

Validity Evidence for the Core Physical Examination in Medical Students

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THESIS

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This thesis is dedicated to my wife, Joy, who supported my efforts pursuing my Master's degree and the eventual completion of my thesis . . . 9 years later. Thanks Joy!

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SUMMARY

Validity evidence for the UCSOM CPE was gathered using data from two classes of approximately 180 medical students from to September 2015 to December 2018. Validity evidence specific to content, response process, internal structure, relationship to other variables and consequences was gathered.

Content and response process evidence was based on the use of content experts to develop the UCSOM CPE and the extensive rater training in the institution's clinical performance center. Correlations of performance on the UCSOM CPE to other assessments of the PE were generally low in the range of 0.14 to 0.23, consistent with correlations between stations of objective structured clinical examinations. Although modest, the largest contributor to score variability was the person-occasion (5.5%) and person-item (5.4%) interactions, indicating that student performance varied by occasion and across items. The overall phi coefficient for the G study of 0.258 suggests low reliability for a single assessment and that other sources of error not considered as facets in this G study contribute significantly to the variance. The 90% pass-fail cut point determined by a modified Angoff approach resulted in a fail rate of 10% to 13% for the UCSOM CPE in first year and 36% to 38% in second year. Clinical skills course directors selected a consensus pass-fail cut score of 80% as a defensible and practical threshold for the UCSOM CPE in its current educational context for entry into supervised clinical practice in the context of a preceptorship experience.

ABSTRACT

Purpose. The Core Physical Exam (CPE) has been proposed as a basis for the Core + Cluster curriculum for teaching and assessing physical examination (PE) skills in medical students. This study provides initial validity evidence for a modified, institution-specific CPE as an assessment of PE skills in medical students.

Methods. The University of Colorado School of Medicine (UCSOM) CPE was developed as a 25-item version of the published CPE. Validity evidence for the UCSOM CPE was gathered using data from two classes of approximately 180 medical students from September 2015 to December 2018. Validity evidence specific to content, response process, internal structure, relationship to other variables and consequences was gathered.

Results. Content and response process evidence was based on the use of content experts to develop the UCSOM CPE and the extensive rater training in the institution's clinical performance center. Correlations of performance on the UCSOM CPE to other assessments of the PE were generally low in the range of 0.14 to 0.23, consistent with correlations between stations of objective structured clinical examinations. The 90% pass-fail cut point determined by a modified Angoff approach resulted in a fail rate of 10% to 13% for the UCSOM CPE in first year and 36% to 38% in second year. Clinical skills course directors selected a consensus pass-fail cut score of 80% as a defensible and practical threshold for the UCSOM CPE in its current educational context for entry into supervised clinical practice in the context of a preceptorship experience.

Conclusion. Initial validity evidence supports the use of UCSOM CPE as a useful educational strategy for teaching physical examination and as a formative assessment of PE competence in medical students.

I. INTRODUCTION

Background

Several teaching strategies and methodologies have been used to teach medical students physical examination (PE) skills, including the Head-to-Toe physical examination (Yudkowsky, 2004), Hypothesis Driven Physical Examination (Yudkowsky, 2009), and Core + Cluster Physical Examination (Gowda, 2014). The strengths and limitations of the educational methods and assessment tools used to teach and assess PE skills have been debated in recently published literature and no single best methodology for teaching PE has been promoted. (Uchida et al., 2014)

The Head-To-Toe physical examination (HTT), a screening PE comprised of about 140 maneuvers performed on a healthy SP, has been used to assess the acquisition of foundational PE skills prior to entering clerkships. The HTT has been showed to be useful as a summative assessment of PE skills prior to entering clerkships. (Yudkowsky, 2004) Because the HTT promotes rote performance of PE maneuvers, however, without attention to abnormal findings or their interpretation, this PE teaching methodology has been criticized as being de-contextualized from patient complaints and not integrated into the overall clinical training program. (Benbassat, 2005 and Yudkowsky, 2009)

The Hypothesis-Driven Physical Examination (HDPE) was developed to promote critical thinking related to the PE in the context of diagnostic challenges within a patient presentation. (Yudkowsky, 2009) Initially developed as an assessment tool, the HDPE model has been

demonstrated as a workable instructional intervention across several medical schools.

(Nishigori, 2011; Allen, 2017 and Garibaldi 2017) The HDPE approach provides students with targeted practice in anticipating, eliciting, and interpreting PE maneuvers in the context of patient cases with focused diagnostic challenges. Unlike the HTT method, the HDPE has the potential to promote the development of clinical reasoning through targeted practice and feedback in the process of the selection and interpretation of PE maneuvers using patient based diagnostic challenges. (Yudkowsky, 2009)

More recently, the Core Physical Examination (CPE), as part of a Core + Cluster curriculum, has been promoted as an instructional and assessment methodology for teaching PE skills. (Gowda-2, 2014) The CPE consists of 37 key PE items to be performed by a student on every newly admitted patient, based on a survey of internal medicine clerkship directors and clinical skills course directors. (Gowda, 2014) Advocates of the CPE intend that the CPE maneuvers should be taught in combination with symptom-driven clusters of additional PE maneuvers. Certain clusters of PE maneuvers would be performed on patients depending on their presenting complaints. Advocates of the Core + Cluster curriculum suggest that the CPE be taught early in medical school clinical skills courses in lieu of more comprehensive PE checklists like the HTT. (Gowda-2, 2014) Once the CPE is mastered, additional targeted clusters of PE maneuvers can be introduced (for example, a cardiovascular cluster that includes CPE maneuvers plus additional PE maneuvers) along with education of when each cluster should be completed based on the diagnoses suggested by a patient's presenting complaints. (Gowda-2, 2014)

Beyond the initial proposal of the CPE and the Core + Cluster curriculum suggested by Gowda, no validity evidence has been presented for the CPE or the implementation of a Core + Cluster curriculum to teach PE skills to medical students. At the University of Colorado School of Medicine (UCSOM), a modified version of the CPE known as the UCSOM CPE was developed by faculty and implemented in the school's clinical skills course to assist in the teaching of PE skills to students. The purpose of this study was to provide initial validity evidence for the use of the UCSOM CPE in the assessment of PE skills in medical students in the context of introducing the CPE as part of an evolving Core + Cluster curriculum of teaching PE skills at UCSOM.

