (O-SCORE) item scores determined by blinded faculty video raters.

<table>
<thead>
<tr>
<th>Item</th>
<th>P</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operative Performance Rating System (OPRS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree of prompting or direction</td>
<td>-.92</td>
<td>.001</td>
</tr>
<tr>
<td>Instrument handling</td>
<td>.94</td>
<td>.005</td>
</tr>
<tr>
<td>Respect for tissue</td>
<td>.94</td>
<td>.005</td>
</tr>
<tr>
<td>Time and motion</td>
<td>.94</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Operation flow</td>
<td>.95</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Overall performance</td>
<td>.95</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Ottawa Surgical Competency OR Evaluation (O-SCORE)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge of procedural steps</td>
<td>.94</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Technical performance</td>
<td>.93</td>
<td>.001</td>
</tr>
<tr>
<td>Visuospatial skills</td>
<td>.92</td>
<td>.001</td>
</tr>
<tr>
<td>Efficiency and flow</td>
<td>.86</td>
<td>.007</td>
</tr>
<tr>
<td>Communication</td>
<td>.92</td>
<td>.001</td>
</tr>
</tbody>
</table>
### TABLE 2 – PROCEDURE REPORT

<table>
<thead>
<tr>
<th>Primary Procedure</th>
<th>Baseline Period 12/1/11-6/30/12</th>
<th>Study Period 12/1/12-6/30/13</th>
<th>P value</th>
<th>Bonferroni Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#s</td>
<td>OR times (min) Mean± SD</td>
<td>#s</td>
<td>OR times (min) Mean± SD</td>
</tr>
<tr>
<td>Appendectomy Laparoscopic</td>
<td>135</td>
<td>48±27</td>
<td>170</td>
<td>52±32</td>
</tr>
<tr>
<td>Appendectomy Open</td>
<td>22</td>
<td>46±20</td>
<td>18</td>
<td>45±17</td>
</tr>
<tr>
<td>Banding Gastric Laparoscopic</td>
<td>20</td>
<td>66±22</td>
<td>9</td>
<td>74±34</td>
</tr>
<tr>
<td>Cholecystectomy Laparoscopic (General)</td>
<td>176</td>
<td>85±43</td>
<td>199</td>
<td>84±43</td>
</tr>
<tr>
<td>Cholecystectomy Laparoscopic (Olson)</td>
<td>111</td>
<td>65±28</td>
<td>106</td>
<td>62±23</td>
</tr>
<tr>
<td>Closure Ileostomy Loop</td>
<td>35</td>
<td>89±63</td>
<td>32</td>
<td>100±58</td>
</tr>
<tr>
<td>Excision Abdomen Melanoma</td>
<td>3</td>
<td>68±49</td>
<td>4</td>
<td>99±50</td>
</tr>
<tr>
<td>Excision Arm Melanoma</td>
<td>14</td>
<td>95±78</td>
<td>19</td>
<td>55±26</td>
</tr>
<tr>
<td>Excision Chest Melanoma</td>
<td>25</td>
<td>64±42</td>
<td>28</td>
<td>72±43</td>
</tr>
<tr>
<td>Excision Face Melanoma</td>
<td>13</td>
<td>101±73</td>
<td>21</td>
<td>96±55</td>
</tr>
<tr>
<td>Excision Leg Melanoma</td>
<td>10</td>
<td>58±25</td>
<td>15</td>
<td>74±52</td>
</tr>
<tr>
<td>Gastrectomy Laparoscopic</td>
<td>5</td>
<td>111±45</td>
<td>10</td>
<td>111±66</td>
</tr>
<tr>
<td>Gastrectomy Open</td>
<td>8</td>
<td>198±58</td>
<td>12</td>
<td>150±73</td>
</tr>
<tr>
<td>Gastrectomy Sleeve Laparoscopic</td>
<td>56</td>
<td>96±22</td>
<td>70</td>
<td>98±47</td>
</tr>
<tr>
<td>Heller Myotomy Laparoscopic</td>
<td>15</td>
<td>163±77</td>
<td>11</td>
<td>167±58</td>
</tr>
<tr>
<td>Hemicolecetomy Left Laparoscopic</td>
<td>32</td>
<td>168±70</td>
<td>40</td>
<td>205±75</td>
</tr>
<tr>
<td>Hemicolecetomy Left Open</td>
<td>48</td>
<td>193±106</td>
<td>25</td>
<td>168±90</td>
</tr>
<tr>
<td>Hemicolecetomy Right Laparoscopic</td>
<td>43</td>
<td>139±83</td>
<td>41</td>
<td>132±42</td>
</tr>
<tr>
<td>Hemicolecetomy Right Open</td>
<td>57</td>
<td>154±113</td>
<td>22</td>
<td>133±57</td>
</tr>
<tr>
<td>Hemorrhoidectomy (General)</td>
<td>42</td>
<td>28±22</td>
<td>59</td>
<td>28±23</td>
</tr>
<tr>
<td>Hemorrhoidectomy (Olson)</td>
<td>55</td>
<td>21±14</td>
<td>92</td>
<td>24±18</td>
</tr>
<tr>
<td>Herniorrhaphy Inguinal Laparoscopic (General)</td>
<td>17</td>
<td>66±43</td>
<td>21</td>
<td>60±25</td>
</tr>
<tr>
<td>Herniorrhaphy Inguinal Laparoscopic (Olson)</td>
<td>15</td>
<td>61±20</td>
<td>43</td>
<td>59±26</td>
</tr>
<tr>
<td>Herniorrhaphy Inguinal Open (General)</td>
<td>65</td>
<td>74±34</td>
<td>96</td>
<td>78±45</td>
</tr>
<tr>
<td>Herniorrhaphy Inguinal Open (Olson)</td>
<td>127</td>
<td>70±22</td>
<td>104</td>
<td>63±24</td>
</tr>
<tr>
<td>Herniorrhaphy Umbilical (General)</td>
<td>21</td>
<td>51±25</td>
<td>27</td>
<td>66±40</td>
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<tr>
<td>Herniorrhaphy Umbilical (Olson)</td>
<td>39</td>
<td>45±22</td>
<td>40</td>
<td>48±28</td>
</tr>
<tr>
<td>Herniorrhaphy Ventral Laparoscopic (General)</td>
<td>25</td>
<td>109±43</td>
<td>19</td>
<td>100±43</td>
</tr>
<tr>
<td>Herniorrhaphy Ventral Laparoscopic (Olson)</td>
<td>16</td>
<td>73±24</td>
<td>14</td>
<td>52±18</td>
</tr>
<tr>
<td>Herniorrhaphy Ventral Open (General)</td>
<td>12</td>
<td>94±40</td>
<td>29</td>
<td>89±63</td>
</tr>
<tr>
<td>Herniorrhaphy Ventral Open (Olson)</td>
<td>15</td>
<td>72±45</td>
<td>18</td>
<td>52±26</td>
</tr>
<tr>
<td>I&amp;D Peri-Rectal Abscess</td>
<td>12</td>
<td>26±14</td>
<td>30</td>
<td>34±27</td>
</tr>
<tr>
<td>Nissen Fundoplication Laparoscopic</td>
<td>40</td>
<td>136±66</td>
<td>37</td>
<td>132±41</td>
</tr>
<tr>
<td>Pancreatectomy Splenectomy Laparoscopic</td>
<td>10</td>
<td>196±63</td>
<td>7</td>
<td>184±113</td>
</tr>
<tr>
<td>Parathyroidectomy</td>
<td>23</td>
<td>113±48</td>
<td>31</td>
<td>107±58</td>
</tr>
<tr>
<td>Proctocolectomy Ileo-Anal Anastomosis Open</td>
<td>11</td>
<td>195±73</td>
<td>13</td>
<td>202±130</td>
</tr>
<tr>
<td>Resection Low Anterior Open</td>
<td>6</td>
<td>192±118</td>
<td>3</td>
<td>202±135</td>
</tr>
<tr>
<td>Thyroidectomy</td>
<td>58</td>
<td>198±98</td>
<td>48</td>
<td>188±89</td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>13</td>
<td>73±64</td>
<td>9</td>
<td>51±29</td>
</tr>
<tr>
<td>Whipple Open</td>
<td>35</td>
<td>252±133</td>
<td>20</td>
<td>298±126</td>
</tr>
</tbody>
</table>
**TABLE 3A - FACULTY OREEM RESULTS: 2012 VS. 2013**

