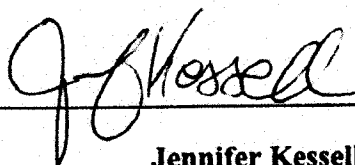
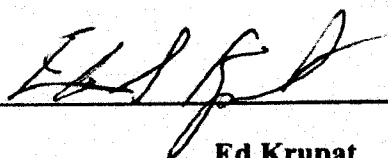


This Thesis, Examining Uncertainty in Internal Medicine Education: A Mixed Methods Study, presented by Mark Johnson, and Submitted to the Faculty of The Harvard Medical School in Partial Fulfillment of the Requirements for the Master of Medical Sciences in Medical Education has been read and approved by:



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Date: April 30, 2018



HARVARD
MEDICAL SCHOOL

Master of Medical Sciences
in Medical Education

EXAMINING UNCERTAINTY IN INTERNAL MEDICINE EDUCATION:
A MIXED-METHODS STUDY

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A Thesis Submitted to the Faculty of
The Harvard Medical School
in Partial Fulfillment of the Requirements
for the Degree of Master of Medical Sciences in Medical Education
Harvard University
Boston, Massachusetts.
May, 2018

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Abstract

Objective: Tolerance of uncertainty is recognized by the ACGME as an important competency for physicians. Predictions for the future role of physicians in settings where informatics and algorithms aid decisions points to the importance of embracing uncertainty in order to 1) avoid pitfalls of uncertainty and 2) develop trusting and meaningful doctor-patient relationships. This study aimed to identify perceptions and behaviors related to uncertainty.

Study Design and Setting: This mixed-methods study explored perceptions and manifestations of uncertainty in the hospital setting at a US academic medical center. Qualitative methods included observations of clinical activities and interviews with resident and attending physicians. A cross-sectional survey utilized three validated survey instruments assessing perceptions of uncertainty, the learning environment, and symptoms of burnout.

Results: Four ethnographic themes were identified: 1) acknowledging uncertainty 2) sharing uncertainty in the healthcare environment 3) strategies for dealing with uncertainty: actions and inactions, and 4) understanding the impact of uncertainty on the patient. Six qualitative themes were identified in interviews: 1) awareness of uncertainty, 2) uncertainty is multi-dimensional, 3) challenges with uncertainty, 4) ways of dealing with uncertainty, 5) the impact of uncertainty in the learning environment, and 6) desire for culture change. Surveys demonstrated residents have more perceived stress from uncertainty than attending physicians

(15.6 [5.0] vs. 19.0 [3.6], $p < 0.05$). Residents also had significantly higher symptoms of burnout than attending physicians (7.1 [2.9] vs. 4.9 [2.0], $p < 0.05$). Higher anxiety from uncertainty significantly correlated with perceiving the learning environment as more competitive and stressful ($r = 0.51$, $p < 0.01$) and increased symptoms of burnout ($r = -0.41$, $p < 0.01$). No significant correlations were noted between disclosure of uncertainty, gender, and years since graduating medical school.

Conclusions: Uncertainty is rife in the academic inpatient medical setting, and is perceived and acted upon differently by resident and attending physicians. Perceptions and behavior in relation to uncertainty is influenced by the learning environment and the culture of medicine. It seems essential for the medical education system to develop strategies to embrace uncertainty to benefit physician wellness and promote high quality therapeutic relationships with patients.

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Acknowledgements

What made this project unique, and also fulfilling, was how a community of people united around a shared curiosity. Each individual who played a part in this project contributed something unique and valuable to what is now the finished product. I am grateful for those who decided to take up the research process with me, including my advisors Arabella Simpkin (MD, MMSc) and Gordon Schiff (MD) as well as my qualitative research teammates Horatio Rudolph Thomas and Galina Gheihman — this project would not be the quality it is today without you.

My ability to conduct this project rests in gratitude to the robust support of my committee member and mentor, Andrew Olson (MD). Andrew went beyond signing the IRB to generously make himself available throughout the research process to get things done. But that is not all. Andrew also listened and patiently guided me through the daunting challenge of the residency selection process.

Central to the quality of this research was the openness and generosity of the resident and attending physicians of the University of Minnesota Department of Medicine who provided not only their time, but honesty and transparency for the lived experience of medical practice and training. Their contributions added to the richness and depth of this study in meaningful ways.

