Mastery Skill Assessment in Hepato-Pancreato-Biliary Surgical Ultrasound

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THESIS

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LIST OF ABBREVIATIONS

AHPBA-FC	Americas Hepato-Pancreato-Biliary Association-Fellowship Council
EPA	Entrustable Professional Activity
HPB	Hepato-Pancreato-Biliary
IOUS	Open Ultrasound
LAPUS	Laparoscopic Ultrasound
MCQ	Multiple-choice question
O-SCORE	Ottawa Surgical Competency Operating Room Evaluation
US	Ultrasound

SUMMARY

A standardized curriculum in Hepato-Pancreato-Biliary (HPB) ultrasound (US), has been in place since 2014 for HPB surgical fellows. (Hagopian, 2020a; Hagopian, 2020b) Developed with the principles of Mastery learning, this educational framework includes two assessment tools for laparoscopic (LAPUS) and open US (IOUS) in HPB Surgery (Hagopian 2020a), which are scored using an entrustment scale. (Gofton, 2012)

A formative Hepato-Pancreato-Biliary US skills practicum is offered annually to graduating HPB surgical fellows, using the IOUS and LAPUS assessment tools. The specific aim of this work is to collect validity evidence for the IOUS and LAPUS tools within Messick's framework (Messick, 1989), while establishing and applying Mastery standards to a sample of graduating fellows.

Eleven expert faculty were surveyed to evaluate the importance of each IOUS and LAPUS skill and to set Mastery Angoff probabilities. Fellow performances were evaluated using the IOUS and LAPUS tools during two annual US skills practicums, and the Mastery cut scores were applied. Twenty-nine of 37 (78.5%) fellows agreed to have their de-identified data evaluated. The mean fellow performance entrustment scores (across all skills) were 4.1/5 and 3.9/5, while the mean global fellow performances were 3.6/5 and 3.5/5 for IOUS and LAPUS, respectively. Overall, the majority of fellows were found to not be meeting the entrustment standards, as determined by expert faculty, to perform IOUS or LAPUS.

I. INTRODUCTION

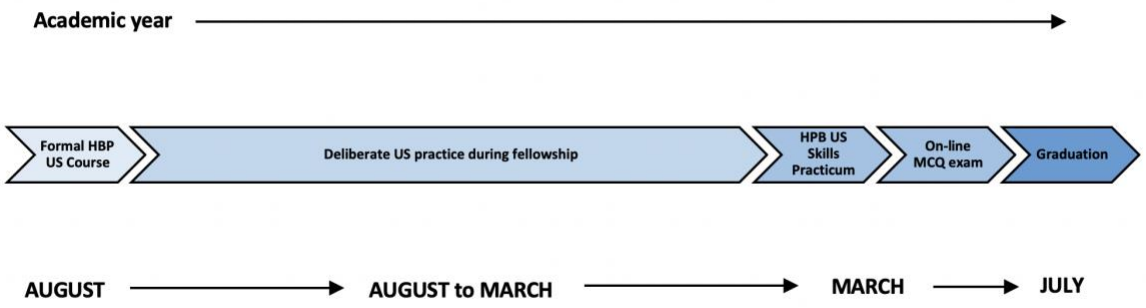
A. Background

The use of ultrasound (US) in the operating room is an important component in many diagnostic and therapeutic approaches in surgery. US is particularly useful in hepato-pancreato-biliary (HPB) surgical procedures for adjunctive procedures such as identifying known lesions, screening for occult lesions, and ensuring a proper resection line. Because of its importance in HPB procedures, proficiency in US is an educational requirement for fellowship training in HPB Surgery (AHPBA, 2019). A standardized curriculum and assessment (HPB US Fellows' Course) for the Americas Hepato-Pancreato-Biliary Association-Fellowship Council (AHPBA-FC) HPB fellowships, based on mastery learning principles (Lineberry, 2019b), has been in place since 2014. (Hagopian, 2020a; Hagopian, 2020b) (Figure 1) As part of the curriculum, fellows participate in a formative HPB US skills practicum prior to graduation where technical skill in HPB intraoperative open ultrasound (IOUS) and laparoscopic ultrasound (LAPUS) is assessed based on the objectives of the Course. (Appendix A)

Alignment of an assessment scale with the trainee's readiness to practice is crucial for patient and procedure safety. The Ottawa Surgical Competency Operating Room Evaluation (O-SCORE) (Gofton, 2012) was adopted for use in scoring the IOUS and LAPUS assessment tools (Appendix B) as it is an established entrustment scale, which aligns with the assessors' judgements and is applicable in a mastery approach.

FIGURE 1

Progression of HPB Fellows' US Curriculum and Assessment over Academic year



This schematic demonstrates the framework of the Fellows' HPB Ultrasound course work, practice and assessment over the academic year. The fellows attend a day-long course work in ultrasound, following which they return to their clinical environments and practice operative ultrasound under the direction of local faculty. The course work is completed with both written (on-line) and a skills practicum assessment prior to graduation.

B. Interpretation/Use Argument

Validity refers to use of the scores of a tool for a specified purpose or decision. According to the *Standards for Educational and Psychological Testing*, "Validity refers to the degree to which evidence and theory support the interpretations of test scores for proposed uses of tests." (AERA, 2014, p.11) In Messick's framework (Messick, 1989), adopted by the *Standards*, there are five major sources of validity evidence: content, response process, internal structure, relations to other variables, and consequences. This work is concerned with establishing if the IOUS and LAPUS

assessments are suitable tools to determine that graduating HPB fellows are well prepared to perform operative HPB US independently (*interpretation/use argument*).

C. Specific Aim

The purpose of this work is to collect validity evidence and to establish and apply Mastery standards (cut scores) for use of the IOUS and LAPUS assessment tools to assess fellows' readiness to perform HPB US in independent practice. This study met criteria for exemption by the University of Illinois-Chicago Institutional Review Board (2019-0265).

II. METHODS

A. IOUS and LAPUS assessment tools: Development

The IOUS and LAPUS assessment tools were initially created by the primary author to provide formative performance feedback to FC-AHPBA HPB Fellows during the annual skills practicum. Following each practicum, core faculty members debriefed and refined the faculty prompts/cues and skills assessed. The skills are categorized as basic (4), liver (6), biliary (2), and pancreas (2). All but 2 skills are matched across IOUS and LAPUS, such that the same skills are tested in both the open and laparoscopic approach. Given differences in the emphasis of skills in IOUS or LAPUS, 2 skills are unique to setting: 1) "Identify the caudate lobe" (IOUS only); and 2) "Demonstrate liver parenchymal scan" (LAPUS only).