A validity investigation is the process of collecting and interpreting evidence to support decisions about assessments. (Cook, 2015) Understanding the strengths and weaknesses of an assessment as well as the purposes and intent of the assessments are key considerations when considering validity evidence. Using conceptual frameworks for validity evidence can help to organize the data. In this thesis, a combination of two frameworks will be used. The first framework will be used to detail the validity evidence results and a second framework will be used to make the concluding argument. The combination of frameworks provides complementary lenses through which to view the validity evidence for the UCSOM CPE. Using Messick's framework for validity evidence (the first framework), evidence will be presented based on content, response process, internal structure, relationships to other variables, and consequences. (Messick, 1989) Kane's validity framework (the second framework) will be used to summarize the overall validity argument for the use of the UCSOM CPE as an assessment of PE competence in medical students. (Kane, 2013)

II. METHODS

Instructional Methods and Assessments

The UCSOM CPE consists of a 25-item subset of the originally published 37-item CPE (Gowda, 2014). The UCSOM CPE does not include the neurologic items nor jugular venous pulsation, carotid pulses, temperature, or height/weight/body mass index included in the published CPE, since these PE maneuvers are taught to students as additional PE items that are part of the body system PE maneuvers taught to UCSOM students. The UCSOM PE curriculum is implemented using a combination of PE teaching assistants (who serve as standardized patients and raters for the clinical performance center), senior medical students, and clinical faculty in the pre-clinical years in the context of a clinical skills course. The content of the UCSOM PE curriculum is primarily a body system-based curriculum, but the clinical skills course directors have begun to introduce the CPE as the first step to evolve to a Core + Cluster curriculum as a teaching and learning approach for PE skill development in UCSOM medical students. See Appendix A for a detailed listing of the UCSOM CPE items and scoring criteria.

In the first year of medical school, students learn the UCSOM CPE as well as six complete body systems: head and neck, pulmonary, cardiovascular, abdominal, upper musculoskeletal and lower musculoskeletal body systems. Each set of body system PE maneuvers is made up of a subset of items contained within the UCSOM CPE plus additional PE maneuvers. For instance, the pulmonary body system PE includes 4 CPE maneuvers and 8 additional maneuvers. The total number of items contained within the six body systems is similar in scope to most versions of the HTT with a total of 104 PE items taught at the UCSOM. Later in the first year the UCSOM

CPE is taught as a 25-item cohesive subset of PE maneuvers that borrows from all six body systems. In the second year of medical school, the UCSOM CPE is revisited by students along with the introduction of the neurologic body system PE maneuvers. Students at UCSOM are assessed on their clinical skills in each semester during their clinical skills course. In the first two years of training, clinical skills assessments emphasize either body systems or the UCSOM CPE as the basis for the PE component of each assessment. In the third year, a single 10-station clinical skills assessment emphasizes the selection and performance of PE maneuvers in the context of a series of clinical cases.

Table 1 summarizes descriptive information about the clinical skills assessments at the UCSOM over the first three years of the curriculum. Students are assessed on three out of the six complete body systems in a PE-only Objective Structured Clinical Exam (OSCE) in the fall of their first year (M1-Fall: Systems). Next, students are assessed on the UCSOM CPE in the spring of first year (M1-Spring: CPE) in the context of a comprehensive medical encounter of a patient establishing care in a clinic. In the fall of second year (M2-Fall: Neuro), students are assessed on the neurologic body system examination in the context of a focused medical encounter of a patient presenting with a neurologic complaint. In the spring of second year (M2-Spring: CPE), students are assessed on the UCSOM CPE plus 7 additional items from the abdominal body system as part of comprehensive medical encounter of a patient presenting with an abdominal complaint. During the third year of medical school, medical students have a comprehensive performance assessment that is a 10-station OSCE of focused medical encounters (M3-Spring: OSCE) designed to prepare students for the United States Medical Examination Licensing

Examination (USMLE) Step 2 Clinical Skills assessment. Each case of the M3-Spring: OSCE assessment contains a selected number of UCSOM CPE items and additional PE items based on the presenting complaints of the patient.

Standardized patients (SPs) portray the cases and serve as in-room raters. PE maneuvers are scored as performed, performed incorrectly (partial credit), or not performed. Students are explicitly instructed to perform the full UCSOM CPE in the M1-Spring: CPE and M2 Spring: CPE assessments. All students receive feedback from an expert facilitator during a video review of their performance on both the M1-Spring: CPE and the M2-Spring: CPE assessments. Students scoring below the pass-fail cut point have an additional video review with clinical skills course faculty prior to taking the remediation assessment.

Study Participants

This study was conducted at the UCSOM with data from clinical skills assessments of the medical student Classes of 2019 and 2020 during the first three years of their medical training. For the Class of 2019, 182 students were studied from September 2015 through December 2018. For the Class of 2020, 184 students were studied from September 2016 through December 2018.

The study was considered exempt by the University of Colorado and University of Illinois Chicago institutional review boards.

Validity Evidence

Validity evidence was collected based on Messick's framework. (Messick, 1989)

Content evidence. A focus group of 5 selected content experts including clinical block directors and clinical skills course directors selected the most relevant PE items for the UCSOM CPE from the PE items taught in the UCSOM clinical skills course through discussion and consensus. In creating the UCSOM CPE, these faculty members were asked to consider the adequacy of the UCSOM CPE as an assessment of PE skill in medical students in relation to curriculum goals and learning objectives, appropriateness for starting clinical block experiences, and relevance to clinical practice. The developed UCSOM CPE was presented to the entire group of clinical block directors (approximately 20 members) for discussion of the adequacy of the UCSOM CPE in achieving these aims.

Response process. Assessment materials were created by the clinical course directors. Materials for students included descriptions and explanatory materials for the performance for each PE maneuver, rationale for scoring methods for the PE maneuvers, and an explanation of the use and interpretation of performance scores. The clinical skills course directors and personnel from the clinical performance center assured adherence with the assessment training process and quality assurance procedures related to scoring of the assessment.

Internal structure. The internal structure was assessed by examining reliability using generalizability (G) theory. Variance components and G-studies were conducted using G-String

across the M1-Spring: CPE assessment and the M2-Spring: CPE assessments. (Bloch 2012) Fully-crossed design was used, with person (p) crossed with UCSOM CPE items (i) and occasion (o) as facets. Persons (p) were the objects of measurement, items (i) were fixed (assuming a finite set of CPE items measured), and the occasion (o) for the assessment were considered random (M1-Spring: CPE and M2-Spring: CPE). Other potential facets (i.e., raters) were not considered as this data were not available.

Relationship to other variables. Spearman correlation coefficients were calculated to measure associations between the five clinical skills assessments across the first three years of the curriculum at UCSOM. Spearman correlations were performed in lieu of Pearson correlations as the results of the assessments were not normally distributed given the high overall means for PE performance.