I am grateful to the Masters of Medical Sciences in Medical Education program leadership, Jennifer Kesselheim (MD, MEd, MBE) and Ayres Heller (MEd), for their guidance, council, and wisdom in fulfilling the requirements of this degree granting program. Their advice, together with committee member Edward Krupat (PhD), greatly enriched my experience.

Throughout each phase of my education and life's journey have been my parents, William and Kristin Johnson, and sister Janna with their tireless support and council which I value so greatly. It is their listening, accommodation, and generosity that endures and continues to provide me with balance.

This work was conducted with support from Students in the Master of Medical Sciences in Medical Education program of Harvard Medical School. The content is solely the responsibility of the authors and does not necessarily represent the official views of Harvard University and its affiliated academic health care centers.

CHAPTER 1: INTRODUCTION AND BACKGROUND

The quest to eliminate or minimize uncertainty from clinical practice has been a central paradigm in modern medicine. In the last fifty years, biomedical research has driven the emergence of evidence-based medicine, which brings the best scientific evidence to the clinician and patient decision-making process. Exponential face-paced growth in biomedical research continues to push the frontier of knowledge and enhance diagnostic and therapeutic understandings of disease. More recently, precision medicine has attempted to further reduce uncertainty in the diagnostic process through the use of genomics and proteomics to inform and tailor individual therapies. The new field of biomedical artificial intelligence (AI) melds human and machine learning, bringing algorithms to anything that can be automated, aiming to improve and aid human reasoning. While all of these forces are driving medicine to achieve new successes and frontiers, doctors are also keenly aware of the what is perhaps the most important skill required to practice clinical medicine — the need to navigate diagnostic and therapeutic decision-making in the face of ubiquitous uncertainties.

Although uncertainty is undoubtedly inherent to medicine, its presence makes most of us deeply uncomfortable. It is in all aspects of life which are non-linear, complex, and often unpredictable. Clinical practice is no exception (Ghosh, 2004). It manifests in physician and patient uncertainty about the future, biological variability of disease, cognitive bias, errors in test interpretation, differing opinions and values among patients and providers, and in the process complexities of healthcare systems (Han, Klein, & Arora, 2011). Historically, uncertainty was identified as an important part of the practice of medicine. William Osler famously coined medical practice as a “science of uncertainty, and an art of probability” (Bean & Bean, 1950). Tolerating uncertainty is an important and necessary skill for effective patient care and for the self-care of the physician. It has also been recognized by the Accreditation Council in Graduate Medical Education (ACGME), and is included in their milestones as an important competency for trainee physicians (The Internal Medicine Milestone Project., 2015) (The Lancet, 2010). Approaches to dealing with uncertainty in medicine is receiving renewed attention as a “new frontier” in the age of faster expanding patient centered precision medicine and therapeutic advancement (Simpkin & Schwartzstein, 2016). Predictions for the future role of physicians, in a setting where informatics and algorithms aid decisions, points to the importance of skill in embracing the lived experience of uncertainty for patients in order to form a trusting and meaningful doctor-patient relationship – essential for authentic patient-centered care (Armstrong, 2018).

Unfortunately, within the culture of medicine there is a deep rooted unwillingness to acknowledge uncertainty (Logan & Scott, 1996). Prior studies link intolerance of uncertainty to burnout, ineffective communication strategies, cognitive bias, and inappropriate resource use (Kruglanski & Webster, 1996) (Bhise et al., 2018) (Cooke, Doust, & Steele, 2013). In the setting of medical education lies increasingly worrisome statistics on physician burnout, which appear to be accelerating (Shanafelt et al., 2015). Roughly half of medical residents are burned out, have a high rate of suicide among professionals, and may contribute to career shifts away from medicine for a more sustainable work-life balance. Perceptions that link anxiety to uncertainty with validated measures of burnout and resilience are also well known (Simpkin et al., 2018). Little is understood, however, between how tolerance of uncertainty changes, develops, or is perceived by different roles in the academic culture of medicine.

Working Definitions of Uncertainty in Medicine: Can they be Unified?