B. Data source: Faculty Survey

A faculty survey was distributed to faculty with expertise in HPB Surgery and HPB US (Appendix C) to gather information in support of content and consequential validity. Faculty were recruited from the current membership of the AHPBA US subcommittee of AHPBA Education and Training Committee and those who had previously taught at the Fellows' HPB US Course *and* served on AHPBA Program Director's Committee.

1. Content validity

Content validity evidence aims to confirm that the assessment, and assessment instruments and items, systematically test the construct of interest. (Lineberry, 2019a) Confirmation that items are developed, revised, and reviewed by content experts contributes to content evidence.

The faculty survey asked participants to evaluate each skill item (14 skills each for IOUS and LAPUS) and the overall tool. Each item was reviewed to determine if the ability to perform the skill impacted procedure and/or patient outcome. Definitions were provided to faculty as follows:

- *Procedure outcome* refers to the outcome of the specific procedure, such as incomplete resection or ablation.
- *Patient outcome* refers to outcomes specific to the patient, such as morbidity, mortality and long-term survival.

Faculty agreement was defined as $\geq$ 70% of participants agreeing that either procedure or patient outcome would be impacted.

Faculty also were asked to classify each skill as essential (i.e., *critical* for safe performance of IOUS/LAPUS during HPB surgery), important (i.e., *important, but not critical* for safe US performance) or not important. An "importance" score of 3, 2, or 1 was assigned for the faculty judgment of essential, important, or not important, respectively, for each skill. An *essential skill* was defined as one with a mean importance score of $\geq$ 2.5.

After evaluating each assessment tool, faculty were asked if any skill items should be added and/or deleted. Responses were reviewed and suggestions summarized. Numeric survey results are summarized descriptively.

2. Consequential Validity: Standard setting

1. Mastery Angoff method (compensatory)

In mastery standard setting, the concept of the *borderline* (marginally competent) student is replaced with one who is *well-prepared*, such that judges are asked to estimate the performance

of the student (or trainee) "…who is *well prepared to succeed*…" (Yudkowsky, 2015, p.1496) To ensure fellows are well-prepared to practice HPB US, a modified Mastery Angoff method was used. (Downing, 2006; Linberry, 2015; Yudkowsky, 2015; Yudkowsky 2019)

To establish mastery standards, faculty were asked regarding each individual item *"What is the probability that a graduating HPB fellow, who is well-prepared for independent practice (i.e., level 5 entrustment), is able to perform this skill? ____%"* The O-SCORE rubric was provided on the survey. The cut (passing) score across all items (*Mastery Angoff*) for IOUS and LAPUS were determined by the mean across all items and judges.

The "global score" represents the entrustment score assigned to the fellow at the completion of the assessment and represents the assessor's overall entrustment following the completion of all individual tasks. (Appendix B) Similar to the standard setting for each individual item to determine the Mastery Angoff, faculty judges were asked to determine the probability that a well-prepared fellow would be able to perform the IOUS and LAPUS procedures, i.e., the *global score*. The cut global score (*Global Mastery Angoff)* was determined by the mean global score across all judges.

Descriptive statistics, including the mean rating, standard deviation, minimum and maximum ratings across all judges for each item and the overall global scores were determined.

2. Patient Safety method (non-compensatory)

In the patient safety approach cut scores are determined separately for essential and non-essential items. Core to this approach is that accomplishment of non-essential items *does not*

compensate for essential items. The trainee must achieve the specified number (percent) of essential skills, and separately, the relevant number of non-essential skills. (Yudkowsky, 2014)

Essential skills were determined based on an importance score of $\geq$ 2.5/3 for each individual skill (see *Content validity*, above), whereas skills with a score of < 2.5/3 were considered non-essential. To establish *Patient safety* standards, Mastery Angoff cut scores were calculated separately for essential and non-essential skills.

C. Data Source: Fellows' Practicum

The US Skills practicum was conducted in a simulated setting using an abdominal ultrasound phantom ("*IOUSFAN*" Abdominal Intraoperative & Laparoscopic Ultrasound Phantom, Kyoto Kagaku Co., LTD, Japan) and a standard US system typically employed by the HPB surgical community (BK Medical, Peabody MA and/or Hitachi Aloka, Hitachi Healthcare Americas, Twinsburg OH). Specific to LAPUS assessment, a standard laparoscopic tower and camera equipment (Stryker, Kalamazoo MI and/or Karl Storz, Miami FL) was used. At the start of each assessment, the fellow was oriented to the specific US system, indicating the location of important controls for adjustments during the US assessment.

IOUS and LAPUS were assessed separately, each by a different faculty member. Each assessment session for either IOUS or LAPUS lasted 15-20 minutes. The assessor scored an entrustment level for each skill before moving to the next. After completion of all 14 skills, the global (overall) entrustment score for HPB US was given.

Immediately following completion of the practicum, fellows were surveyed to evaluate the skills practicum and describe their experiences using US during their fellowship.

1. Response Process Validity

Response process evidence refers to the extent to which "…examinees' [and any observers' or raters'] cognitions and behaviors… are consistent with the intended interpretation and uses of scores..." (Lineberry, 2019a) This includes how faculty are calibrated to rate fellows consistently, how the faculty consistently deliver the assessment, how the HPB fellows interpret the questions asked, and quality control of the assessment.

a. Faculty pre-briefing/Rater training

Prior to the use of the assessment tool and entrustment scale, the core faculty discussed the use of the assessment tools to ensure consistent scoring. The entrustment scale (O-SCORE) was discussed and consensus was reached in its use with multiple examples of fellow behaviors aligned with the appropriate entrustment level. Furthermore, a standardized *"faculty prompt"* for each skill was read to prompt the fellow to decrease misperception and miscommunication during the assessments.

b. Fellow reaction

Fellows completed a post-practicum survey to ask about the clarity of task, adequacy of the inanimate US model, and prior experience with US. Questions utilized a 4-point Likert scale. (Likert, 1932)

c. Quality control

All scoring was done on paper and transcribed by the primary author. Following the practicum, fellows were contacted via email for written consent for use of their de-identified data. Separate spreadsheets of de-identified data were transcribed to analyze the fellows' entrustment scores (as assigned by assessment faculty) and the fellows' questionnaire responses.

2. Consequential Validity: Standards application

Consequences of score interpretation and use provide consequential validity evidence. (Lineberry, 2019a) This refers to the impact on trainees, patients, and society from the scores and decisions. Consequential validity evidence is supported by the process and outcomes of setting the mastery cut scores.

The mastery learning standards (cut scores) obtained from the faculty survey were applied to fellows' performance scores to determine the theoretical pass/fail rates for the group (no cut scores were applied in practice). The probabilities and cut scores were converted from a percentage cut score to an equivalent entrustment (Equivalent entrustment = [Cut score %] * 5). These entrustment standards (for both IOUS and LAPUS) were applied to the individual and mean group fellow performances, for each individual skill item, final (across all items), and global entrustments. Individual and mean group fellow entrustment performances were tallied and descriptive statistics applied.