Consequences. The consequences of establishing pass-fail cut scores at the UCSOM using normative standards (1.5 or 2 standard deviations (SD) below the mean), clinical course director determined consensus scores, and an item level, modified Angoff score were explored. Historically, pass-fail cut scores for assessments had been established as either clinical skills course director determined consensus pass-fail cut scores (80% or 75%) or normative determined pass-fail cut scores. For the UCSOM CPE, an item level, modified Angoff standard setting exercise was conducted with 8 faculty including 2 clinical preceptors, 2 clinical block directors, and 4 clinical skills course directors. The experts were asked to estimate the percentage of borderline students who would correctly perform each item. The borderline

student was defined as a minimally competent student to enter into supervised practice with an individual preceptor in their clinical practice setting. Prior to the start of the standard setting process, judgments were informed by performance data from the initial assessments of the UCSOM CPE. The pass-fail cut point was determined following two iterations of discussion at the item level. (Norcini, 2003)

III. RESULTS

Validity Evidence

Content Evidence. The focus group of 5 content experts created the UCSOM CPE as a 25-item set of PE maneuvers to be performed on patients undergoing a comprehensive medical encounter. The group concluded that the UCSOM CPE matched curricular objectives, was appropriate for clinical block experiences, and met their expectations of students entering preceptorship experiences. In addition to justifying the inclusion of individual PE items in the UCSOM CPE, these content experts verified the scoring criteria for each PE maneuver.

Following a presentation of the UCSOM CPE, the entire group of 20 UCSOM clinical block directors attested to the ability of the UCSOM CPE to serve as a foundation of comprehensive medical encounters. The clinical block directors also approved the item performance instructions in the scoring rubric, agreed that the UCSOM would be appropriate for clinical block experiences, and agreed that the UCSOM CPE supported the overall UCSOM clinical skill curriculum objectives. (Appendix A)

Response Process. Assessment materials created by the clinical skills course directors included the SP case, scoring rubrics for clinical skills, and instructions for students, SPs, and raters. Students were provided rationale and explanations of both scoring methods and performance scores.

The clinical performance center training process involved both a 4-hour SP and rater training session and 4-hour SP portrayal and rater practice session. At the SP and rater training session,

the case and scoring rubrics were reviewed in detail with the SPs and raters. Participants were given the opportunity to review and score a video of the case with a mastery performance of the clinical skills. For the SP portrayal and rater practice, SPs portrayed the case for each other and received feedback and raters watched a non-exemplary version of the case and discussed scoring for individual items in a large group.

A subset of all ratings for each SP and rater were reviewed real time by another rater as a quality check of rater performance. Expert raters, in a blinded fashion, re-watched and re-scored videos of all the borderline and failing students, corrected any errors in the initial rater scoring, and provided feedback to the raters for any errors identified. Data related to the inter-rater reliability of rater quality checks or expert rater review of borderline and failing student performance are not available.

Internal Structure. Means and standard deviations for each assessment across the first three years of medical training are shown in Table 1. High overall means of PE performance across the assessments in the first two years of medical training suggest that students are able to perform recently learned PE skills in a clinical performance center assessment setting. The results of the G study for the Class of 2020 are shown in Table 2. Although modest, the largest contributor to score variability was the person-occasion (5.5%) and person-item (5.4%) interactions, indicating that student performance varied by occasion and across items. The overall phi coefficient for the G study of 0.258 suggests low reliability for a single assessment and that other sources of error not considered as facets in this G study contribute significantly

to the variance. Decision (D) studies determined that increasing the number of iterations of assessing the UCSOM CPE to six occasions would increase the phi coefficient to 0.486.

Increasing the number of items in the UCSOM CPE to 37 items (similar to the published CPE) would increase the phi coefficient to 0.281.

Table 1. Summary of UCSOM Clinical Skills Assessments Detailing Number of Core and Non-Core Physical Examination Items

Sequence of Assessments	Exam Content	# UCSOM CPE Items	# Additional PE Items	Mean (SD)	
				Class of 2019	Class of 2020
M1-Fall: Systems*	Cluster 1			92.5 (5.4)	89.9 (5.2)
	- Head and Neck	6	14		
	- Pulmonary	4	8		
	- Upper Musculoskeletal	1	16		
	Total	11	38		
	Cluster 2				
	- Abdominal	4	10		
	- Cardiovascular	7	6		
	- Lower Musculoskeletal	1	18		
	Total	12	34		
M1-Spring: CPE	Comprehensive Medical Encounter: UCSOM CPE items only ^a	25	0	94.8 (5.6)	95.7 (4.8)
M2-Fall: Neuro	Focused Medical Encounter: Neurologic Body System PE items only ^a	0	15	95.6 (4.6)	91.4 (7.5)
M2-Spring: CPE	Comprehensive Medical Encounter: UCSOM CPE items only; additional abdominal PE items not included in analysis ^a	25	0	90.3 (7.5)	91.2 (7.9)
M3-Spring:^b OSCE	Ten Focused Medical Encounters: Various UCSOM PE items and Additional Items	13	16	68.1 (9.1)	Not available

Notes:

* Students are tested on either Cluster 1 or Cluster 2 (3 out of 6 body systems) for the M1 Fall Systems assessment.

^a Same for classes of 2019 and 2020

^b Data available for Class of 2019 only

Table 2: Generalizability Study Class of 2020 with Persons (p) as the Object of Measurement and Occasion (o) and Items (i) as Facets

	Class of 2020		
Effect	Degrees of Freedom	Variance Component	% Variance Component
p	182	0.001	2
o	1	0.001	2.02
i	24	0.001	1.97
po	182	0.002	5.53
pi	4368	0.002	5.41
io	24	0.001	1.58
poi/e	4368	0.036	82.8

Relationship to other variables. Spearman correlations between the UCSOM clinical skills assessments are detailed in Table 3. The UCSOM CPE assessments in M1-Spring: CPE were significantly correlated to the three assessments during years one and two and the M3-Spring: OSCE. Correlations of the M1-Spring: CPE assessment to the M2-Spring: CPE assessment, both of which contain all UCSOM CPE items, were higher than correlations to the body system assessments. Only those students taking both assessments are included in a given correlation.

Table 3: Relationships to Other Variables: Spearman Correlations Between Assessments for the Physical Examination Assessments by Class

Class of 2019	M1-Fall: Systems	M1-Spring: CPE	M2-Fall: Neuro	M2-Spring: CPE
M1-Fall: Systems N=182				
M1-Spring: CPE N=181	0.14 P=.05 179			
M2-Fall: Neuro N=181	0.16 P=.03 179	0.08 P=.28 179		
M2-Spring: CPE N=180	0.20 P<.01 175	.13 P=.08 176	0.20 P<.01 177	
M3-Spring: OSCE N=173	0.20 P=.02 150	0.22 P<.01 150	0.08 P=.31 150	0.08 P=.40 147
Class of 2020	M1-Fall: Systems	M1-Spring: CPE	M2-Fall: Neuro	
M1-Fall: Systems N=184				
M1-Spring: CPE N=183	0.14 P=.05 183			
M2-Fall: Neuro N=184	0.12 P=.11 183	0.18 P=.06 183		
M2-Spring: CPE N=184	0.16 P=.03 183	.23 P<.01 183	0.34 P<.01 184	

Note: Associated p values and numbers of students included in the correlations are included below the correlation.