SA: strongly agree = 4  
A: agree = 3  
U: unsure = 2  
D: disagree = 1  
SD: strongly disagree = 0

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2013</th>
<th>p-value</th>
<th>Statistical significance after application of Bonferroni correction (p&lt;.001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>My resident and I got along well.</td>
<td>3.8 ± .4</td>
<td>3.5 ± .5</td>
<td>.01</td>
<td>NS</td>
</tr>
<tr>
<td>My resident was enthusiastic about learning</td>
<td>3.3 ± .8</td>
<td>3.2 ± .6</td>
<td>.79</td>
<td>NS</td>
</tr>
<tr>
<td>I had a genuine interest in my resident's progress.</td>
<td>3.6 ± .5</td>
<td>3.4 ± .5</td>
<td>.20</td>
<td>NS</td>
</tr>
<tr>
<td>My resident understood what I was trying to teach him or her.</td>
<td>3.4 ± .6</td>
<td>3.1 ± .7</td>
<td>.13</td>
<td>NS</td>
</tr>
<tr>
<td>I gave my resident time to practice their surgical skills in the operating room.</td>
<td>2.8 ± 1.3</td>
<td>2.9 ± 1.1</td>
<td>.61</td>
<td>NS</td>
</tr>
<tr>
<td>When the resident did not perform well I took over the procedure.</td>
<td>2.8 ± 1.3</td>
<td>3.1 ± 1</td>
<td>.38</td>
<td>NS</td>
</tr>
<tr>
<td>Before the operation, my resident and I discussed the planned procedure.</td>
<td>2.6 ± 1.3</td>
<td>2.5 ± 1</td>
<td>.75</td>
<td>NS</td>
</tr>
<tr>
<td>Before the operation, my resident and I discussed what part of the procedure he or she would perform.</td>
<td>1.6 ± 1.2</td>
<td>1.8 ± .9</td>
<td>.54</td>
<td>NS</td>
</tr>
<tr>
<td>I expected my resident’s surgical skills would be better than they actually were.</td>
<td>1.3 ± 1</td>
<td>2 ± 1</td>
<td>.03</td>
<td>NS</td>
</tr>
<tr>
<td>I gave my resident feedback on their performance.</td>
<td>3 ± .9</td>
<td>2.8 ± .9</td>
<td>.46</td>
<td>NS</td>
</tr>
<tr>
<td>My feedback was constructive.</td>
<td>2.9 ± .7</td>
<td>3 ± .6</td>
<td>.73</td>
<td>NS</td>
</tr>
<tr>
<td>The atmosphere in the operating room was pleasant.</td>
<td>3.8 ± .4</td>
<td>3.4 ± .5</td>
<td>.01</td>
<td>NS</td>
</tr>
<tr>
<td>My resident was too slow for me to let them operate.</td>
<td>0.9 ± 0.8</td>
<td>1.5 ± 1.2</td>
<td>.05</td>
<td>NS</td>
</tr>
<tr>
<td>In the operating room I had to correct my resident often</td>
<td>1.9 ± 1.1</td>
<td>1.6 ± 1.1</td>
<td>.47</td>
<td>NS</td>
</tr>
<tr>
<td>The anesthesiologist put pressure me to operate myself to reduce anesthetic time.</td>
<td>0.5 ± 0.9</td>
<td>0.7 ± 0.7</td>
<td>.44</td>
<td>NS</td>
</tr>
<tr>
<td>The staff in the operating room was friendly to my resident.</td>
<td>3.5 ± 0.7</td>
<td>3.2 ± 0.8</td>
<td>.11</td>
<td>NS</td>
</tr>
<tr>
<td>My resident felt like part of a team in the operating room.</td>
<td>3.6 ± 0.6</td>
<td>3.2 ± 0.6</td>
<td>.04</td>
<td>NS</td>
</tr>
<tr>
<td>My resident was so stressed in the operating room that they did not learn as much as they could have.</td>
<td>0.8 ± 1</td>
<td>1.1 ± 0.9</td>
<td>.26</td>
<td>NS</td>
</tr>
<tr>
<td>When my resident was in the operating room there was nobody to cover the service.</td>
<td>1.4 ± 1.1</td>
<td>1.4 ± 1.2</td>
<td>.99</td>
<td>NS</td>
</tr>
<tr>
<td>The level of supervision I provided in the operating room was adequate for my resident's level.</td>
<td>3.5 ± 0.6</td>
<td>3.1 ± 0.6</td>
<td>.02</td>
<td>NS</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>The operations performed on my rotation were generally too complex for the resident(s) I was assigned.</td>
<td>1.7 ± 1.1</td>
<td>1.7 ± 1.1</td>
<td>.91</td>
<td>NS</td>
</tr>
<tr>
<td>The elective operating room case list had an appropriate mix of cases to suit my resident(s).</td>
<td>3 ± 0.7</td>
<td>2.6 ± 0.9</td>
<td>.13</td>
<td>NS</td>
</tr>
<tr>
<td>My resident(s) had plenty of opportunity to assist.</td>