Uncertainty in healthcare lacks a unified definition and conceptual model. Physicians, nurses, and other healthcare providers have written about uncertainty extensively, and voice the need for acknowledgment because of its centrality to the lived experience of patients and healthcare providers. The concept of uncertainty is generally thought of as a subjective cognitive awareness of one's lack of knowledge. It is a form of metacognition, or an awareness and understanding of one's own thought process (Merriam-Webster, Inc, 2004). When individuals sense this, different behavioral actions must inherently follow. It is the inherent variation of behavior when uncertainty is perceived that lack investigation and clear understanding in medicine.

Different taxonomies of uncertainty in healthcare have been proposed (Alam et al., 2017). In general, uncertainty is categorized into knowledge limitations of the underpinnings of disease, the healthcare process, and the lived patient-centered experience. More complex models include reference to the higher-level cognitive reasoning processes that individuals face (Han et al., 2011). These taxonomies call out a key dichotomous distinction for uncertainty separating “knowable” from “unknowable” forms of knowledge.

As an example, the development and refinement of electronic decision aids makes the assumption that uncertainty may be eliminated by information gathering and learning — the limits of which are termed *epistemic* uncertainty (Tannenbaum, Fox, & Ülkümen, 2017). This is why we go to school to learn and improve our funds of knowledge, and why we pursue biomedical research to attempt to stamp out disease. Epistemic uncertainty, however, is only one form of uncertainty. In highly variable and imperfect situations like clinical medicine, uncertainty can be irreducible (at the moment or in the future) due to the inherent variability of life's processes. This type of uncertainty is termed *aleatory* uncertainty. In this domain, single-minded adherence to the ideology of eliminating uncertainty is considered a potential danger to the care of patients, especially as it relates to invasive diagnostic testing (Babrow & Kline, 2000). Medicine has many highly variable and imperfect situations where information may not align optimally with recognized information sources. Facing this variability, and the fast paced clinical environment, clinicians therefore must to tolerate uncertainty and practice diligent communication and follow-up behavior in its' wake. It is this second form of uncertainty, *aleatoric* uncertainty, that is the focus of the present investigation.

Uncertainty in the Clinical Learning Environment

The clinical activity and culture of an academic hospital centers around attending physicians, residents, and students working to provide quality patient care, while at the same time fostering training and learning. In this setting learners confront uncertainty in diagnosis, patient responses to treatment, and in healthcare outcomes that are far from binary. Educational activities are necessarily joined with the clinician job of providing care. Physicians and learners in this context, and arguably all patient-care activities, continually go through daily decision-making processes that are imbued with knowledge gaps and data that are fragmented and incomplete — leaving practitioners and learners hanging for a known answer.

There have been frequent calls for further research to better understand uncertainty in healthcare education and identify valuable strategies for patients and physicians to acknowledging, manage, and cope with uncertainty. In the nursing literature Mishel has written extensively about patients' experiences with the “uncertainty of illness.” She developed a general

framework through which to measure the amount of uncertainty experienced by patients with acute and chronic conditions. Such information has led to preliminary instruments aimed to quantify to lived illness-related uncertainty experienced by patients. Prior work has also sought to quantify uncertainty as it relates to the work of physicians and physician trainees (Gerrity, DeVellis, & Earp, 1990) (Hancock, Roberts, Monrouxe, & Mattick, 2015).

In addition to measures, further study is needed to qualitatively identify what defines uncertainty in the mind of the physician and physician trainee. Such information may lead to strategies for acknowledging uncertainty that promote mastery, professionalism, a curricular blueprint, and one that promotes greater humility and safety for patients (The Internal Medicine Milestone Project., 2015). The traditional approach for promoting learning and excellence have been more performance oriented in medicine, which is in conflict with more recent evidence suggesting the benefits of healthier, more mastery oriented learning environments (Krupat et al., 2017). Recently, program directors at internal medicine programs in the United States have agreed that traditional accounts of performance orientation and bullying, however infrequent, of medical residents has a negative impact on the learning culture (Ayyala et al., 2018). This is unfortunate evidence of the impact the culture of medicine has on the acknowledgment of vulnerabilities and uncertainties of trainees and physicians, thus overshadow opportunities for learning and, importantly, establishing patient trust.