Consequences. The outcome of the modified Angoff pass-fail score determination was 90%, which would have resulted in a failure rate of 10-13% in the M1-Spring CPE and 36-39% for the M2-Spring CPE. Because of the large number of failures resulting from setting the pass-fail cut point at 90%, the clinical skills course directors carefully considered the consequences of other pass-fail cut points. Failure rates for the 1.5 SD below the mean pass-fail cut point were in the range of 6-8% in the M1-Spring CPE and 5-10% for the M2-Spring CPE. Failure rates for the 80% consensus pass-fail cut point were in the range of 1-2% in the M1-Spring CPE and 8-10% for the M2-Spring CPE. Table 4 shows the numbers of students failing each year based upon the various pass-fail cut points.

Table 4: Impact of Standard Setting for UCSOM CPE in M1 Spring CPE and M2 Spring CPE Assessments

	M1 Spring CPE				M2 Spring CPE			
	Class of 2019 N = 181 Mean (SD) = 94.8 (5.6)		Class of 2020 N = 183 Mean (SD) = 95.7 (4.8)		Class of 2019 N = 181 Mean (SD)= 90.3 (7.6)		Class of 2020 N = 185 Mean (SD) = 91.2(7.8)	
Standard setting method	Cut Score	Number of Failures (%)	Cut Score	Number of Failures (%)	Cut Score	Number of Failures (%)	Cut Score	Number of Failures (%)
Modified Angoff	90%	24 (13%)	90%	18 (10%)	90%	66 (36%)	90%	69 (38%)
1.5 SD Below the Mean	86%	11 (6%)	88%	14 (8%)	79%	9 (5%)	80%	18 (10%)
2 SD Below the Mean	84%	9 (5%)	86%	10 (5%)	75%	4 (2%)	76%	6 (3%)
Consensus cut score: 80%	80%	5 (2%)	80%	2 (1%)	80%	14 (8%)	80%	18 (10%)
Consensus cut score: 75%	75%	1 (0.5%)	75%	1 (0.5%)	75%	4 (2%)	75%	6 (3%)

IV. DISCUSSION

This paper presents initial validity evidence for the use of the UCSOM CPE as an assessment of PE competence in medical students. In the results we detailed the validity evidence obtained from each of Messick's five sources. Here we incorporate that evidence within Kane's validity framework to summarize the overall validity argument for the use of the CPE as an assessment of PE competence in medical students. The argument follows a stepwise approach through each of the four inferences in Kane's validity framework—scoring, generalization, extrapolation, and implications. (Cook, 2015)

The *scoring* inference (translating an observation into a score) was supported by expert review of UCSOM CPE items and ongoing quality assurance processes in the clinical performance center. Formal evaluation of inter-rater reliability of both the real-time quality checks and the video reviews of the borderline and failing students would strengthen this inference. As part of improving the response process for the assessment, clinical skills course directors can better assure that students understand the task of performing the individual PE items for the assessments through think out loud exercises with the scoring rubrics, further enhancing this inference.

The *generalization* inference involves the extent to which a score on a given assessment is representative of performance in a testing setting. The low generalizability coefficient suggests that inferences about PE skills based on the UCSOM CPE alone should be made with caution.

The person-occasion interaction indicates that different students performed differently on

different testing occasions. This is not the same as the case-specificity commonly observed in OSCEs, in which different students perform more or less well on different cases. Case specificity is due to students having to select and perform the history and PE items appropriate to different patients and their presenting problems. In contrast, in both occasions of the UCSOM CPE (M1-Spring: CPE and M2-Spring: CPE) students were explicitly instructed to perform the full CPE, with items known in advance. Learner-specific factors contributing to score differences between occasions may include learning or unlearning (decay) of PE skills from Spring of M1 to Spring of M2 and motivation of individual learners to prepare for the assessment. Rater-specific factors related to the scoring of specific items are another likely source of error contributing to variance. The low (though statistically significant) correlations between performance in M1-Spring and M2-Spring CPEs are consistent with the G-study results. Based on the D-study, moderate improvements in the generalizability coefficient would result from increasing the number of occasions that the UCSOM CPE is assessed, and minimal improvement from increasing the number of items in the UCSOM CPE. The low generalizability coefficient suggests that the UCSOM CPE in isolation should be used primarily as a formative assessment; however, the UCSOM CPE could be in conjunction with other assessments for high-stakes decisions related to advancement and promotion.

The *extrapolation* inference relates to using the score as a predictor of real-world performance. The clinical skills course directors and selected clinical block directors that initially created the UCSOM PE believe that the set of PE maneuvers contained within the UCSOM CPE are very relevant to real-world for performance and can be used as the set of PE maneuvers to be

performed during comprehensive medical encounters in the clinical setting. Additionally, this same group of experts assert that the UCSOM CPE serves as a workable educational strategy for teaching physical examination skills to medical students at UCSOM. Absent performance measures in clinical settings, the relationship of UCSOM CPE scores to other assessments of PE skills may provide some indication of the transfer of skills beyond the UCSOM CPE. The correlations between the various UCSOM clinical skills assessments are similar to the correlations between cases of an OSCE, which has been shown to be in the range of 0.1 to 0.3 between stations. (Folque de Mendoca Patricio, 2012 and Elstein, 1978) These correlations between different PE assessments are consistent with case specificity, since each of the system-based assessments included different subsets of CPE and non-CPE items. The correlation to the 10-station M3-Spring: OSCE provides the closest proxy to a real patient care setting. The slightly stronger correlation is probably due to the (presumptively) higher reliability of a 10-station assessment.

The *implication* inference (applying the score to inform a decision) was probed by exploring the impact of different passing standards. The consensus pass-fail cut scores and the normative cut scores were significantly lower than the cut score established using the modified Angoff procedure. The 90% Angoff cut score would result in a large number of student failures, especially for the M2-Spring: CPE (36–38% failure rate), when compared to 1.5 SD below the mean cut score (5-10% failure rate) and the 80% consensus cut score (8-10% failure rate) for the same assessment. Our experience at UCSOM suggests that the 90% cut score may realistically represent a well-prepared level of PE competence for entering into supervised

clinical practice, rather than the targeted minimally competent or borderline student for entry into a pre-clinical supervised preceptorship. As all students participate in video review of their CPE performance with an expert faculty facilitator, many deficiencies in clinical performance are identified and corrected making additional remediation of students scoring near but below the 90% pass-fail cut score unnecessary. Given the low reliability and the resources involved in preparing and implementing the remediation assessment, establishing a pass-fail cut score at 90% seems unwarranted. Ultimately, the clinical skills course directors considered the 80% consensus pass-fail cut score as a defensible (because of the lack of high correlations to other PE competence assessments) and practical (because of the costs involved in remediating large numbers of students) pass-fail cut point for the UCSOM CPE in its current educational context for entry into supervised practice within a clinical preceptorship experience.