III. RESULTS

A. Faculty Survey (Content Validity Evidence)

Twelve of 15 faculty returned the completed survey. Of the 12 returned surveys, 1 faculty assigned Mastery Angoff probabilities ≤ 25% for 5/14 IOUS and 12/14 LAPUS skills, while the remaining faculty mean Mastery Angoff probabilities were ≥ 86% for those same skills. To account for these outlier scores, the faculty member assigning the lowest cut scores was removed from the standard setting procedures. This faculty was also excluded from the content validity analysis to maintain consistency.

1. Content Validity

Eleven (11) faculty responses were included in the content validity analysis. For both IOUS and LAPUS, ≥ 73% faculty agreed that all individual items impacted either the procedure or patient outcome. (Table I) The mean faculty importance score was ≥ 2.5/3 for 86% (12/14) of IOUS and 93% (13/14) of LAPUS items, meeting criteria as essential skills. Two items which did not meet essential criteria included were similar in IOUS (pancreas stand-off ultrasound, importance score 2.36) and LAPUS (liver stand-off ultrasound, importance score 2.45). One additional IOUS skill did not meet essential criteria (pancreatic duct identification and measurement, importance score 2.45).

TABLE I

OPERATIVE ULTRASOUND SKILL IMPACT ON OUTCOME, AS DETERMINED BY EXPERT FACULTY (N=11)

Skill Category	IOUS Skill	Impacts outcome, % faculty agreement	LAPUS Skill	Impacts outcome, % faculty agreement
BASIC	Operate adjustments to optimize the ultrasound image (liver)	91%	Operate adjustments to optimize the ultrasound image (liver)	91%
	Operate adjustments to optimize the ultrasound image (pancreas)	91%	Operate adjustments to optimize the ultrasound image (pancreas)	82%
	Find and describe the US characteristics of an abnormal lesion (pancreas)	91%	Find and describe the US characteristics of an abnormal lesion (liver)	91%
	*Scan the pancreas using stand-off ultrasound	73%	*Scan the liver using stand-off ultrasound	73%
LIVER	Identify and scan each hepatic vein	100%	Identify and scan each hepatic vein	100%
	Identify the portal vein bifurcation and scan to the left and right branches	100%	Identify the portal vein bifurcation and scan to the left and right branches	100%
	Identify the right portal vein branches	91%	Identify the right portal vein branches	91%
	Identify the right portal vein segmental branches	91%	Identify the right portal vein segmental branches	91%
	Identify the left portal vein and its branches	91%	Identify the left portal vein and its branches	91%
	Identify the caudate lobe (segment 1)	91%	Demonstrate liver parenchymal sweep-scan	91%
BILIARY	Scan the gallbladder	82%	Demonstrate gallbladder ultrasound	73%
	Scan the extrahepatic bile duct	100%	Identify and scan the extrahepatic bile duct	100%
PANCREAS	Identify the vascular relationships of the pancreas	100%	Identify the ultrasound landmarks of the pancreas	100%
	*Identify and measure the pancreatic duct	73%	Scan the pancreas	100%

* No expert faculty consensus, if essential skill.

Faculty made 17 and 13 suggestions for additions or deletions for IOUS and LAPUS, respectively. Suggested additions included demonstrating 1) targeting-needle guidance (IOUS N=5; LAPUS N=4), 2) color Doppler (IOUS N=3; LAPUS N=2), and 3) basic skills, including print and record (IOUS N=2; LAPUS N=2). Two faculty suggested combining two liver US items, "Identify the right portal vein branches" and "Identify the right portal vein segmental branches," while others individually suggested adding other skills, including, for example, identification of intraductal biliary pathology.

B. Standard setting procedures (Consequential Validity)

1. Mastery Angoff cut scores (compensatory)

Mean Mastery Angoff cut scores for 14 IOUS and 14 LAPUS *individual items* ranged from 86% to 97% (entrustment scores, 4.3-4.8) and 86% to 98% (entrustment scores, 4.3-4.9), respectively. (Table II) The breakdown of Mastery Angoff cut scores (and equivalent entrustment scores) per skill category (basic, liver, biliary and pancreas) are depicted in Table II.

Overall, *Mastery Angoff cut scores* across all individual skills were 92% and 91% for IOUS and LAPUS, respectively. These correspond to mastery equivalent entrustment cut scores 4.6 and 4.5 for IOUS and LAPUS, respectively. The *Global Mastery Angoff cut scores* were 96% and 89% for IOUS and LAPUS, respectively. These data correspond to global mastery equivalent entrustment cut scores 4.8 and 4.5 for IOUS and LAPUS, respectively. (Table III)

TABLE II

MASTERY STANDARDS BY SKILL CATEGORY, AS DETERMINED BY EXPERT FACULTY (N=11)

Skill Category	IOUS Skill	Angoff probability across judges, mean (SD)	*Equi-valent Entrust-ment score	#Category Angoff cut score (Equivalent Entrustment)	LAPUS Skill	Angoff probablility across judges, mean (SD)	*Equi-valent Entrust-ment score	#Category Angoff cut score (Equivalent Entrustment)
BASIC	Operate adjustments to optimize the ultrasound image (liver)	97% (5.6%)	4.8	92% (4.6)	Operate adjustments to optimize the ultrasound image (liver)	97% (5.6%)	4.8	92% (4.6)
	Operate adjustments to optimize the ultrasound image (pancreas)	94% (9.0%)	4.7		Operate adjustments to optimize the ultrasound image (pancreas)	91% (9.5%)	4.6	
	Find and describe the US characteristics of an abnormal lesion (pancreas)	92% (10.8%)	4.6		Find and describe the US characteristics of an abnormal lesion (liver)	91% (14.4%)	4.5	
	Scan the pancreas using stand-off ultrasound	87% (18.2%)	4.3		Scan the liver using stand-off ultrasound	87% (17.1%)	4.3	
LIVER	Identify and scan each hepatic vein	97% (6.4%)	4.8	93% (4.6)	Identify and scan each hepatic vein	91% (11.6%)	4.6	90% (4.5)
	Identify the portal vein bifurcation and scan to the left and right branches	97% (8.1%)	4.8		Identify the portal vein bifurcation and scan to the left and right branches	91% (13.3%)	4.6	
	Identify the right portal vein branches	92% (11.3%)	4.6		Identify the right portal vein branches	88% (17.5%)	4.4	
	Identify the right portal vein segmental branches	90% (12.0%)	4.5		Identify the right portal vein segmental branches	86% (16.6%)	4.3	
	Identify the left portal vein and its branches	92% (9.1%)	4.6		Identify the left portal vein and its branches	91% (10.3%)	4.6	
	Identify the caudate lobe (segment 1)	90% (15.3%)	4.5		Demonstrate liver parenchymal sweep-scan	94% (7.7%)	4.7	
BILIARY	Scan the gallbladder	99% (3.0%)	5.0	94% (4.7)	Demonstrate gallbladder ultrasound	98% (3.4%)	4.9	93% (4.7)
	Scan the extrahepatic bile duct	90% (12.5%)	4.5		Identify and scan the extrahepatic bile duct	88% (9.9%)	4.4	
PANCREAS	Identify the vascular relationships of the pancreas	91% (9.4%)	4.6	88% (4.4)	Identify the ultrasound landmarks of the pancreas	88% (13.7%)	4.4	89% (4.5)
	Identify and measure the pancreatic duct	86% (12.4%)	4.3		Scan the pancreas	90% (12.0%)	4.5	