Evidence on the Impact of Uncertainty in Healthcare

Empirical studies focusing on uncertainty are sparse and limited. Little research has rigorously quantified the impact that uncertainty has on physicians, patients, the medical learning environment, and the diagnostic process. While significant advances have been made in neurobiology over the past few decades, direct scientific investigation for how uncertainty is manifest, perceived, and communicated across the arc of training and practice for physicians is far from perfect. However, strong defenses against, and denial of, uncertainties are consistent observations made by sociologists studying medical training (Bucher & Stelling, 1977). Characterizing perceptions and behaviors during uncertain situations and identifying effective strategies for acknowledging uncertainty is an important gap in curriculum development, the culture of education, and for ensuring safe, transparent and accountable patient care of the highest quality.

No comprehensive study of the ways uncertainty is expressed, through implicit or explicit means, have been published related to the clinical learning environment, especially as it relates to medicine in GME setting of the 21st century. Furthermore, how to effectively manage burnout remains an important and unanswered question. Therefore, we undertook a mixed-method study attempting to openly explore how uncertainty is perceived and communicated in the culture of hospital medicine and measure related aspects of the learning environment and physician wellness through the following specific aims:

1. To understand qualitatively how uncertainty is explicitly referenced and implicitly understood in the inpatient medical setting using ethnographic observations and phenomenology (interviews).

2. To quantitatively assess and correlate measurements of the learning environment, tolerance of uncertainty, and symptoms of burnout using validated scales for residents and attending physicians.

CHAPTER 2: DATA AND METHODS

The present analysis is a mixed-method study investigating perceptions and manifestations of uncertainty in the clinical environment of hospital medicine. Three separate components, one quantitative and two qualitative, were used to rigorously triangulate the nature and issues of uncertainty in this clinical-educational setting. The internal medicine inpatient ward was chosen for its rich number of patient interactions, educational moments, and centrality to medical education. The quantitative analysis utilized three validated survey measures for assessing perceptions of uncertainty using the Physicians' Reaction to Uncertainty Scale (M. S. Gerrity et al., 1990), the learning environment using the Educational Climate Inventory (Krupat et al., 2017), and burnout with the two-item Maslach Burnout Inventory (West, Dyrbye, Sloan, & Shanafelt, 2009). Qualitative methodologies included ethnography (observation) on inpatient rounding and phenomenology (interviews) with semi-structured interviews. The study data were collected at an academic teaching hospital affiliated with the University of Minnesota in Minneapolis, Minnesota, USA. The research design and protocol was a combined effort between faculty at the University of Minnesota, Minneapolis, USA and Harvard Medical School in Boston, Massachusetts, USA. Institutional review board approval was obtained from both the hospital and the affiliated academic institutions. (Harvard IRB #17-0941 and UMN IRB #00000518). The study period occurred over a three-month period during the summer of 2017 (between June and September).

For each part of this mixed-method study, participants were recruited based upon the following major criteria: 1) residents providing inpatient care at the selected institution in either the internal medicine or combined internal medicine-pediatric residencies or 2) current faculty in either internal medicine or combined internal medicine and pediatric departments with a minimum experience of one academic year of responsibility teaching and practicing on the inpatient wards. Further details of recruitment and selection are provided in the design sections corresponding to each study section.

This mixed method study was structured to minimize cross contamination between the various components. For this reason, ethnographic observations were first performed to investigate the lived experience of practicing physicians in the inpatient setting prior to participants learning the study aims. After saturation of the ethnographic data, as deemed by the principle observer, distribution of the survey occurred. Finally, interviews were offered to individuals after survey completion. In this way, survey measurements proceed in-depth questioning and reflection on the topic of uncertainty in medicine.

ETHNOGRAPHIC OBSERVATIONS

We approached ethnography as a method for understanding and describing the social dynamics taking place in the lived experience of residents and attending physicians who practice in inpatient academic settings. The principle author and observer (MJ) is a registered medical

student as well as an enrolled master's student in medical education with training in qualitative methods, including ethnography. During the period of observation MJ took the role of a shadowing medical student during the study period. In this way, immersion into the team and participation could occur in a routine manner while also minimize contamination of the workings of the team. The purpose of this ethnography portion was to document and to acknowledge the multiple realities apparent in the lives of others.

Participants

We chose a convenience sample of a single inpatient academic teaching environment where internal medicine and combined internal medicine-pediatric faculty and residents practice. Teams were identified as eligible based upon the team structure of attending, senior resident (PGY-2 or PGY-3), and junior resident (PGY-1) during the study period. Following identification, the principle author (MJ) obtained written informed consent for observation and documentation of team behavior and communication, however participants were not made aware of the specific aim of the study. Patients were informed immediately prior to meeting the observational researcher (MJ) and given the option to decline direct observation.