As the UCSOM CPE is an institution-specific, 25-item version of the published 37-item CPE, the applicability of these results to the full CPE may be limited. High overall means on the assessments during the first two years of medical training demonstrate that students perform well on assessments close in proximity to the educational sessions in which they learn the PE materials relevant for that assessment. This supports the use of the UCSOM CPE as an instructional strategy for teaching medical students initial PE skills. The decline in performance on the UCSOM CPE from M1-Spring: CPE to M2-Spring: CPE suggests that additional practice sessions and repeated CPE assessments should be offered to assure PE skill competence. Follow-up assessments of CPE performance throughout medical school may help better understand this decline.

Next steps in the evolution of the UCSOM PE curriculum towards a Core + Cluster curriculum include a transition away from body systems to specific PE clusters with a continuing emphasis on the UCSOM CPE. These curricular changes should prompt an increase in the frequency of assessment using the UCSOM CPE, the introduction of new assessments focused on the selection of PE clusters based on presenting symptoms, and adjustments to the sequencing of the UCSOM assessments. Additional assessments of PE performance should be considered in clerkships and clinical preceptorship experiences. Furthermore, a review of the communication skills assessment and medical documentation skills assessment would facilitate a review of the overall clinical skills assessment structure at UCSOM. The new assessment framework would likely continue to include frequent assessments but with multiple stations for each clinical skill domain (i.e. PE, communications, medical documentation) rather than formative, single case assessments integrating PE, communication, and medical documentation skills.

Scholarly work related to the development and incorporation of PE clusters as part of the PE curriculum for the Core + Cluster curricula at UCSOM, an expansion of the items included in the UCSOM CPE, and additional correlations to other variables, such as performance in clerkships or to the USMLE Step 2 Clinical Skills assessment would be reasonable next steps in the evolving considerations for teaching and assessing PE competence in medical students.

V. CONCLUSION

This paper presents the initial argument for the use of UCSOM CPE in the assessment of the PE skills of pre-clinical medical students. Validity evidence supports the use of the UCSOM CPE as an instructional strategy for teaching medical students physical examination skills and as a formative assessment of readiness for precepted clinical experiences. UCSOM CPE scores may be used in conjunction with other assessments of the PE to support high-stakes decisions such as readiness to advance into clinical rotations.

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VII. LIST OF TABLES

Table 1. Summary of UCSOM Clinical Skills Assessments Detailing Number of Core and Non-Core Physical Examination Items

Sequence of Assessments	Exam Content	# UCSOM CPE Items	# Additional PE Items	Mean (SD)	
				Class of 2019	Class of 2020
M1-Fall: Systems*	Cluster 1			92.5 (5.4)	89.9 (5.2)
	- Head and Neck	6	14		
	- Pulmonary	4	8		
	- Upper Musculoskeletal	1	16		
	Total	11	38		
	Cluster 2				
	- Abdominal	4	10		
	- Cardiovascular	7	6		
	- Lower Musculoskeletal	1	18		
	Total	12	34		
M1-Spring: CPE	Comprehensive Medical Encounter: UCSOM CPE items only ^a	25	0	94.8 (5.6)	95.7 (4.8)
M2-Fall: Neuro	Focused Medical Encounter: Neurologic Body System PE items only ^a	0	15	95.6 (4.6)	91.4 (7.5)
M2-Spring: CPE	Comprehensive Medical Encounter: UCSOM CPE items only; additional abdominal PE items not included in analysis ^a	25	0	90.3 (7.5)	91.2 (7.9)
M3-Spring:^b OSCE	Ten Focused Medical Encounters: Various UCSOM PE items and Additional Items	13	16	68.1 (9.1)	Not available

Notes:

* Students are tested on either Cluster 1 or Cluster 2 (3 out of 6 body systems) for the M1 Fall Systems assessment.

^a Same for classes of 2019 and 2020

^b Data available for Class of 2019 only

Table 2: Generalizability Study Class of 2020 with Persons (p) as the Object of Measurement and Occasion (o) and Items (i) as Facets

	Class of 2020		
Effect	Degrees of Freedom	Variance Component	% Variance Component
p	182	0.001	2
o	1	0.001	2.02
i	24	0.001	1.97
po	182	0.002	5.53
pi	4368	0.002	5.41
io	24	0.001	1.58
poi/e	4368	0.036	82.8

Table 3: Relationships to Other Variables: Spearman Correlations Between Assessments for the Physical Examination Assessments by Class

Class of 2019	M1-Fall: Systems	M1-Spring: CPE	M2-Fall: Neuro	M2-Spring: CPE
M1-Fall: Systems N=182				
M1-Spring: CPE N=181	0.14 P=.05 179			
M2-Fall: Neuro N=181	0.16 P=.03 179	0.08 P=.28 179		
M2-Spring: CPE N=180	0.20 P<.01 175	.13 P=.08 176	0.20 P<.01 177	
M3-Spring: OSCE N=173	0.20 P=.02 150	0.22 P<.01 150	0.08 P=.31 150	0.08 P=.40 147
Class of 2020	M1-Fall: Systems	M1-Spring: CPE	M2-Fall: Neuro	
M1-Fall: Systems N=184				
M1-Spring: CPE N=183	0.14 P=.05 183			
M2-Fall: Neuro N=184	0.12 P=.11 183	0.18 P=.06 183		
M2-Spring: CPE N=184	0.16 P=.03 183	.23 P<.01 183	0.34 P<.01 184	

Note: Associated p values and numbers of students included in the correlations are included below the correlation.

Table 4: Impact of Standard Setting for UCSOM CPE in M1 Spring CPE and M2 Spring CPE Assessments

	M1 Spring CPE				M2 Spring CPE			
	Class of 2019 N = 181 Mean (SD) = 94.8 (5.6)		Class of 2020 N = 183 Mean (SD) = 95.7 (4.8)		Class of 2019 N = 181 Mean (SD)= 90.3 (7.6)		Class of 2020 N = 185 Mean (SD) = 91.2(7.8)	
Standard setting method	Cut Score	Number of Failures (%)	Cut Score	Number of Failures (%)	Cut Score	Number of Failures (%)	Cut Score	Number of Failures (%)
Modified Angoff	90%	24 (13%)	90%	18 (10%)	90%	66 (36%)	90%	69 (38%)
1.5 SD Below the Mean	86%	11 (6%)	88%	14 (8%)	79%	9 (5%)	80%	18 (10%)
2 SD Below the Mean	84%	9 (5%)	86%	10 (5%)	75%	4 (2%)	76%	6 (3%)
Consensus cut score: 80%	80%	5 (2%)	80%	2 (1%)	80%	14 (8%)	80%	18 (10%)
Consensus cut score: 75%	75%	1 (0.5%)	75%	1 (0.5%)	75%	4 (2%)	75%	6 (3%)