* *Calculated from mean cut score:* Entrustment cut score = (Cut score) * 5; # Mean cut score across skills category

2. Patient Safety cut scores (non-compensatory)

The *Patient Safety Mastery cut scores* (non-compensatory) for the 12/14 IOUS and 13/14 LAPUS essential skills were 93% and 91%, respectively. These correspond to patient safety mastery entrustment cut scores for essential skills of 4.7 and 4.6 for IOUS and LAPUS, respectively. The patient safety cut scores for the 2 IOUS non-essential skills ("Scan the pancreas using stand-off ultrasound" and "Identify and measure the pancreatic duct") and the 1 LAPUS non-essential skill ("Scan the liver using stand-off ultrasound") were 86% (4.3 equivalent entrustment) and 87% (4.3 equivalent entrustment), respectively. (Table III)

TABLE III

MASTERY STANDARDS, AS DETERMINED BY EXPERT FACULTY(N=11)

	IOUS Skill		LAPUS	
	*Mean Cut Score	#Equivalent Entrustment Score	*Mean Cut Score	#Equivalent Entrustment Score
MASTERY ANGOFF (Across all skills)	92%	4.6	91%	4.5
PT SAFETY (Essential skills)	93%	4.7	91%	4.6
PT SAFETY (Non-essential skill)	86%	4.3	87%	4.3
GLOBAL MASTERY ANGOFF (Overall performance)	96% (SD, 6.4%)	4.8	89% (SD, 13.8%)	4.5

* Global Mastery Angoff score is calculated as the mean probability across all judges and is reported with the standard deviation (SD). Final Mastery Angoff and Patient Safety cut scores are a sum of the probabilities across the judges.; *# Calculated from mean cut score:* Entrustment cut score = (Cut score) * 5

C. Standards application (Consequential Validity Evidence)

A total of 29 of 37 (78.5%) fellows who participated in the 2019 or 2020 US skills practicum consented to have their de-identified data included in the study. Mean fellow entrustment scores fell below *individual item entrustment* standards for 12/14 IOUS and 13/14 LAPUS items and for the skill categories of basic, liver and biliary skills in both IOUS or LAPUS. Mean scores were above entrustment standards in pancreas skills for IOUS, but not LAPUS. Specifically, fellows met entrustment in 1/4 basic, 0/6 liver, 0/2 biliary, and 1/2 pancreas IOUS items and 1/4 basic, 0/6 liver, 0/2 biliary, and 0/2 pancreas LAPUS items. (Table IV)

TABLE IV

APPLICATION OF STANDARDS, ACCORDING TO ULTRASOUND SKILL CATEGORY, TO OVERALL HPB FELLOW PERFORMANCE

	IOUS				LAPUS			
SKILL CATEGORY (# skills)	*Entrust-ment cut scores by skill category	Fellow Performance (N=29) based on Entrustment Score by skill category, mean (SD), #range	No. (%) skills where mean fellow performance meets entrustment	Operative case ultrasound use during fellowship, as reported by Fellows (N=29), median (range)	*Entrust-ment cut scores by skill category	Fellow Performance (N=29) based on Entrustment Score by skill category, mean (SD), #range	No. (%) skills where mean fellow performance meets entrustment	Operative case ultrasound use during fellowship, as reported by Fellows (N=29), median (range)
BASIC (n=4)	4.6	4.1 (0.6), 3.4-4.8	1/4 (25%)	N/A	4.6	4.2 (0.2), 3.9-4.3	1/4 (25%)	N/A
LIVER (n=6)	4.6	4.0 (0.6), 3.0-4.5	0/6 (0)	90% (20-100%)	4.5	3.7 (0.1), 3.5-3.9	0/6 (0)	80% (0-100%)
BILIARY (n=2)	4.7	4.1 (0.1), 4.0-4.2	0/2 (0)	20% (0-100%)	4.7	3.9 (0.2), 3.8-4.1	0/2 (0)	10% (0-100%)
PANCREAS (n=2)	4.4	4.6 (0.2), 4.4-4.8	1/2 (50%)	50% (0-100%)	4.5	3.9 (0.1), 3.9-4.0	0/2 (0)	40% (0-100%)

* Entrustment cut scores represent the equivalent entrustment score. Refer to Table II for Mastery Angoff category cut scores as determined by faculty. # Range represents the range of the mean fellow performances.

Fellows did not meet *Mastery Angoff* equivalent entrustment standards for either IOUS or LAPUS; The mean fellow entrustment score was 4.1 (SD 0.6, range 2.6-4.9) for IOUS and 3.9 (0.7, range 2.7-5) for LAPUS. The mean *Global Mastery* entrustment score across fellows was 3.60 (SD 0.8, range 2-5) in IOUS and 3.5 (SD 1.0, range 2-5) in LAPUS, which did not meet entrustment standards of 4.8 and 4.5, respectively. (Table V)

TABLE V:

APPLICATION OF ENTRUSTMENT STANDARDS TO OVERALL HPB FELLOW PERFORMANCE

	IOUS		LAPUS	
	*Entrustment cut scores based on faculty ratings (N=11)	Fellow Performance based on Entrustment Score (N=29), mean (SD), #range	*Entrustment cut based on faculty ratings (N=11)	Fellow Performance based on Entrustment Score (N=29), mean (SD), #range
Entrustment, ACROSS ALL SKILLS	4.6	4.1 (0.6), 2.6-4.9	4.5	3.9 (0.7), 2.7-5
Entrustment, ESSENTIAL SKILLS	4.7	4.1 (0.7), 2.4-4.9	4.6	3.9 (0.7), 2.6-5
Entrustment, NON-ESSENTIAL SKILL	4.3	4.8 (0.5), 3-5	4.3	4.3 (0.9), 2-5
Entrustment, GLOBAL	4.8	3.6 (0.8), 2-5	4.5	3.5 (1.0), 2-5

* Entrustment cut scores represent the equivalent entrustment score. Refer to Table III for Mastery Angoff cut scores as determined by faculty. # Range represents the range of the mean fellow performances.