<td>3.5 ± 0.5</td>
<td>3.1 ± 0.9</td>
<td>.09</td>
<td>NS</td>
</tr>
<tr>
<td>There were enough operating room days per week for my resident(s) to gain the appropriate experience.</td>
<td>3.5 ± 0.6</td>
<td>3.1 ± 0.9</td>
<td>.09</td>
<td>NS</td>
</tr>
<tr>
<td>Senior residents or fellows took away my resident(s) opportunities to operate.</td>
<td>1.1 ± 1</td>
<td>1.1 ± 1.2</td>
<td>.87</td>
<td>NS</td>
</tr>
<tr>
<td>The number of emergency procedures was sufficient for my resident(s) to gain adequate operative experience.</td>
<td>2.4 ± 1.3</td>
<td>1.9 ± 1.2</td>
<td>.18</td>
<td>NS</td>
</tr>
<tr>
<td>The variety of emergency cases gave my resident(s) appropriate exposure to emergency surgery.</td>
<td>2.6 ± 1.3</td>
<td>1.8 ± 1.1</td>
<td>.04</td>
<td>NS</td>
</tr>
<tr>
<td>My resident(s) missed out on operative experience because of restrictions on working hours.</td>
<td>2.1 ± 1.6</td>
<td>2 ± 1.4</td>
<td>.78</td>
<td>NS</td>
</tr>
<tr>
<td>My resident(s) had the opportunity to develop the skills required at their stage.</td>
<td>3.2 ± 0.6</td>
<td>2.9 ± 0.5</td>
<td>.06</td>
<td>NS</td>
</tr>
<tr>
<td>The nursing staff disliked when my resident(s) operated as the operations took longer.</td>
<td>1.1 ± 1</td>
<td>1.2 ± 0.9</td>
<td>.70</td>
<td>NS</td>
</tr>
<tr>
<td>My resident(s) was too busy doing other work to go to the operating room.</td>
<td>0.8 ± 0.9</td>
<td>1.1 ± 1</td>
<td>.28</td>
<td>NS</td>
</tr>
<tr>
<td>My resident(s) was/were often too tired to get the most out of teaching in the operating room.</td>
<td>0.5 ± 0.5</td>
<td>0.7 ± 0.7</td>
<td>.31</td>
<td>NS</td>
</tr>
<tr>
<td>My resident(s) was/were asked to perform operations alone that they did not feel competent at.</td>
<td>0.3 ± 0.5</td>
<td>0.6 ± 0.8</td>
<td>.16</td>
<td>NS</td>
</tr>
<tr>
<td>My resident(s) was/were paged during operations.</td>
<td>3.1 ± 0.9</td>
<td>3.2 ± 0.8</td>
<td>.92</td>
<td>NS</td>
</tr>
<tr>
<td>The operative cases were too long to facilitate a positive learning experience.</td>
<td>0.9 ± 0.7</td>
<td>1.1 ± 0.8</td>
<td>.45</td>
<td>NS</td>
</tr>
<tr>
<td><strong>TABLE 3B - RESIDENT OREEM RESULTS: 2012 VS. 2013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **SA**: strongly agree = 4  
**A**: agree = 3  
**U**: unsure = 2  
**D**: disagree = 1  
**SD**: strongly disagree = 0 |
<p>| | <strong>2012</strong> | <strong>2013</strong> | <strong>p-value</strong> | <strong>Statistical significance after application of Bonferroni correction (p&lt;.001)</strong> |
| My attending and I got along well. | $3.6 \pm 0.8$ | $3.6 \pm 0.6$ | $.82$ | NS |
| My attending was enthusiastic about teaching. | $3.3 \pm 0.7$ | $3.4 \pm 0.7$ | $.82$ | NS |
| My attending had a genuine interest in my progress. | $3.4 \pm 0.8$ | $3.2 \pm 0.8$ | $.43$ | NS |
| I understood what my attending was trying to teach me. | $3.4 \pm 0.6$ | $3.4 \pm 0.8$ | $.92$ | NS |
| My attending’s surgical skills were very good. | $3.5 \pm 0.6$ | $3.6 \pm 0.7$ | $.81$ | NS |
| My attending gave me time to practice my surgical skills in the operating room. | $3.2 \pm 1.2$ | $2.9 \pm 1.2$ | $.44$ | NS |
| My attending immediately took the instruments away when I did not perform well. | $1.5 \pm 0.9$ | $1.3 \pm 1.2$ | $.56$ | NS |
| Before the operation, my attending discussed the surgical technique planned. | $1.8 \pm 1.3$ | $1.8 \pm 1.2$ | $.10$ | NS |
| Before the operation, my attending discussed what part of the procedure I would perform. | $1.3 \pm 1.1$ | $1.3 \pm 1$ | $.88$ | NS |
| My attending expected my surgical skills to be as good as his/ hers. | $1.8 \pm 1.1$ | $1.2 \pm 0.8$ | $.07$ | NS |
| My attending gave me feedback on my performance. | $2.5 \pm 1.1$ | $2.3 \pm 1.2$ | $.69$ | NS |