VIII. APPENDIX

UCSOM CPE Items and Scoring Rubric

Question Text	Instructions
GENERAL: Performed general assessment.	Learner must verbalize assessment of <u>one or more</u> of the following: level of distress, stated age, nutritional status, OR clothing.
VITALS: Measured and assessed heart rate, rhythm, and quality.	Learner must take pulse, verbalize rate AND assessment of rate, rhythm, OR quality
VITALS: Measured blood pressure and stated systolic and diastolic pressures	Learner must take blood pressure on one arm AND verbalize results. At least arm should be supported and legs uncrossed.
VITALS: Measured respiratory rate and assessed rate and character of respirations	Learner must measure respirations, verbalize measurement AND assessment of the character of respirations.
HENT CORE: Completed an external inspection of the eyes.	Learner must verbalize external inspection of eyes including orbital area, conjunctiva, sclera, iris, OR pupils.
HENT CORE: Tested pupillary reaction to light.	Learner must test pupillary reaction to light using a light source.
HENT CORE: Inspected oral cavity.	Learner must inspect the oral cavity (lips, teeth, gums, mucous membranes, and tongue), AND at a minimum verbalize inspection of <u>one</u> area. Inspection items can include color, lesions, swelling, contour/movement of tongue, OR dental health.
HENT CORE: Inspected posterior pharynx.	Learner must inspect the posterior pharynx (palate, uvula, tonsils, & pharynx) AND at a minimum verbalize inspection of <u>one</u> area. Inspection items can include color, exudates, lesions, OR tonsil size.
HENT CORE: Palpated submandibular, anterior cervical and supraclavicular lymph nodes.	Learner must verbalize the names of and palpate submandibular, anterior cervical, and supraclavicular lymph nodes AND at a minimum verbalize inspection of <u>ONE</u> area. Inspection items

	can include size, consistency, mobility, shape, tenderness, OR symmetry.
HENT CORE: Palpated thyroid.	Learner must verbalize palpation of thyroid for size, symmetry, nodules, enlargement, or tenderness. Maneuver could be performed with or without swallowing.
CV CORE: Inspected and palpated the precordium including the apical impulse/PMI	Learner must expose chest in order to inspect. Palpate precordium AND apical impulse/PMI.
CV CORE: Auscultated heart with diaphragm with patient supine.	Learner must auscultate on skin using diaphragm with patient supine, in minimum of 4 sites including 2nd interspaces R & L sternal borders, 4th/5th interspaces L sternal border, & apex
CV CORE: Auscultated apex of heart with bell with patient supine.	Learner must auscultate on skin using bell at the 5th interspace midclavicular line
CV CORE: Assess lower extremities for edema comparing side to side.	Learner must assess for edema on at least one location on the lower extremities comparing side to side for five seconds.
CV CORE: Palpated radial AND dorsalis pedis OR posterior tibial pulses.	Learner must palpate pulses using 2-3 fingers on the skin and compare side to side.
PULM CORE: Inspected front, back and ribs for size, shape, symmetry, and use of accessory muscles or presence of retractions.	Learner must expose chest and verbalize inspection of chest for size, shape, or symmetry, AND use of accessory muscles or presence of retractions.
PULM CORE: Percussed the posterior chest	Learner must percuss minimum of 3 regions and compare side to side
PULM CORE: Auscultated the anterior AND posterior chest.	Learner must auscultate a minimum of 2 regions on anterior chest AND 3 regions on posterior chest

ABD CORE: Inspected skin, size, shape, and contour.	Learner must have patient in supine position with abdomen exposed from sternum to pubic symphysis using gown and drape to maintain modesty AND verbalize inspection of some aspect of the skin size, shape, OR contour of abdomen.
ABD CORE: Auscultated 4 quadrants of the abdomen.	Learner must listen in all 4 quadrants of the abdomen prior to percussion or palpation.
ABD CORE: Performed light and deep palpation.	Learner must perform light and deep palpation in 4 quadrants. (all 4 quadrants light and then all 4 deep, or can do light then deep at same time)
ABD CORE: Palpated the liver edge.	Learner must perform and verbalize palpation of the liver edge. (can use hook method)
UE/LE CORE: Performed a general inspection front and back of each extremity.	Learner must inspect front & back of arms and legs, and verbalize inspection for gross deformity, alignment, symmetry, muscle hypertrophy, OR muscle atrophy. (can be sitting or standing)
UE/LE CORE: Performed a general inspection of joints.	Learner must inspect hands and knees and verbalize inspection for swelling, redness, OR deformities bilaterally.
SKIN/HAIR/NAILS CORE: Inspected skin.	Learner must verbalize inspection of skin for color, lesions, OR moisture. Can be done while performing any body area (pulm/CV/ABD/Extremities).

IX. VITA

Todd Anthony Guth, M.D

1. General Information

Work Address: University of Colorado
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 12401 East 17th Avenue
 Aurora, CO 80045
 (720) 848-6863 Office

Home Address: 9197 East 28th Place
 Denver, CO 80238

E-mail: todd.guth@ucdenver.edu

2. Education

Medical and Undergraduate Education:

2000	Doctor of Medicine University of Chicago, Pritzker School of Medicine
1995	Bachelor of Arts, Biological Sciences John Carroll University

Graduate Medical Education:

2006-2010	Residency in Emergency Medicine Denver Health Medical Center Denver, CO
2000-2001	Internship in Internal Medicine National Naval Medical Center Bethesda, MD

Post-Graduate Education:

2012-Present	Master of Health Professions Education (ongoing) University of Illinois, Chicago Chicago, IL
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Thesis Project for Completion in 2019: Validity Evidence for the Core Physical Examination using Messick's Validity Framework

3. Physician Appointments

Current roles: *I currently serve in two roles in the UCSOM undergraduate medical curriculum as the **Associate Director of Clinical Skills, Foundations of Doctoring Curriculum** and the **Co-Director of the Emergency Care Clerkship**. I work clinically as an Attending Physician at the University of Colorado Hospital on the Anschutz Medical Campus. I have previously worked in the United States Navy as part of a Health Professions Scholarship that I received for medical training. During my time in the Navy, I served as a flight surgeon on an aircraft carrier for two combat deployments and several humanitarian relief missions.*

Academic Appointments:

2012-Present Assistant Professor

University of Colorado, School of Medicine
Department of Emergency Medicine
Anschutz Medical Campus
Aurora, CO

2010-2012

Medical Education Research Fellow
University of Colorado, School of Medicine
Department of Emergency Medicine
Anschutz Medical Campus
Aurora, CO