Patient safety standards were applied. One fellow did not meet the *Patient Safety* (non-compensatory) cut score for IOUS essential skills, however met the Mastery Angoff (compensatory) IOUS entrustment score. Similarly, 3 fellows did not meet the non-compensatory Patient Safety cut score for essential skills, but met the compensatory Mastery Angoff entrustment score in LAPUS. (Data not shown)

D. Fellow questionnaire (Response Process Validity Evidence)

Twenty-eight of 29 fellows (96.6%) reported that the faculty's explanation was adequate and that they understood the requested tasks. Twenty-four fellows (82.8%) reported that the model was accurate, while 21 (72.4%) felt the model was representative of a live case. (Table VI)

TABLE VI:

FELLOW RATING OF PRACTICUM* (RESPONSE PROCESS VALIDITY EVIDENCE)

	Mean (SD) N= 29	% Agree/ Strongly agree N= 29	Median (range) N= 29
The faculty's explanation of the equipment was adequate so that I could perform well during the practicum.	3.6 (0.7)	96.6%	4 (1-4)
I understood the tasks the faculty asked me to perform.	3.4 (0.7)	96.6%	3 (1-4)
The model used during the practicum was accurate.	3.1 (0.8)	82.8%	3 (1-4)
The model used during the practicum was representative of a live patient case.	2.86 (0.8)	72.4%	3 (1-4)

*Rating based on a 4-point Likert-type scale: (1) strongly disagree (2) disagree; (3) Agree; (4) strongly agree (Likert, 1932)

Fellows were asked to quantify their use of ultrasound during liver, biliary and pancreas operative cases. Fellows reported higher usage of ultrasound during liver cases in both IOUS (median 90%, range 20-100%) and LAPUS (median 80%, range 0-100%) as opposed to during biliary (median $\leq$ 20%) or pancreas (median $\leq$ 50%) open or laparoscopic cases. Table IV contrasts the fellows' reported uses and overall performances in each skill (liver, biliary and pancreas) IOUS and LAPUS category.

IV. DISCUSSION

A. Summary/Implications

This study presents initial content, response process, and consequential validity evidence and establishes mastery standards for the HPB IOUS and LAPUS assessment tools. For two cohorts of HPB fellows, the majority were found to not be meeting the resulting entrustment standards to perform IOUS or LAPUS. This is the first work in the development and use of assessment tools of HPB surgical US, a key adjunct to safe HPB surgery. The results demonstrate the utility of such assessments in the real-world practice of HPB surgery to effectively assess US skill in graduating North America HPB fellows.

Graduating HPB fellows should be experts in the field of HPB surgery and this includes the use of US in the surgical setting. Because it is of interest to ensure that the fellow is not just *minimally competent*, but is *well-prepared* for independent practice, a mastery learning and assessment framework was adopted in this work. The goal in mastery learning is for all learners to achieve a pre-determined level of performance, regardless of the time frame to achievement. The principles of mastery learning and assessment are vital components for competency-based education. (Yudkowsky, 2015) Like mastery learning, competency-based education focuses on standards of performance to ensure that the learner has an acceptable level of proficiency. (ten Cate, 2013) Olle ten Cate asserts that competencies are *abilities* of physicians (ten Cate, 2007; ten Cate, 2013), which is in contrast to the *activities* the physician performs. He defines *entrustable professional activities*, or EPAs, as "… those professional activities that together constitute the mass of critical

elements that operationally define a profession." (ten Cate, 2007, p. 544). The successful performance and interpretation of ultrasound in the operating room, in both open and laparoscopic settings, is an essential task of the HPB surgeon and is an EPA. A skills assessment, such as the IOUS and LAPUS, is a necessary component of this entrustment.

B. Curriculum reform: *Narrowing the performance gap*

Based on the mastery standards set by expert faculty in this work, graduating HPB fellows are not meeting entrustment to perform IOUS or LAPUS. While some certification standards may be set to a minimum performance, to ensure patient safety, minimal competency is not the standard for clinical performance. A fellow performing at a minimal competency is at risk of incorrectly using and interpreting operative HPB US, which can directly impact patient safety and outcome. In this work, mastery standard setting was intentional for this reason: to ensure a well-prepared fellow. While some may argue that mastery standards are "too high," the authors assert that mastery standards ensure patient safety. Data in this study furthermore underscores the importance of applying not only mastery standards, but also patient safety standards. One fellow did not meet the Patient Safety (non-compensatory) cut score for IOUS essential skills, while 3 fellows did not meet these standards in LAPUS. In each of these cases, the Mastery Angoff equivalent entrustment score was achieved. It is important to note that these fellows would have achieved passing scores if patient safety standards were not applied. This is critical as without application of patient safety standards, the risk is passing an individual whose performance is potentially unsafe. Without applying patient safety standards, an individual who is not able to perform one or more essential US skills has the potential to have passed the assessment.

The gap between observed performance and mastery standards can be narrowed by curricular changes at the accreditation and program levels. To address concerns of US procedure volume, beginning in 2021, the AHPBA Education and Training Committee will mandate minimum numbers of US procedures for graduation and attainment of the HPB Surgery certificate. (AHPBA, 2020) While these numbers of US procedures represent an absolute minimum, (Hagopian, 2020b) this new change in policy to include US procedures in the requirements for graduation and attainment of the HPB Surgery certificate is a statement of the importance of US in the practice of HPB Surgery.

At the programmatic level, a deliberate and intentional incorporation of US in the fellows' educational framework can not only provide further instruction beyond the US coursework, but can also emphasize the value of US in the daily practice of HPB Surgery. Opportunities to deliver such instruction include the AHPBA HPB Fellows' monthly Grand Rounds in addition to new opportunities in the virtual setting. Impacted by COVID-19, the annual in-person AHPBA Fellows US course was replaced by a virtual instructional offering in 2020. Educational offerings in both in-person and virtual settings which emphasize case-based instruction and discussions can capitalize on demonstrating the use and value of US in HPB operative cases.

Fellows reported the percentage of time US was used during their operative cases during fellowship training. While the fellow-reported median percent uses of US during open and laparoscopic liver cases were 90% and 80%, respectively, fellows did not meet entrustment for either IOUS or LAPUS for liver category skills. Given the high usage of US during liver cases, there exist opportunities at the program level to improve instruction and experience leading to

performance improvement. However, the low reported usages during biliary and pancreas cases indicate the need for increased usage to improve the fellow experience. This low reported median usage may indicate a low perceived value of biliary and pancreas US. As discussed above, educational offerings during the fellowship year may impact not only the fellows' but also faculty's perceptions of the value of US in pancreas and biliary cases.