Ethnographic Methodology

The principle author (MJ) directly observed medical teams undergoing normal activities related to patient care and teaching over a 14-day period at the beginning of the study period (June 2017). Observations were focused on teams' explicit reference to and discussion of points of uncertainty. This included intra-team, inter-team, and clinician-patient interactions. Topics purposefully included, but were not limited to, discussions of diagnostic uncertainty, prognostic uncertainty, therapeutic uncertainty, patient communication, and discussions about educational topics. The principle author wrote jottings, brief written records of events and impressions captured by key words and phrases, followed by detailed field notes immediately following each day of observation. Descriptions were open-ended, however, focused daily behavior and interactions among the team, between the team and other healthcare providers, and in the communication with patients. Observations were continued until review by the principle author demonstrated saturation. Field notes were stored in a secure online databank, and de-identified prior to analysis.

Through an inductive approach, the de-identified field notes were iteratively coded by the principle author (MJ) with refinement as patterns emerged from the data. Qualitative analysis was aided by the use of software (*Dedoose Version 8.0.35*, 2018). After the complete list of codes were compiled, two investigators independently reviewed the code agreement with the field notes (MJ and AS). Discrepancies were resolved through discussion. The final written representation of the field notes reflects the process of iterative and inductive approach to the data.

INTERVIEWS

Semi-structured in-depth interviews were conducted to investigate resident and attending physicians' perceptions of uncertainty in the hospital environment. The guiding questions for the interview were created with input from residents and physicians. The interview guide was pilot

tested three times for coherence prior to the beginning of the study, with modifications for clarity. The content areas focused on 1) attitudes about uncertainty, 2) behavior when feeling uncertain, and 3) clinical and educational significance of uncertainty. All interviews were conducted by the principle author (MJ).

Recruitment

Participants were sampled in a stratified manner to include equal representation of various stages of training (PGY years) and years of practice for attending physicians (newly in practice to end of career physicians). Recruitment occurred through email solicitations to departments of internal medicine and combined internal medicine and pediatric programs. Interviews were conducted in person, apart from two interviews which occurred over the phone. The semi-structured approach ensured all questions pertinent to the research question were explored, however encouraged participants to explore issues considered most relevant. All interviews were audio recorded and professionally transcribed prior to analysis.

Interview Analysis Methodology

Qualitative analysis of the transcripts took an inductive approach using trained qualitative researchers who understand that sharing multiple perspectives are an integral part to the research process. Three independent analysts looked at the material (MJ, HT, GG). In addition to the principle author (MJ) both analysts were current medical students (HT and GG). Both co-readers came to the work with prior experience in methods of inductive qualitative analysis. Through interpretation, discussion, and testing of constructs, agreed upon coding rubrics and a thematic construction were established.

CLINICIAN SURVEY

Following the period of observation, we conducted a cross-sectional study of faculty and residents practicing at a single general internal medicine teaching ward. This was the same ward as that of the ethnographic study component. Data were collected from July through September 2017. Surveys were distributed in paper form and collected immediately after completion and stored in a secure location until analysis. Various surveys exist for measuring perceptions of uncertainty, the learning environment, and physician wellness exist, and our choice of survey components were based upon validation in the literature and refinement where possible.

Survey Development

The survey included three validated scales measuring 1) perceptions of uncertainty in the clinical setting, 2) an assessment of the learning environment, and 3) assessment for burnout among the physicians in our sample. Surveys were distributed in paper form during times identified as minimally disruptive to physicians' schedule (i.e. over the noon hour or prior to a noon conference). To ensure privacy of responses the survey proctor directly collected completed surveys, kept them out of sight, and immediately transported to a locked location until

analysis. After completing the necessary analysis, written surveys were shredded and destroyed using the University of Minnesota's services readily available in the Department of Medicine.