| My attending’s feedback was constructive. | $2.8 \pm 0.9$ | $2.8 \pm 0.9$ | $.79$ | NS |
| My attending was in too much of a rush to let me operate. | $1.4 \pm 1$ | $1.4 \pm 1$ | $.83$ | NS |
| The atmosphere in the operating room was pleasant. | $3.2 \pm 0.8$ | $3.3 \pm 0.6$ | $.67$ | NS |
| In the operating room, I was corrected in front of medical students, nurses, and/or other residents in an unprofessional manner. | $0.9 \pm 0.7$ | $0.5 \pm 0.8$ | $.09$ | NS |
| The anesthesiologist put pressure on my attending to operate him/herself to reduce anesthetic time. | $0.7 \pm 0.7$ | $0.5 \pm 0.5$ | $.43$ | NS |
| The staff in the operating room was friendly. | $3.3 \pm 0.7$ | $3.6 \pm 0.5$ | $.11$ | NS |
| I felt part of a team in the operating room. | $3.3 \pm 0.8$ | $3.7 \pm 0.6$ | $.12$ | NS |
| I was so stressed in the operating room that I did not learn as much as I could have. | $1.2 \pm 1$ | $0.9 \pm 0.7$ | $.29$ | NS |
| When I was in the operating room there was nobody to cover the service. | $1.4 \pm 1.3$ | $1.5 \pm 1.3$ | $.85$ | NS |
| The level of supervision my attending provided in the operating was adequate for my level | $2.9 \pm 0.6$ | $3.2 \pm 0.9$ | $.32$ | NS |
| The operations performed on this rotation were generally too complex for my level. | $1.2 \pm 0.8$ | $1.3 \pm 1.1$ | $.77$ | NS |</p>
<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean ± SD</th>
<th>t-Value</th>
<th>p-Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>The elective operating room case list had an appropriate mix of cases to suit my training.</td>
<td>2.7 ± 1</td>
<td>3.1 ± 1</td>
<td>.18</td>
<td>NS</td>
</tr>
<tr>
<td>I had plenty of opportunity to assist.</td>
<td>2.9 ± 0.8</td>
<td>3.1 ± 1</td>
<td>.60</td>
<td>NS</td>
</tr>
<tr>
<td>There were enough operating room days per week for me to gain the appropriate experience.</td>
<td>2.7 ± 1.2</td>
<td>3.2 ± 0.9</td>
<td>.22</td>
<td>NS</td>
</tr>
<tr>
<td>Senior residents or fellows took away my opportunities to operate.</td>
<td>1.5 ± 1.2</td>
<td>1.1 ± 1</td>
<td>.28</td>
<td>NS</td>
</tr>
<tr>
<td>The number of emergency procedures was sufficient for me to gain adequate operative experience.</td>
<td>2.3 ± 1.2</td>
<td>2.1 ± 0.9</td>
<td>.51</td>
<td>NS</td>
</tr>
<tr>
<td>The variety of emergency cases gave me appropriate exposure to emergency surgery.</td>
<td>1.7 ± 1.3</td>
<td>1.7 ± 1</td>
<td>.95</td>
<td>NS</td>
</tr>
<tr>
<td>I missed out on operative experience because of restrictions on working hours.</td>
<td>1.2 ± 1</td>
<td>1.1 ± 1.2</td>
<td>.74</td>
<td>NS</td>
</tr>
<tr>
<td>I had the opportunity to develop the skills required at my stage.</td>
<td>2.9 ± 0.8</td>
<td>2.8 ± 0.9</td>
<td>.59</td>
<td>NS</td>
</tr>
<tr>
<td>The nursing staff disliked when I operated as the operation took longer.</td>
<td>1.1 ± 0.9</td>
<td>1.2 ± 1.2</td>
<td>.79</td>
<td>NS</td>
</tr>
<tr>
<td>I was too busy doing other work to go to the operating room.</td>
<td>1.3 ± 1.3</td>
<td>1.3 ± 1.3</td>
<td>.93</td>
<td>NS</td>
</tr>
<tr>
<td>I was often too tired to get the most out of teaching in the operating room.</td>
<td>1.2 ± 0.8</td>
<td>1 ± 0.6</td>
<td>.35</td>
<td>NS</td>
</tr>
<tr>
<td>I was asked to perform operations alone that I did not feel competent at.</td>
<td>0.9 ± 0.9</td>
<td>0.6 ± 0.5</td>
<td>.16</td>
<td>NS</td>
</tr>
<tr>
<td>I was paged during operations.</td>
<td>3.3 ± 0.7</td>
<td>3.1 ± 0.7</td>
<td>.49</td>
<td>NS</td>
</tr>
<tr>
<td>The operative cases were too long to facilitate a positive learning experience.</td>
<td>0.8 ± 0.4</td>
<td>0.8 ± 0.4</td>
<td>.49</td>
<td>NS</td>
</tr>
</tbody>
</table>
Attending Name: 