C. Validity evidence and its threats

The current study collected content validity evidence for the IOUS and LAPUS assessment tools by faculty experts in HPB surgery and HPB US. Agreement was reached among faculty (>70%) that all IOUS and LAPUS items (skills) impacted either patient or procedure outcome. Despite this, expert faculty did not reach consensus if 3 skills, 2 IOUS and 1 LAPUS, were essential. Two of these skills focus on "stand-off" ultrasound, which is utilized when identifying a surface lesion of the liver. While expert faculty did not find this as "essential," this skill is very useful in small, thin structures, such as the bile duct and pancreas, and in surface liver lesions. Perhaps because alternative methods, such as palpation or visualization, may potentially identify a surface lesion, the "stand-off" US method was deemed "non-essential." Furthermore, faculty did not reach consensus if identification and measurement of the pancreas duct (IOUS) were essential. Of note, these skills deemed "non-essential" were still determined to impact patient/procedure outcome.

Some faculty suggested the addition of certain skills, including targeting and other basic skills. While targeting is an important skill in US, it is considered *interventional US*, while the current assessment tools focus on *diagnostic US*. The development of an assessment tool focusing on interventional US, including targeting is the subject of further work. The use of Doppler is another

important skill in HPB US, however cannot be evaluated in the simulation setting using the current US phantom. Importantly, the balance in the category of tested US skills was weighted toward liver (6 skills) as compared to biliary (2 skills) and pancreas (2 skills), a construct underrepresentation threat to validity. (Lineberry, 2019a) The addition of at least 2 skills in both biliary and pancreas categories would balance the assessment tools and address this threat to validity.

Fellows responded favorably to the US practicum. The majority agreed/strongly agreed (≥96%) that the tasks requested by faculty were understandable and equipment explanations were adequate. Furthermore, the majority also agreed/strongly agreed (≥72%) that the model was accurate and representative of a live case. Thus, neither the faculty, equipment, or model served as construct-irrelevant variance threats to validity. (Lineberry, 2019a)

The adoption of the HPB US course as a requirement for HPB fellowship would be a policy decision as would the adoption of a certification program for practicing HPB surgeons. The scoring and use of the IOUS and LAPUS assessment tools in these settings would impact the examinee, the profession, and patients and society. Achievement of entrustment during an US skills practicum contributes to ensuring a high standard of HPB US practice of the examinee and impacts positively the HPB surgical community and society. Certification of technical skill can potentially improve patient outcomes and quality of care.

D. Limitations and Future Study

This study included only 2 years of graduating fellow data, of which 78% of fellows agreed to have their de-identified data included. While the AHPBA Fellows HPB US course is not currently required, its completion is strongly suggested for receipt of the AHPBA HPB Surgery Certificate.

The validity evidence presented supports adoption of the HPB US course as a policy requirement. Further work to collect validity evidence on the reliability of the results of the assessments would continue to strengthen this argument. Inter-rater reliability studies are an area of current investigation. Linking the fellow practicum performances to standardized examination performances, such as the American Board of Surgery qualifying examination or a potential HPB Surgery certifying examination, could provide additional validity evidence.

E. Conclusion

Two cohorts of AHPBA-FC HPB fellows did not meet HPB US Mastery Standards as determined by a panel of expert faculty. Changes in educational policy or curriculum may narrow this performance gap. Validity evidence supports the use of the IOUS and LAPUS assessment tools in evaluating readiness for practice in operative US for HPB Surgery and may be used as a model for certification in HPB US. Certification in HPB US at a mastery level for practicing HPB surgeons or the addition of the HPB US assessment to the HPB Surgery certificate requirements will contribute to the skill confirmation of the HPB surgeon potentially leading to improvement in patient outcomes for HPB Surgery.

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APPENDIX A

HPB US Skills Learning Objectives

*By the end of the **intraoperative ultrasound scanning (IOUS)** hands-on lab, the participant will:*

1. Show proper handling of the intraoperative US probe.
2. Operate adjustments (frequency, depth, gain, TGC, focus) properly to optimize the ultrasound image for IOUS.
3. Describe and demonstrate slide, rotate, rock, and tilt probe manipulations on either the liver or pancreas.
4. Describe and perform transverse and longitudinal scanning planes of the liver, gallbladder, bile duct and pancreas.
5. Demonstrate intraoperative liver ultrasound and identify:
   a) the junction of the vena cava with each hepatic vein (right, middle and left).
   b) each hepatic vein and scan from its origin to termination.
   c) the portal vein bifurcation and scan to its right and left branches.
   d) the right portal vein and its segmental branches
   e) the left portal vein and its segmental branches
6. Demonstrate intraoperative liver parenchymal sweep-scan while identifying liver sections, sectors, and segments.
7. Demonstrate intraoperative gallbladder and bile duct ultrasound.
8. Demonstrate intraoperative pancreas ultrasound using direct, compression, and saline immersion scanning methods.
9. Find, localize, describe, and measure a lesion in the liver and pancreas.

By the end of the laparoscopic ultrasound scanning (LAPUS) hands-on lab, the participant will:

1. Show proper handling of the laparoscopic US probe.
2. Identify trocar placement for laparoscopic ultrasound.
3. Operate adjustments (frequency, depth, gain, TGC, focus) properly to optimize the ultrasound image for LAPUS.
4. Describe and demonstrate slide, rotate, rock, and tilt probe manipulations on either the liver or pancreas.
5. Demonstrate laparoscopic liver ultrasound and identify:
   a) the junction of the vena cava with each hepatic vein (right, middle and left).
   b) follow each hepatic vein from its origin to termination.
   c) the portal vein bifurcation and follow its right and left branches.
6. Demonstrate laparoscopic liver parenchymal sweep-scan while identifying liver sections, sectors, and segments.
7. Demonstrate laparoscopic gallbladder and bile duct ultrasound.
8. Demonstrate laparoscopic pancreas ultrasound using direct, compression, and saline immersion scanning methods.
9. Find, localize, describe, and measure a lesion in the liver and pancreas.