The Physicians' Reaction to Uncertainty Scale was developed to differentiate the perceived stress under uncertain clinical situations and the willingness to disclose uncertainty to patients and colleagues (M. S. Gerrity et al., 1990). Further refinement and construct validation of the scale has occurred (Martha S. Gerrity, White, DeVellis, & Dittus, 1995). Four subscales were included: anxiety due to uncertainty (Cronbach's alpha = 0.86); concern about bad outcomes (Cronbach's alpha = 0.73); and reluctance to disclose uncertainty to patients (Cronbach's alpha = 0.79) and colleagues (Cronbach's alpha = 0.72). Items responses occur on a 6-point Likert scale ranging from "Strongly agree" to "Strongly disagree". The subscales were scored with higher values indicating more stress from uncertainty or more reluctance to disclose uncertainty.

We utilized single item measures for the Maslach Burnout Inventory (MBI) to assesses emotional exhaustion and depersonalization, which has prior use with physicians (West et al., 2009). The 22-item MBI is the gold standard for the assessment of burnout in the medical literature (Maslach, Jackson, & Leiter, 1997). However, its length limits feasibility for use in surveys addressing multiple content domains. Therefore, validated single item measurements were used to quantify symptoms of burnout. Emotional exhaustion was assessed by the statement, "I feel burned out from my work" and depersonalization by the statement, "I've become more callous toward people since taking this job." Responses occurred on a 7-point Likert scale with response options ranging from "never" to "daily". Consistent with prior literature, responses of "weekly" or more were considered to meet the criteria for burnout. To quantify and associate symptoms of burnout with other variables in our small sample size, statistical analyses were performed with a summative score of responses to emotional exhaustion and depersonalization.

The Educational Climate Inventory (ECI) is a survey instrument for measuring the learning environment on a scale ranging from performance orientation to mastery and learning (Krupat et al., 2017). In educational settings it is known that positive student perceptions of the learning environment are important for high levels of achievement, mastery of the material, and a reduced rate of burnout (Dyrbye et al., 2009). Our study used the ECI questions under slight language modification to more accurately reflect the context of GME and CME. Any changes in question wording were reviewed by the scale author and pilot tested on resident and attending physicians prior to data collection. Respondents selected answers on 4-point Likert scale ranging from "strongly agree" to "strongly disagree". Scores for the ECI include total score, and subscales of 1) competitiveness and stress, 2) centrality of learning, and 3) passive learning and memorization. This scale enabled the quantification of the learning environment as perceived by residents and attending physicians.

Recruitment

Participants were recruited to complete the survey based upon meeting the major criteria of 1) residents providing inpatient care at the selected institution in either the internal medicine or combined internal medicine-pediatric residencies or 2) current faculty in either internal medicine or combined internal medicine and pediatric departments with a minimum experience of one academic year of responsibility teaching and practicing on the inpatient wards. In addition, residents were required to have experienced a minimum of 2 weeks on the inpatient

medical ward for acclimatization prior to being offered the survey. A period of acclimatization was deemed necessary under the assumption that individuals need time to experience a new setting before thoughtful reflection and evaluation can occur. Incoming resident interns were allowed to participate after 8 weeks of inpatient experience.

Survey Analysis

Standard descriptive statistics were used to characterize the sample. Assumptions for normalized response variation were analyzed for the aggregated sample and role specific responses (for example resident vs. attending, data not shown). We assessed the distribution of the continuous variables and the bivariate relationship between and transformed these variables as appropriate. To evaluate associations between the scores for perceptions of uncertainty, ratings of the learning environment, and burnout we conducted a series of bivariate analyses assessing for statistical differences and confounders using two-tailed *t*-tests or one-way ANOVA for continuous variables and Pearson chi square tests for categorical variables. We also performed a pairwise correlation analysis for the assessment of relationships among the continuous and categorical variables pertaining to the research questions. All the analyses were performed using commercially available statistical software (STATA version 14.1; StataCorp LP, TX).

CHAPTER 3: RESULTS

ETHNOGRAPHIC OBSERVATIONS

Observation totaled 60 hours in the inpatient setting in the study period. Over this time, a total of 8 attending physicians, 15 residents, and 22 varied support staff (e.g. consult physician, interdisciplinary teams, and other healthcare professionals) were observed. The research question we applied to the data explored how the culture of the healthcare environment shapes patient management around points of uncertainty. Behavior around uncertainty was categorized as explicit and implicit, and classified by situational context.