2009-2010

Chief Resident, Emergency Medicine
Denver Health Medical Center
Denver, CO

Clinical Appointments:

2010-Present Attending Physician

University of Colorado Hospital
Department of Emergency Medicine
Anschutz Medical Campus
Aurora, CO

2007-2009

Flight Surgeon, Colorado Air National Guard
Buckley Air Force Base, Denver, CO

2004-2006

Flight Surgeon, Fleet Logistics Support Squadron THREE ZERO
Naval Air Station North Island, CA

2002-2004

Flight Surgeon, Carrier Air Wing THREE
Naval Air Station Jacksonville, FL

2002-2004

Flight Surgeon, USS Harry S. Truman
Naval Station Norfolk, VA

4. Leadership Positions

National Positions:

2015-2012	Society of Academic Emergency Medicine (SAEM) Sub-Committee Chair for Medical Student Symposium to the Program Committee
2009-2011	Emergency Medicine Residents' Association (EMRA) Academic Affairs Representative Executive Member, Board of Directors Chairman, EMRA National Educational Task Force
2009-2011	Council of Residency Director (CORD) EMRA Resident Liaison to the Board of Directors
2010-2011	Society of Academic Emergency Medicine (SAEM) EMRA Resident Liaison to the Board of Directors

Institutional Positions:

2014-Present	Emergency Medicine Clerkship, Co-Clerkship Director
2011-Present	Foundations of Doctoring Course, Associate Director of Clinical Skills
2013-2015	Foundations of Doctoring Course, Interim Director of Physical Examination
2011-2014	Emergency Medicine Clerkship, Assistant Clerkship Director

Departmental Positions:

2015-Present	Denver Health Residency in Emergency Medicine, Education Track Faculty Co-Chair and Resident as Educator Module Leader
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5. Membership in Professional Organizations

Professional Societies:

2010-Present	Association of American Medical Colleges (AAMC)
2006-Present	Emergency Medicine Residents' Association (EMRA)
2006-Present	Society of Academic Emergency Medicine (SAEM)
2005-Present	American College of Emergency Physicians (ACEP)

2004-Present	American Academy of Emergency Medicine (AAEM)
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6. Licensure and Certifications

2011	Emergency Medicine Board Certified, American Board of Emergency Medicine
2007	Medical License, State of Colorado, Current

7. Major Committee and Service Responsibilities

Current Committees: *I currently serve as a **Subcommittee Chair** and **Committee Member for the Academic Affairs Committee** for the American College of Emergency Physicians. In this committee, I help address education and training issues that impact medical students, resident physicians, and practicing physicians. I also serve on two UCSOM educational committees, the **Clinical Block Directors Committee** and the **Longitudinal Curriculum Committee**, and participate in task forces as required. I serve as a member of the Clinical Pathways Committee and the Continuous Quality and Improvement Committee for the Department of Emergency Medicine to develop efficient and consistent clinical care pathways and ongoing quality improvement efforts for the patients presenting to our emergency department for care. Lastly, I serve on the Denver Health Residency in Emergency Medicine Education Committee providing input and oversight for the educational experiences within our local residency program.*

National Committees:

2010-Present	ACEP, Academic Affairs Committee, Member, Subcommittee Chair
2016	National Board of Medical Examiners (NBME), Served as a United States Medical Licensing Examination (USMLE) Step 2 Clinical Skills Pilot Standard Setting Panelist
2011-2015	SAEM, Annual Meeting Program Planning Committee, Member National Medical Student Symposium, Sub-Committee Chair

Institutional Committees:

2014-Present	Clinical Block Directors Committee, Member
2011-Present	Longitudinal Curriculum Committee, Member
2010-2016	Academy of Medical Educators, Executive Committee, Member

Departmental Committees:

2015-Present	Clinical Pathways Committee, Member
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2012-Present	Emergency Department Continuous Quality and Improvement Committee, Member
2009-Present	Denver Health Residency in Emergency Medicine (DHREM), Education Committee, Member
2009-20017	DHREM, Program Evaluation and Advisory Committee, Member

8. Honors, Special Recognition, and Awards

2017	Selection as an Affiliate Faculty Member of the Center for Bioethics and Humanities at the University of Colorado School of Medicine.
2016	Selection as a Member of the Academy of Medical Educators at the University of Colorado School of Medicine.
2016	Selection as the Outstanding Clinical Educator in 2016 by the Graduating Class of 2016 at the University of Colorado School of Medicine.
2013	EMRA Outstanding Contribution to Emergency Medicine Education Award as Editor-in-Chief of Resident as Educator handbook.
2012	Patient Safety and Quality Improvement Travel Scholarship and Award National Patient Safety Conference, "Transforming Mindsets"
	Outstanding Manuscript in Leadership and Organization Structure for MHPE 504 Course in Health Professions Master Degree
2009	Outstanding Resident in Pediatric Emergency Medicine
2008	EMRA, Local Action Award Denver CARES Winter Clothing Drive
2000	University of Chicago, Pritzker School of Medicine Graduation with Honors
1995	John Carroll University Graduation with Honors Summa Cum Laude Outstanding Graduate of the Biological Sciences Alpha Sigma Nu, Jesuit National Honor Society Kolenich Award Outstanding Graduate in the Pre-Health Professions

9. Research Training and Education

2010-2011	Teaching Scholars Program (Audited Program) University of Colorado, Academy of Medical Educators
2009-2010	Medical Education Research Certificate (MERC) Program Sponsored by Council of Residency Directors (CORD) and Association of American Medical Colleges (AAMC)
2009-2010	ACEP Teaching Fellowship ACEP Headquarters, Dallas, TX
2008-2009	ACEP Emergency Medicine Basic Research Skills (EMBRs) Workshop ACEP Headquarters, Dallas, TX

10. Report of Teaching:

Teaching Focus:

*My teaching focuses upon **undergraduate medical education** but also includes **graduate medical education** and **continuing medical education**. The bulk of my teaching at the UCSOM and nationally has been focused on medical students as the target audience and as the subjective matter for presentations involving the **teaching of clinical reasoning**, the **remediation of challenging learners**, and the **teaching bedside clinical skills**. I have spoken nationally on the development of Resident as Educator programs and provided workshops on Resident as Educator topics. This work culminated in the publication of a Resident as Educator Handbook that is used by many emergency medicine residency programs as a resource for their resident as educator programs. **I was inducted into the Academy of Medical Educators based upon my direct teaching and curriculum development efforts in 2016.***

Undergraduate Medical Education:

2012- Present	Foundations of Doctoring Curriculum, UCSOM
	Associate Director of Clinical Skills
	Faculty Preceptor
	Communications Small Group Coach
	Physical Examination Small Group Facilitator
	Interim Associate Director of Physical Examination (2013-2015)

Within the Foundations of Doctoring Curriculum, I serve as the primary faculty member for the development and implementation of the clinical reasoning sub-curriculum and for the development and implementation of the clinical skills assessments. I also serve

as a small group facilitator for some physical examination sessions, as a faculty preceptor for students needing additional clinical hours or remediation of clinical skills during preceptorship, and, as a communication coach for some communications sessions. I also provide remediation support for students who are needing to remediate clinical skills assessments.