APPENDIX B
HPB Ultrasound Skills Assessment Tools: IOUS

Please rate the each skill (and overall) according to the following entrustment level:

(1) "I had to do it" - *ie., Requires complete hands-on guidance, did not do it, or was not given the opportunity to do*
(2)"I had to talk them through" *(ie., Able to perform tasks but requires constant direction)*
(3) "I had to prompt them from time-to-time" *(ie., Demonstrates some independence but requires intermittent direction)*
(4) "I needed to be in the room just in case" – *ie., independence but unaware of risks and still requires supervision for safe practice*
(5) "I did not need to be there" - *ie., Complete independence, understands risks and performs safely, practice ready* (Gofton, 2012)

PART 1 : Intraoperative Open Ultrasound (IOUS)								
	SKILL/OBJECTIVE	FACULTY PROMPT	1 "I did it for him/her"	2 "I talked him/her through"	3 "I prompted him/her "	4 "I needed to be there"	5 "I didn't need to be there"	COMMENT
1	Operate adjustments to optimize the ultrasound image (liver).	***"Optimize the ultrasound image for the liver using the ultrasound controls."***	○	○	○	○	○	
2	Identify and scan each hepatic vein	***"Identify the right, middle, and left hepatic veins and scan each one from its origin to termination."***	○	○	○	○	○	
3	Identify the portal vein bifurcation and scan to the left and right branches	***"Identify the portal vein bifurcation and follow to the main left and right portal branches."***	○	○	○	○	○	
4	Identify the right portal vein branches	***"Identify the main right portal vein and follow to its branches."***	○	○	○	○	○	
5	Identify the right portal vein segmental branches	***"Follow the right portal vein branches to their segmental branches and name each one."***	○	○	○	○	○	
6	Identify the left portal vein and its branches	***"Identify the left portal vein and follow to its segmental branches and name each one."***	○	○	○	○	○	
7	Identify the caudate lobe (segment 1)	***"Identify segment 1 and its boundaries(s)."***	○	○	○	○	○	
8	Scan the gallbladder	***"Scan the gallbladder and identify and describe at least 2 abnormal findings."***	○	○	○	○	○	
9	Scan the extrahepatic bile duct	***"Scan the extrahepatic bile duct from the hilum to pancreas and identify and describe at least 1 abnormal finding."***	○	○	○	○	○	
10	Operate adjustments to optimize the ultrasound image (pancreas).	***"Optimize the ultrasound image of the pancreas, using the stomach as an acoustic window."***	○	○	○	○	○	
11	Identify the vascular relationships of the pancreas	***"Identify the SMV, portal vein, splenic vein and SMA in relationship to the pancreas."***	○	○	○	○	○	
12	Identify and measure the pancreatic duct	***"Identify the pancreatic duct and the intrapancreatic bile duct."***	○	○	○	○	○	
13	Find and describe the US characteristics of an abnormal lesion	***"Scan the pancreas from the uncinate to tail and identify a lesion: measure it, state its location and describe its US characteristics."***	○	○	○	○	○	
14	Scan the pancreas using stand-off ultrasound	***"Demonstrate stand-off ultrasonography of pancreas using saline immersion."***	○	○	○	○	○	

OVERALL Entrustment Level: (1-5)

FACULTY Printed Name/*Signature*

APPENDIX B (cont.)
HPB Ultrasound Skills Assessment Tools: LAPUS

Please rate the each skill (and overall) according to the following entrustment level:

(1) "I had to do it" - *ie., Requires complete hands-on guidance, did not do it, or was not given the opportunity to do*

(2)"I had to talk them through" *(ie., Able to perform tasks but requires constant direction)*

(3) "I had to prompt them from time-to-time" *(ie., Demonstrates some independence but requires intermittent direction)*

(4) "I needed to be in the room just in case" *– ie., independence but unaware of risks and still requires supervision for safe practice*

(5) "I did not need to be there" - *ie., Complete independence, understands risks and performs safely, practice ready* (Gofton, 2012)

PART 2 : Laparoscopic Ultrasound (LAPUS)								
	SKILL/OBJECTIVE	FACULTY PROMPT	1 "I did it for him/her"	2 "I talked him/her through"	3 "I prompted him/her"	4 "I needed to be there"	5 "I didn't need to be there"	COMMENT
1	Operate adjustments to optimize the ultrasound image (liver).	***"Optimize the ultrasound image for the liver using the ultrasound controls."***	○	○	○	○	○	
2	Identify and scan each hepatic vein	***"Identify the right, middle, and left hepatic veins and scan each one in its longitudinal axis."***	○	○	○	○	○	
3	Identify the portal vein bifurcation and scan to the left and right branches	***"Identify the portal vein bifurcation and follow to the main left and right portal branches."***	○	○	○	○	○	
4	Identify the right portal vein branches	***"Identify the main right portal vein and follow to its branches."***	○	○	○	○	○	
5	Identify the right portal vein segmental branches	***"Follow the right portal vein branches to their segmental branches and name each one."***	○	○	○	○	○	
6	Identify the left portal vein and its branches	***"Identify the left portal vein and follow to its segmental branches and name each one."***	○	○	○	○	○	
7	Demonstrate liver parenchymal sweep-scan.	***"Perform a systematic sweep-scan of each section of the liver parenchyma."***	○	○	○	○	○	
8	Find and describe the US characteristics of an abnormal lesion	***"Find 2 lesions in the liver, 1 in the right and 1 in the left. For each one: measure it, state its location and describe its ultrasound characteristics."***	○	○	○	○	○	
9	Scan the liver using stand-off ultrasound	***"Demonstrate stand-off ultrasonography of segment 8 using saline immersion."***	○	○	○	○	○	
10	Demonstrate gallbladder ultrasound.	***"Scan the gallbladder in its longitudinal and transverse axes."***	○	○	○	○	○	
11	Identify and scan the extrahepatic bile duct.	***"Identify the extrahepatic bile duct and scan its length in two orientations."***	○	○	○	○	○	
12	Operate adjustments to optimize the ultrasound image (pancreas).	***"Optimize the ultrasound image of the pancreas, using the stomach as an acoustic window."***	○	○	○	○	○	
13	Identify the ultrasound landmarks of the pancreas	***"Identify the SMA, SMV, PV, SV, and left renal vein boundaries of the pancreas."***	○	○	○	○	○	
14	Scan the pancreas	***"Scan the pancreas from the uncinate to tail in two orientations."***	○	○	○	○	○	

OVERALL Entrustment Level: (1-5)