During the ethnographic portion of this study internal medicine physicians and residents were found to have multidimensional responses and actions when acknowledging and dealing with uncertainty. Four themes emerged from the ethnographic study of how culture in a healthcare environment shapes the handling of uncertainty: 1) acknowledging uncertainty, 2) sharing uncertainty in the healthcare environment, 3) dealing with uncertainty: actions and inactions, and 4) impact of uncertainty on the patient.

Theme 1: Acknowledging Uncertainty

Senior members of the clinical team are most explicit in talking about uncertainty. The offering of facts was the role of the learner, and evaluation and judgement was primarily the role of more senior clinicians (Table A). For the internal medicine team, social interaction occurred between all members of the team, however judgement and action was constructed most often by the attending or senior resident. Through recalling concepts about disease or health, facts were offered in oral accounts (i.e. presentations), and evaluated and reconciled with prior knowledge primarily by more authoritative figures.

Junior members were rarely observed to be the ones to acknowledge uncertainty, and through body language became uncomfortable when asked to evaluate a problem and offer a solution. Junior members, instead, either showed a lack of medical knowledge or a desire for guidance from more senior clinicians in how to understand and contextualize their own uncertainty about knowledge with the uncertainty of the situation. Junior clinicians appeared to instead be more comfortable approaching uncertain situations through passive observation.

Interpretation	Representative Field Note Excerpt
Attending physicians explicitly reference or “call out” uncertainty	<p><i>The attending explicitly references his uncertainty in how these separate findings are related, or even if they are. “I don't know if they are related” he says. “It is highly unusual for a hernia to directly cause bacteremia.” Acknowledging this low likelihood, he considers other possible causes including a bowel perforation or an abscess. The team watches passively as the attending physician describes his thought process.</i></p> <p><i>During this patient encounter the medical student and the intern were very concise and unwilling to show ambiguity in their language with the patient. However, the attending seems much more willing. In one occasion she said from the corner of the room “we don't really know” in response to a patient question. This is the first time she had spoken in the entire patient encounter apart from introductions.</i></p> <p><i>As we walked through the different cases they grapple with uncertainty often, and it is typically the attending physician who explicitly acknowledges it.</i></p>

Among the team, the role of educational evaluator and medical practitioner was displayed by the senior clinicians (attending physician and senior resident) and defined much of the behavior of the junior clinicians (intern and medical student). Junior clinicians mostly vocalized facts and sometimes would make a cursory evaluation, but this was infrequent and often took place after discussions with more authoritative figures (Table B). Passive learning through observation appeared to be the safest way to avoid formal evaluation.

Educational efforts on behalf of attending physicians and senior residents sometimes promoted junior team members to articulate a medical plan. Most often, what junior team-members offered was in agreement with senior clinicians. However, instances of judgement failure were also common. Learners tended to fall back on summarizing facts and preferred to state a desire for gathering further information (through looking at the medical record or seeking decision aids). In this way, junior clinicians side-stepped the evaluative portion of questions often. Avoiding or hiding uncertainty can occur by talking around the question, or saying “yeah” to closed questions. Uncertainty was often implicit in these instances and was non-verbally communicated. Failing to express judgement may be attributed to worrying about misalignment of one’s answer with the desired answer of the senior clinicians or illuminating gaps in learning. This may be attributable to gaps in personal knowledge or in understanding how to evaluate the information at hand. The reason for choosing safe responses was likely linked to the medical culture and educational environment.