Resident Name: 

Date: 

Operation: 

Procedural Difficulty: Compared to my entire previous experience with this procedure or, if my experience with this procedure is limited, compared to my overall procedural experience: In terms of difficulty/complexity, I would rank this procedure as among the: 

Easiest 1/3 ☐, middle 1/3 ☐, most difficult 1/3 ☐ 

Based on his/her performance in this operation, I view the resident as being in the: 

☐ SHOW AND TELL STAGE: Resident is in process of learning basics of operation (i.e. surgical anatomy, how to handle instruments and use equipment, steps of the operation, proper tissue planes, how to best position his/her body, etc.). Resident essentially observes and assists but may participate in some parts of the procedure such as opening and/or closing the incision. Attending “shows” resident how procedure is done and “tells” resident what needs to be known.

☐ ACTIVE HELP STAGE: Resident begins to assume the “surgeon” role in some parts of the operation with attending inserting him/herself as needed including swapping “surgeon” and “assistant” roles with the resident periodically. For parts of the case where resident assumes the surgeon role, the attending “actively” assists, essentially guiding the resident through the operation (i.e. smart help).

☐ PASSIVE HELP STAGE: Although some floundering, the resident is capable of safely doing significant parts of the procedure without active guidance/intervention from attending as long as the attending is providing passive assistance. However, the resident struggles with parts of the procedure when the attending (or an equally skilled assistant) is not the first assistant.

☐ SUPERVISION ONLY STAGE: The resident safely and fluidly performs the operation and can effectively incorporate OR staff or a junior resident as a first assistant. The attending does not need to scrub in and is present in the OR to provide supervision and consultation if needed.

The Zwisch scale for progressive procedural autonomy with essential information for data collection, definition of procedural difficulty levels, and descriptive anchors for each Zwisch level.

Figure 1: Zwisch scale of progressive autonomy
Diagram of the work flow of basic steps involved in using PASS to assess a trainee's procedural performance.

**Figure 2: PASS Workflow**
Figure 3 (ref. 37): Zwisch Levels by resident post-graduate year (PGY) for all residents for all operations.

Graphic representation of the overall distribution of Zwisch levels assigned to residents by surgical faculty based on their resident PGY level for all operative procedures performed by resident with surgical faculty.
Figure 4 (ref. 37): Zwisch levels by complexity for all residents for all operations.

Graphic representation of the overall distribution of Zwisch levels assigned by surgical faculty based on the level of procedural complexity for all operative procedures performed by resident with surgical faculty.
Figure 5 (ref. 37): Zwisch levels for all residents for all operations, grouped by the prior experience of the resident with the index rated procedure.

Graphic representation of the overall distribution of Zwisch levels assigned by surgical faculty based on residents' previous experience with the same procedure for all operative procedures performed by resident with surgical faculty.
APPENDICES

Addendum 1

Dear Jonathan,

Thank you for your e-mail.

As an Elsevier journal author, you retain various rights including inclusion of the article in a thesis or dissertation (provided that this is not to be published commercially) whether in part or in toto; see http://www.elsevier.com/about/company-information/policies/copyright#Author%20rights for more information. As this is a retained right, no written permission is necessary provided that proper acknowledgement is given.

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Best Wishes,

Laura

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Permissions Helpdesk Associate
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F: (215) 239-3805
E: l.stingelin@elsevier.com
Addendum 2

Institutional Review Board Office
Northwestern University

Biomedical IRB
750 North Lake Shore Drive
Suite 700
Chicago, Illinois 60611
312-503-9338

Social and Behavioral Sciences IRB
600 Foster Street
Chambers Hall, Second Floor
Evanston, Illinois 60208
847-467-1723

11/7/2014

Dr. Debra DaRosa
Surgery
ddarosa@nmh.org

IRB Project Number: CR3_STU00051694
Project Title: Operating Room Resident Supervision Project
Project Sites:

Northwestern Memorial Hospital (NMH)

Sponsor Information (Grant #, if applicable):

View Northwestern Memorial Hospital

NMH EAM 238

Submission Considered: Continuing Review Submission Number: CR3_STU00051694
Submission Review Type: Expedited
Review Date (for Expedited Review): 11/7/2014


Dear Dr. DaRosa,

The IRB considered and approved your submission referenced above through 11/6/2015. As Principal Investigator (P.I.), you have ultimate responsibility for the conduct of this study, the ethical performance of the project, and the protection of the rights and welfare of human subjects. You are required to comply with all NU policies and procedures, as well as with all applicable Federal, State and local laws regarding the protection of human subjects in research including, but not limited to the following:

- Not changing the approved protocol or consent form without prior IRB approval (except in an emergency, if necessary, to safeguard the well-being of human subjects).
- Obtaining proper informed consent from human subjects or their legally responsible representative, using only the currently approved, stamped consent form.
- Promptly reporting unanticipated problems involving risks to subjects or others, or promptly reportable non-compliance in accordance with IRB guidelines.
- Submit a continuing review application 45 days prior to the expiration of IRB approval. If IRB re-approval is not obtained by the end of the approval period indicated above, all research related activities must stop and no new subjects may be enrolled.

IRB approval includes the following:

**Written Consent Form/Consent Form and Authorization for Research:**

Name

ICF revised v.10.19.12.doc

**Protocol:**

Name

Operating Room Resident Supervision Project Protocol 11-8-2012.docx

**Survey/Questionnaires:**

Name

mental imagery questionnaire.pdf

OR environment survey

For more information regarding IRB Office submissions and guidelines, please consult http://irb.northwestern.edu. This Institution has an approved Federalwide Assurance with the Department of Health and Human Services: FWA00001549.
Addendum 3

University of Illinois
at Chicago

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Approval Notice

Continuing Review (Response To Modifications)

May 20, 2015

Jonathan Fryer, MD, Surgery
676 N. St. Clair Street, Suite 1900
Chicago, IL 60611
Phone: (312) 695-9194

RE: Protocol # 2012-0462

“Improving Intraoperative Teaching and Assessment (a Substudy of Validity Evidence for a Competency Based Resident OR Instruction and Assessment System)”

Dear Dr. Fryer:

Your Continuing Review (Response To Modifications) was reviewed and approved by the Expedited review process on May 19, 2015. You may now continue your research. Please note the following information about your approved research protocol:


Approved Subject Enrollment #: 50 (31 @ Northwestern, 0 @ UIC)

Additional Determinations for Research Involving Minors: These determinations have not been made for this study since it has not been approved for enrollment of minors.