FACULTY Printed Name/*Signature*

APPENDIX C
Faculty Survey: IOUS

SKILL: INTRAOPERATIVE OPEN US		Does the ability to perform this skill impact:				Is this skill ESSENTIAL, IMPORTANT. or NOT IMPORTANT for an HPB fellow to have to safely practice HPB US?			What is the probability that an HPB fellow, who is well-prepared for independent practice (i.e., level 5 entrustment) is able to perform this skill?
		Procedure outcome?		*Patient outcome?*					
		YES	NO	YES	NO	ESSENTIAL	IMPORTANT	NOT IMPORTANT	(%)
1	Operate adjustments to optimize the ultrasound image (liver).	○	○	○	○	○	○	○	_____%
2	Identify and scan each hepatic vein	○	○	○	○	○	○	○	_____%
3	Identify the portal vein bifurcation and scan to the left and right branches	○	○	○	○	○	○	○	_____%
4	Identify the right portal vein branches	○	○	○	○	○	○	○	_____%
5	Identify the right portal vein segmental branches	○	○	○	○	○	○	○	_____%
6	Identify the left portal vein and its branches	○	○	○	○	○	○	○	_____%
7	Identify the caudate lobe (segment 1)	○	○	○	○	○	○	○	_____%
8	Scan the gallbladder	○	○	○	○	○	○	○	_____%
9	Scan the extrahepatic bile duct	○	○	○	○	○	○	○	_____%
10	Operate adjustments to optimize the ultrasound image (pancreas).	○	○	○	○	○	○	○	_____%
11	Identify the vascular relationships of the pancreas	○	○	○	○	○	○	○	_____%
12	Identify and measure the pancreatic duct	○	○	○	○	○	○	○	_____%
13	Find and describe the US characteristics of an abnormal lesion	○	○	○	○	○	○	○	_____%
14	Scan the pancreas using stand-off ultrasound	○	○	○	○	○	○	○	_____%
*	Overall performance of IOUS	What is the probability that an HPB fellow, who is well-prepared for independent practice (ie., level 5 entrustment), is able to perform IOUS?							_____%

OVERALL EVALUATION OF ASSESSMENT TOOL: INTRAOPERATIVE OPEN US
Is/Are there any skill(s) that you would add to this skills list?
1.
2.
3.
4.
5.
Is/Are there any skill(s) that you would remove from this skills list? (#skill)

APPENDIX C (cont.)
Faculty Survey: LAPUS

SKILL: LAPAROSCOPIC US		Does the ability to perform this skill impact:				Is this skill ESSENTIAL, IMPORTANT. or NOT IMPORTANT for an HPB fellow to have to safely practice HPB US?			What is the probability that an HPB fellow, who is well-prepared for independent practice (i.e., level 5 entrustment) is able to perform this skill?
		Procedure outcome?		*Patient outcome?*					
		YES	NO	YES	NO	ESSENTIAL	IMPORTANT	NOT IMPORTANT	(%)
1	Operate adjustments to optimize the ultrasound image (liver).	○	○	○	○	○	○	○	_____%
2	Identify and scan each hepatic vein.	○	○	○	○	○	○	○	_____%
3	Identify the portal vein bifurcation and scan to the left and right branches.	○	○	○	○	○	○	○	_____%
4	Identify the right portal vein branches.	○	○	○	○	○	○	○	_____%
5	Identify the right portal vein segmental branches.	○	○	○	○	○	○	○	_____%
6	Identify the left portal vein and its branches.	○	○	○	○	○	○	○	_____%
7	Demonstrate liver parenchymal sweep-scan.	○	○	○	○	○	○	○	_____%
8	Find and describe the US characteristics of an abnormal lesion.	○	○	○	○	○	○	○	_____%
9	Scan the liver using stand-off ultrasound.	○	○	○	○	○	○	○	_____%
10	Demonstrate gallbladder ultrasound.	○	○	○	○	○	○	○	_____%
11	Identify and scan the extrahepatic bile duct.	○	○	○	○	○	○	○	_____%
12	Operate adjustments to optimize the ultrasound image (pancreas).	○	○	○	○	○	○	○	_____%
13	Identify the ultrasound landmarks of the pancreas.	○	○	○	○	○	○	○	_____%
14	Scan the pancreas.	○	○	○	○	○	○	○	_____%
*	Overall performance of LAPUS	What is the probability that an HPB fellow, who is well-prepared for independent practice (ie., level 5 entrustment) is able to perform LAPUS?							_____%

OVERALL EVALUATION OF ASSESSMENT TOOL: LAPAROSCOPIC US
Is/Are there any skill(s) that you would add to this skills list?
1.
2.
3.
4.
5.
Is/Are there any skill(s) that you would remove from this skills list? (#skill)

VITA

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	Core Faculty, Human Dimension (longitudinal course-Phase 1 curriculum), Hackensack Meridian School of Medicine
	Teaching Faculty, Digestion, Metabolism, Nutrition Course, Hackensack Meridian School of Medicine
CURRENT SERVICE:	Chair, Phase 2 Committee (Clinical Clerkships), Hackensack Meridian School of Medicine
	Member, Medical Education Committee (MEC), Hackensack Meridian School of Medicine
	Member, Appointment & Promotions Committee (APC), Hackensack Meridian School of Medicine
	Board Member, Americas Hepato-Pancreato-Biliary Foundation (of the Americas Hepato Pancreato-Biliary Association
	Co-Chair, Americas Hepato-Pancreato-Biliary Association, Education and Training Committee
	Associate Editor, HPB (peer-reviewed journal)
	Chair, Americas Hepato-Pancreato-Biliary Association, Ultrasound Subcommittee, Education and Training Committee
	Chair, American College of Surgeons, National Ultrasound Faculty, Executive Committee
PROFESSIONAL MEMBERSHIPS:	Association for Surgical Education Association of Women Surgeons Society of Surgical Oncology, Fellow New York Surgical Society International Hepato-Pancreato-Biliary Association American College of Surgeons, Fellow

VITA (continued)

PROFESSIONAL MEMBERSHIPS (cont.):

Americas Hepato-Pancreato-Biliary Association
The Society for Surgery of the Alimentary Tract
Society of American Gastrointestinal Endoscopic Surgeons

HONORS/ AWARDS:

First Place for Original Research, "Laparoscopic versus Open Liver Resection A Meta-Analysis of Long-Term Outcome" Parks K.P., Kuo Y.H., Davis J.M., OBrien B., and Hagopian E.J. Jersey Shore University Medical Center Researc Day, Neptune NJ, 11 June 2013

Honorable Mention, Original Faculty Research (Highest Impact Factor Journal) "Laparoscopic Cholecystectomy is the Preferred Approach in Cirrhosis: A Nationwide, Population-Based Study" Chmielecki D., Hagopian E.J., Kuo Y.H., Kuo Y.L., and Davis J. Jersey Shore University Medical Center Research Day, Neptune NJ, 11 June 2013

Member, Compagnons Hépatobiliaires (Hepatobiliary Fellow Society of Professor Henri Bismuth, Distinguished Surgeon and Teacher), 2012

Blakemore Award for Excellence in Surgical Research, Columbia University College of Physicians and Surgeons, 1998

Alpha Omega Alpha Medical Honor Society, Alpha Chapter of Pennsylvania, Jefferson Medical College, 1991

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