2010-Present	Third-Year Clerkship in Emergency Medicine, University of Colorado School of Medicine Clerkship Co-Director Facilitator of Problem-Based Learning Sessions Facilitator of Simulation Sessions Assistant Clerkship Director (2011-2014)
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Within the Emergency Care Clerkship, I serve as a co-director for the course and provide regular direct teaching for educational sessions, including our end of block inter-professional simulation. I have developed and implemented the educational materials used in the clerkship and serve as a Teaching Attending for students rotating on the clerkship.

2011-2012	Inter-Professional Education Curriculum Large Group Facilitator
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2009-2012	Integrated Clinician's Course, University of Colorado School of Medicine Small Group Facilitator Root Cause Analysis Facilitator and Discussant
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Graduate Medical Education:

2016-Present	Resident as Educator Module Director for DHREM
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2011-2017	Gastroenterology and General Signs and Symptoms Module Director for DHREM
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2010-2014	Evidence Based Emergency Medicine, Faculty Member, for DHREM
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2009-2010	Residents as Teachers Course University of Colorado School of Medicine Small Group Facilitator
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10. Selected Presentations and Lectures

Speaking Focus:

My primary areas of selected presentations and lectures involve 1) the development of clinical reasoning skills in medical students, 2) the teaching of clinical skills at the bedside, 3) the development of resident as educator programs, and 4) the remediation of struggling learners.

International Presentations:

"You are not born with it: Teaching intuitive reasoning" Invited workshop. Montreal International Clinical Reasoning Conference, 2014.

National and Regional Presentations:

"Teaching Procedural Skills: It's not do one, see one, teach one anymore." ACGME National Meeting, Orlando, FL March 2017.

"Taking Advantage of the Teachable Moment: A Workshop for Efficient, Learner Centered Clinical Teaching." SAEM National Meeting, New Orleans, LA May 2016.

"Stump the Experts: Solving Challenging Cases in Remediation." SAEM National Meeting, New Orleans, LA May 2016.

"Effective Bedside Teaching" for the Chief Resident Academic Leadership Forum at the SAEM National Meeting, New Orleans, LA May 2016.

"Inter-professional Education in the Emergency Medicine Clerkship." CORD Academic Assembly, Nashville, TN March 2016.

"Diagnosing and Treating the Struggling Learner." SAEM National Meeting, San Diego, CA May 2015.

"Teaching Procedural Skills: It's not do one, see one, teach one anymore." SAEM National Meeting, San Diego, CA May 2015.

"Is it bad? Introversion in EM Bound Students and Residents." CORD Academic Assembly, Phoenix, AZ March 2015.

"Teaching Intuitive Clinical Reasoning: Helping Novices Become Experts." CORD Academic Assembly, New Orleans, LA March 2014.

"Teaching the Difficult Learner Workshop." CORD Academic Assembly, New Orleans, LA March 2014.

"The Why, What, and the How for Developing Physician as Educator Programs for Residents or Medical Students." SAEM National Meeting, Dallas, TX May 2014.

“Effective Use of Clinical Teaching Models.” ACGME National Meeting, Washington DC, March 2014.

Taking Advantage of the Teachable Moment: A workshop for efficient, learner centered clinical teaching.” SAEM National Meeting, Atlanta, GA May 2013.

“Deliberate Metacognition: Teaching learners how to think about how they think.” CORD Academic Assembly, Denver, CO March 2013.

“Resident as Teacher Workshop.” CORD Academic Assembly, Denver, CO March 2013

“Resident as Educator: Clinical Teaching Scripts and Bedside Teaching.” ACEP Scientific Assembly, Resident Track, Denver, CO October 2012.

“Resident as Educator: Learner Centered Teaching” ACEP Scientific Assembly, Resident Track, San Francisco, CA October 2011.

“Understanding Medical Liability Reform” and “Availability of On-call Specialists for Emergency Departments” Small group facilitator. ACEP Leadership and Advocacy Conference, Washington DC, May 2011.

“Chief Resident Panel” served as Panel Moderator and Panel Member, SAEM Annual Meeting, Chief Resident Forum, Boston, MA June 2011.

“Medical Student Forum - Resident Panel” served as Panel Moderator, SAEM Annual Meeting, Medical Student Symposium, Boston, MA, June 2011.

“Top Ten Mistakes to Avoid in Residency” SAEM Western Regional Meeting, Keystone, CO February 2011.

“Rural Workforce Issues in Emergency Medicine” and “Funding Graduate Medical Education” Small group facilitator. ACEP Leadership and Advocacy Conference, Washington DC, May 2010.

Institutional Presentations:

“Introduction to Advocacy in Colorado.” Inaugural Advocacy Day for Denver Health Residency in Emergency Medicine, April 2013.

“Learning Centered Case Based Teaching” Chief Resident Retreat for University of Colorado Chief Residents, Academy of Medical Educators, 2012

“Evidence-Based Emergency Medicine on the Fly” an interactive workup for use of evidence-based emergency medicine resources while working clinically. Evidence-Based Emergency Medicine Course, DHREM, 2011.

“When Mistakes Happen: The Authentic Apology” a small group workshop for the introduction to the conversation of medical error by physicians with their patients, DHREM, 2011.

“Learner-Centered Teaching Scripts” a small group workshop for the introduction of both SNAPPS and One-Minute Preceptor teaching scripts, DHREM 2010, and Department of Emergency Medicine Faculty Retreat, 2011.

11. Research and Publications

Research Focus:

*My published research focuses on the development of **medical education research fellowships** in emergency medicine and **bedside teaching skills**. I have begun to disseminate scholarship on the development of **clinical reasoning curricula**, the development of **inter-professional, team-based simulations** in emergency medicine, and validity evidence for the use of the **core physical examination** in clinical skills training. Other areas of interest in scholarship include 1) the development of assessments in both graduate and undergraduate medical education with a focus on clinical reasoning, team communication, and clinical skill development, 2) the development of inter-professional educational experiences in the clinical environment, and 3) the development of curricula and educational materials to develop residents as educator programs.*

Peer-Reviewed Articles:

Singh R, Huang S, **Guth T**, Konieczkowski M, Sedor JR. Cytosolic domain of the type I interleukin-1 receptor spontaneously recruits signaling molecules to activate a proinflammatory gene. *J Clin Invest*. 1997 Jul 15;100(2):419-28.

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