Performance Sites: UIC, Northwestern University

Sponsor: Augusta Webster Grant Fund

PAF#: Not available

Grant/Contract No: Not available

Grant/Contract Title: Not available
Research Protocol(s):

a) MHPÈ Thesis Proposal: Improving Intraoperative Teaching and Assessment, version date 04/03/12

Recruitment Material(s):

a) None

Informed Consent(s):

a) Informed Consent will be obtained at the performance site, Northwestern University
Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific category:

(7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Please note the Review History of this submission:

<table>
<thead>
<tr>
<th>Receipt Date</th>
<th>Submission Type</th>
<th>Review Process</th>
<th>Review Date</th>
<th>Review Action</th>
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<tr>
<td>05/01/2015</td>
<td>Continuing Review</td>
<td>Expedited</td>
<td>05/07/2015</td>
<td>Modifications Required</td>
</tr>
<tr>
<td>05/13/2015</td>
<td>Response To Modifications</td>
<td>Expedited</td>
<td>05/19/2015</td>
<td>Approved</td>
</tr>
</tbody>
</table>

Please remember to:

⇒ Use your research protocol number (2012-0462) on any documents or correspondence with the IRB concerning your research protocol.
⇒ Review and comply with all requirements on the enclosure,

"UIC Investigator Responsibilities, Protection of Human Research Subjects"
(http://trigger.uic.edu/depts/ovcr/research/protocolreview/irb/policies/0924.pdf)

Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.
We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 413-1835. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,
Jonathan W. Leigh, MPH
IRB Coordinator, IRB # 1
Office for the Protection of Research Subjects

cc: Enrico Benedetti, Surgery, M/C 958
    Alan Schwartz, Faculty Sponsor, M/C 591
    OVCR Administration, M/C 672
REFERENCES


CURRICULUM VITAE
JONATHAN PAUL FRYER, M.D., M.Sc., FACS, FRCSC

1. PERSONAL INFORMATION

Professor of Surgery
Program Director, General Surgery
Vice Chair of Education
Feinberg School of Medicine, Northwestern University
Director, Intestinal Transplantation,
Director, Liver Transplantation
Northwestern Memorial Hospital

Office: Division of Organ Transplantation
Feinberg School of Medicine
Northwestern University
676 North St. Clair Street, Suite 1900
Chicago, Illinois, 60611-2923
Tel. (312) 695-2125
Fax. (312) 695-9194
E-mail: jfryer@nmh.org

Date of Birth: January 10, 1959
Citizenship Status: US Citizen
Married: Sonya Sharpless
Children: Conor Fryer

2. EDUCATION:

1979 - 1981 Faculty of Science (pre-med)
University of Manitoba, Winnipeg, Manitoba, Canada

1981 - 1985 Faculty of Medicine (MD)
University of Manitoba, Winnipeg, Manitoba, Canada

1990 – 1992 Master of Science Degree (Surgery)
University of Manitoba, Winnipeg, Manitoba, Canada
Thesis: In vitro and in vivo assessment of rapamycin as an
immunosuppressive agent in the rabbit

2008 - present Master’s Degree Program in Health Professional Education
University of Illinois, Chicago, Illinois (in progress)
(successfully defended thesis – 8/25/15)
3. GRADUATE MEDICAL EDUCATION:

1985 - 1986   Mixed Surgical Internship, Manitoba Affiliated Teaching Hospitals
              University of Manitoba, Winnipeg, Manitoba, Canada

1986 - 1991   General Surgery Residency, Manitoba Affiliated Teaching Hospitals
              University of Manitoba, Winnipeg, Manitoba, Canada

1993 – 1994   Clinical Fellowship, Transplant Surgery
              University of Minnesota, Minneapolis, Minnesota

1994 – 1995   Extended Clinical/Research Fellowship, Transplant Surgery
              University of Western Ontario, London, Ontario, Canada

4. POSTDOCTORAL RESEARCH TRAINING:

1990 - 1992   Research Fellowship
              University of Manitoba, Winnipeg, Manitoba, Canada
              Thesis: In vitro and in vivo assessment of Rapamycin as an
              Immunosuppressive agent in the rabbit

1992 - 1993   Research Fellowship
              University of Minnesota, Minneapolis, Minnesota

1994 – 1995   Extended Clinical/Research Fellowship, Transplant Surgery
              University of Western Ontario, London, Ontario, Canada

5. BOARD CERTIFICATION & MEDICAL LICENSURE:

College of Physicians and Surgeons of Manitoba  (educational)  1985 - 1986
              (residents)  1986 - 1990
              (full)      1991 - 1992
Minnesota Board of Medical Practice
              (medicine and surgery)  1993 - 1994
College of Physicians and Surgeons of Ontario  (educational)  1994
              (full)      1994 - 1995
Illinois Department of Professional Regulation
              (full)      1995 - present
American Board of Surgery: Board Certified (General Surgery)  #37544  1992
American Board of Surgery: Recertification (General Surgery)  2002 & 2012
The Royal College of Physicians and Surgeons of Canada (General Surgery)  1991 - present
Indiana Medical Licensing Board, #01064951A  (full)  2008
6. MILITARY SERVICE

Not Applicable.

7. FACULTY APPOINTMENTS:

February-June 1992  Lecturer, Faculty of Medicine, University of Manitoba, Winnipeg, Manitoba, Canada

1995 - 2005  Assistant Professor of Surgery Department of Surgery, Division of Organ Transplantation Feinberg School of Medicine, Northwestern University, Chicago, Illinois

2005- 2012  Associate Professor of Surgery Department of Surgery, Division of Organ Transplantation Feinberg School of Medicine, Northwestern University, Chicago, Illinois

2012- present  Professor of Surgery Department of Surgery, Division of Organ Transplantation Feinberg School of Medicine, Northwestern University, Chicago, Illinois

8. HOSPITAL STAFF APPOINTMENTS:

February-June 1992  Health Science Center, Winnipeg, Manitoba, Canada
1995-present  Northwestern Memorial Hospital, Chicago, Illinois
1996-present  Ann & Robert H. Lurie Children’s Hospital, Chicago, Illinois
2011-present  Northwestern Lake Forest Hospital, Lake Forest, Illinois

9. ADMINISTRATIVE APPOINTMENTS:

1995 - present  Director, Intestinal Rehabilitation and Transplantation Program Northwestern Memorial Hospital, Chicago, Illinois
2004 – 2007  Clinical Practice Director, Division of Organ Transplantation Northwestern Memorial Hospital, Chicago, Illinois
2007 – 2011  Associate Director of Liver Transplantation Northwestern Memorial Hospital, Chicago, Illinois
2007 – 2011  Associate Program Director (Curriculum), Department of Surgery, Feinberg School of Medicine, Northwestern University
2011 – 2014
Program Director, Department of Surgery,
Feinberg School of Medicine, Northwestern University

2011 – present
Surgical Director of Liver Transplantation
Northwestern Memorial Hospital, Chicago, Illinois

2014 – present
Vice Chair of Education, Department of Surgery,
Feinberg School of Medicine, Northwestern University

10. COMMITTEE SERVICE:

1995 – present
Liver and Intestinal Subcommittee, Regional Organ Bank of Illinois
1995 – present
Region 7 Representative, United Network for Organ Sharing (UNOS) -
1996 – present
Medical Advisory Board, National Kidney Foundation of Illinois, Inc.
1996
Biomedical Engineering Institute Planning Committee, Feinberg School of Medicine, Northwestern University
1996 – present
Medical Students Research Committee, Feinberg School of Medicine,
Northwestern University
1997 – present
Director of Grand Rounds, Department of Surgery, Northwestern Memorial Hospital
1995 – present
Research Subcommittee, Regional Organ Bank of Illinois/Gift of Hope
1998 – 2000
Chair, Surgery Utilization Management Subcommittee, Northwestern Memorial Hospital
1998 – 2002
Data and Informatics Committee, American Society of Transplant Surgeons
2000 – 2007
Infection Control Committee, Northwestern Memorial Hospital
2002
Institutional Review Board, Northwestern University
2004 – 2006
Newsletter Committee, American Society of Transplant Surgeons
2005 – 2010
Committee for the Workforce, American Society of Transplant Surgeons
2005 – 2010
Co-chair, Curriculum Committee, American Society of Transplant Surgeons
2006 – 2009
Fellowship Training Committee, American Society of Transplant Surgeons
2006 – 2010
Liver/Intestine Committee, American Society of Transplantation
2008 – present
Postgraduate Education Committee, Association of Surgical Education
2010 – 2013
Chair, Curriculum Committee, American Society of Transplant Surgeons
2012 –
NIH Study Section, “Clinical Trials in Organ Transplantation in Children”
2012
American Board of Surgery, Qualifying Exam Consultant
2013 – present
ASTS Educational Executive Committee
2013 – present
ASTS Exam Development Task Force
2014
Northwestern University LCME Quality Improvement Committee
2014
NMH Laboratory Executive Committee
11. AWARDS, HONORS, DISTINCTIONS:

1979 – 1981  Dean's Honor List, University of Manitoba, Winnipeg, Manitoba  
December 1990  American College of Surgeons: Manitoba Chapter Meeting - Scientific Paper Competition: Third Place  
December 1991  American College of Surgeons: Manitoba Chapter Meeting - Scientific Paper Competition: Third Place  
1994  American Society of Transplant Surgeons: Upjohn Award  
2004  Excellence in Teaching Award, Department of Surgery  
Feinberg School of Medicine, Northwestern University, Chicago, Illinois  
2005  Excellence in Teaching Award, Department of Surgery  
Feinberg School of Medicine, Northwestern University, Chicago, Illinois  
2006  Excellence in Teaching Award, Department of Surgery  
Feinberg School of Medicine, Northwestern University, Chicago, Illinois  
2007  Excellence in Teaching Award, Department of Surgery  
Feinberg School of Medicine, Northwestern University, Chicago, Illinois  
2007  Vincent J. O'Connor, Jr. Award for Excellence in Teaching, Department of Urology, Feinberg School of Medicine, Northwestern University, Chicago, Illinois  
2010  Excellence in Teaching Award, Department of Surgery  
Feinberg School of Medicine, Northwestern University, Chicago, Illinois

12. PROFESSIONAL SOCIETY MEMBERSHIPS

1996 - American Association for the Advancement of Science  
1996 - American Association for the Study of Liver Diseases  
1995 - American College of Surgeons - Fellow  
1996 - American Society of Transplant Surgeons  
1996 - American Society for Parenteral and Enteral Nutrition  
1997 - Association for Academic Surgery  
1992 - Canadian Association of General Surgeons  
1996 - Chicago Society for Gastroenterology  
1999 - Chicago Surgical Society  
1995 - National Kidney Foundation of Illinois  
1992 - Royal College of Surgeons of Canada - Fellow  
1996 - Society for Surgery of the Alimentary Tract  
1996 - Transplantation Society  
1998 - International Xenotransplantation Association  
2001 - American Gastroenterological Association  
2001 - American Association of Immunologists  
2005 - Association of Surgical Education  
2006 - American Society of Transplantation  
2007 - Central Surgical Association  
2011 - Association of Program Directors in Surgery  
2014 - American Medical Association
13. OTHER PROFESSIONAL AND SCIENTIFIC ACTIVITY:

1998 - The 5th International Congress for Xenotransplantation – Member Advisory Committee
1999 - 2001 American Society of Transplant Surgeons – Data and Informatics Subcommittee
2001 - Co-chair – 6th International Xenotransplantation Association Congress
2001- Xenotransplantation – Editorial Board
2003 - International Advisory Committee – 8th International Small Bowel Transplant Symposium
2005 - International Advisory Committee - 9th International Small Bowel Transplant Symposium
2006 - International Advisory Committee - 10th International Small Bowel Transplant Symposium
2008 - International Advisory Committee - 11th International Small Bowel Transplant Symposium

14. SPEAKER BOARD/CONSULTANT:

2005- 2009 Consultant, Coram Pharmaceuticals
2005 Speakers Board, Serono Pharmaceuticals

15. TEACHING / SURGICAL EDUCATION:

1995-present Interview and selection of Residency Candidates for the Department of Surgery
1995-present Mock oral examinations for Surgical Residents
1995-1997 Suture Sessions
1996-1999 Preceptor for 2nd year medical students for the Physical Diagnosis Unit
1995-present Teaching of Fellows, residents, and students assigned to Transplant Team
1995-present Teaching of GI/Liver fellow assigned to Transplant Team
1996-present Preceptor to high school students (4), undergrad/medical students (15), surgical residents (1), and postgrad fellows (2) in transplant research lab
1997-present Director, Surgical Grand Rounds, Northwestern University
2002- Clinical Teaching Scholars Program
2003- Team Education Coordinator – Division of Transplantation
2004 Excellence in Teaching Award, Department of Surgery, Northwestern University
2005 Excellence in Teaching Award, Department of Surgery, Northwestern University
2005-2006 Surgical Education Research Fellowship - Association of Surgical Education
2006 Excellence in Teaching Award, Department of Surgery
2006- ASTS - Fellowship Training Committee
2006- ASTS - Fellowship Curriculum development task force
2007 Excellence in Teaching Award, Department of Surgery
2007 Vincent J. O’Connor, Jr. Award for Excellence in Teaching, Department of Urology
2007-2011 Associate Program Director, General Surgery, Northwestern University
2008- ASE - Postgraduate Education Committee
2008- Masters in Health Professional Education (in progress)
2010 Chair, ASTS Curriculum Committee
2010 Examiner, American Board of Surgery Certifying Examination
2010 Excellence in Teaching Award, Department of Surgery
2011-2014 Program Director, General Surgery, Northwestern University
2014- present Vice Chair of Education, Northwestern University
16. RESEARCH GRANTS/CONTRACTS:

1991  Paul H.T. Thorlakson Foundation Research Grant ($10,000)

1991  Surgical Education and Research Fund Grant ($5,000)

1991  Surgical Education and Research Travel Fund Grant ($5,000)

1992  Kidney Foundation of Manitoba Grant ($2,500)

1996  Northwestern University Research Grants Committee ($5,000)  
"Development and Characterization of a Guinea Pig to Mouse Model of Discordant Xenograft Rejection"

1996  Northwestern Memorial Hospital Intramural Research Grants Program ($20,000)  
"Prevention of Hyperacute Rejection of a Pig to Human Cardiac Xenograft Using C1q Inhibitors"

1996  National Kidney Foundation of Illinois, Inc. ($13,134)  
"The Influence of High PRA Serum on Endothelial Cells"

1996  Northwestern Memorial Foundation Grant ($80,000)  
"Intestinal Transplantation Program"

1997  Principal Investigator. The Society of Surgery of the Alimentary Tract ($80,000)  
"Lymphocyte Trafficking in a Murine Model of Intestinal Transplantation"

1997  Principal Investigator, Nextrax Inc. ($463,841), “Optimization of an Ex Vivo Liver Perfusion System”.


1998  Principal Investigator, Nextrax Inc., “A Pilot Study to Evaluate the Safety of Extracorporeal Perfusion of Livers Harvested from Transgenic Swine in Patients with Severe Acute Hepatic Failure.

1997  Co-Investigator, Northwestern Memorial Hospital, Research Committee  
“Study of Infectivity of Porcine Endogenous Retrovirus for Humans: Implications for Xenotransplantation” ($20,000).

2004 Medical School Research grant for student Christopher Chow. ($3,000). "Role of NFkB in Altering Small Bowel Permeability During Rejection" under the mentorship of Drs. Jonathan Fryer and Jenny Zhang.


2006 Principal Investigator - Serono IMG ($60,400) "Influence of recombinant Human Growth Hormone (r-HGH) on intestinal permeability and liver injury in intestinal failure patients receiving parenteral nutrition".

2015 Principal Investigator – American Board of Surgery ($80,000) “Multicenter study of operative autonomy in general surgery residents using SIMPL (System for Improving and Measuring Procedural Learning)”.

17. SCHOLARLY PRODUCTIVITY:

A. Original, peer-reviewed reviewed research articles


B. Editorials, Invited Reviews, Book Chapters, Commentaries, Educational Websites


C. Case reports, Technical Notes, Letters

Not applicable.

D. Proceedings and Non-refereed Papers:


E. Software, world wide web-based publications, exhibits, audiovisual or other teaching material.

Not applicable.

F. Patents

Not applicable.

G. Published Abstracts


18. PRESENTATIONS

Invited Lectures/Visiting Professorships:

Educational Presentations at other Institutions

1. “Short Bowel Syndrome”. Surgical Grand Rounds. Mt. Sinai Hospital, Chicago, IL March 2001
3. “Short Bowel Syndrome” Medical Grand Rounds. Evanston Hospital, November 2001
4. “Short Bowel Syndrome” Surgical Nutrition Rounds. Cook County Hospital, May 2002


34. "Mobile Technology (PASS)", Medbiquitous Annual Conference, Baltimore, Maryland, May 2014.


Abstracts Selected for Presentation at Scientific Meetings:


83. **Fryer JP**. MELD score as a prognostic indicator for adult intestinal failure (IF) patients. Xth International Small Bowel Transplantation Symposium, Santa Monica, CA, September 5 – 8, 2007.


85. **Fryer JP**. Is C-reactive protein (CRP) predictive of progressive liver disease and death in adult intestinal failure patients? Xth International Small Bowel Transplantation Symposium, Santa Monica, CA, September 5 – 8, 2007.

86. **Fryer JP**. Analysis of decision making practices when listing intestine transplant candidates for liver also. Xth International Small Bowel Transplantation Symposium, Santa Monica, CA, September 5 – 8, 2007.


91. Fryer J, Corcoran N, DaRosa D. Use of SCORE curriculum as a template for evaluating and planning program’s clinical curriculum. Surgical Education Week, Salt Lake City, UT, April 28 – May 2, 2009.


110. Teaching and Assessing Residents in the Operating Room, Surgical Education Week, Orlando, FL April 22-27, 2013.