Table B: Examples of Authority and Learner Behavior	
Interpretation	Representative Field Note Excerpt
<p>Authority/Teacher is the loudest voice in the room, and dictates the behavior of the team.</p>	<p><i>The loudest voice in the room and the person the residents and students primarily look at and talk to is the attending physician — who has just arrived. The attending speaks quickly, keeps a professional demeanor, and every so often offers a quick joke to lighten the mood — a distinction from the discussions about patients' poor health, challenging social situations, and death and dying. As we walked through the different cases, the team grapples with different uncertainties often and the attending physician is typically the one who explicitly acknowledges it.</i></p> <p><i>This is the first patient presentation by the intern to the new attending, who asks the attending "Do you want a formal presentation?" At which the attending replies, "I think we can have a SOAP note style presentation, if you're set up for that today?" The intern acknowledges this and agrees that this would be fine. This encounter highlights the hierarchy, within which the attending has control over the type of presentation and behavior of the team.</i></p>
<p>Learner Behavior – producing facts, not knowing what to say, hiding uncertainty</p>	<p><i>The attending asks, "she is a type II diabetic, right?" The junior resident nods and says "yeah," but does not respond in a confident way as if mulling over if she knows this fact or not. She follows this up with "the patient takes 40 Lantus at home" and the attending responds "we should probably cut it in half because that's a pretty hefty dose" because of her concern about low blood sugars. The junior resident then glances at her computer and pulls up the labs for the patient and says, "her blood glucose this morning is in the 120s." Upon hearing this the attending says in a very confident voice "we should hold it then, because she's already low."</i></p> <p><i>[The medical student] attempts to provide a summary statement describing the patient's overall status and includes a long list of things, and seems unsure [she mentions that she didn't sleep much last night too]. The attending then says, "So in this patient you can just say this is an 84-year-old with a complicated past medical history with pneumonia, now improving."</i></p> <p><i>This patient encounter is characterized by gestures from the senior resident of wanting help from the attending. This raises two questions in my mind: 1) does the resident not feel comfortable bringing up uncertainty? Or 2) is the resident surrendering the stage to the attending because he is nonverbally acknowledging his uncertainty (or multiple reasonable options ahead) and ready to receive teaching?</i></p> <p><i>The senior resident asks the medical student what the overall goals are for this patient to return home. The medical student hangs upon this question, and lets silence insert itself into the team's conversation. The student avoids discussing goals, and instead mentions medication changes, and also does not offer any evaluation for discharge — the answer to the explicit question. In order to promote a shift toward judgement, the senior resident rephrases the question "If this patient presented to me in clinic today, would I admit her to the hospital?" The senior resident pauses, and when the student doesn't respond, explains how the patient's current management plans can all be handled as an outpatient.</i></p>

Theme 2: Sharing Uncertainty in the Healthcare Environment

In caring for patients, internal medicine teams construct meaning from the uncertainty of imperfect information through social interaction, prioritizing further information gathering, and utilizing prior medical knowledge (Table C). Recalling concepts about health and disease, context specific information is offered in a narrative to the group through oral accounts (i.e. presentations), and evaluated and reconciled with prior knowledge in the moment. Through deliberation among the team, incongruences are resolved, alternative explanations are offered, and meaning is created and shared among the team.

When uncertainty is expressed it is usually followed by actions calling for more information, but sometimes it is tolerated, acknowledged, and allowed to remain as the team moves on. What distinguishes the behavioral (clinical) action vs. inaction (wait and see approach) is highly context sensitive. The medical team confronts some uncertainty that lingers in time until more information is gathered through activities such as talking to the patient, waiting for a lab test, planning for an assessment at a later time, or through the electronic medical record. In some situations, uncertainty is not resolvable to the extent desired by clinicians (unresolvable) or what clinicians infer as being expected by patients.

Table C: Examples of Sharing Uncertainty in the Healthcare Environment	
Interpretation	Representative Field Note Excerpt
Social interaction creates meaning and purpose when uncertain	<p><i>This patient lives in a long term care facility, and has had several admissions for shortness of breath in the past. “This is going to be a never ending cycle” says the attending in reference to her recent admissions. The patient apparently will get discharged, go back to her facility, and then she will have an episode of SOB followed by severe anxiety (worry based upon prior hospital admissions), followed by more shortness of breath, and ending with a return back to the hospital. “We need to talk with the nurses at the care facility” offers the senior resident, seemingly trying to seek a better understanding for how to manage the likelihood of a future anxiety attack and wanting to avoid a future hospital admission.</i></p> <p><i>“He can probably go home on antibiotics” says the attending physician. The resident who had introduced the patient gives a big sigh, because he is concerned about the challenging mental health circumstances of this patient making his return home difficult. Focusing on the options for patient care here in the hospital, he seems puzzled and lost in knowing what to consider. The social worker proposes “maybe we should consider consulting psychiatry?” The resident offers thanks for the suggestion, and says “yes we can do that” and looks reassured as if this plan provides a definitive actionable step under his control.</i></p>
Expressing frustration when there is no clear answer is a way of showing uncertainty	<p><i>“I tried to explain why her hemoglobin is low” says the intern. “She keeps asking about it” and “sometimes it’s frustrating to just not know what’s causing this” she says in regard to the patient’s low hemoglobin.</i></p>

(continued)

Table C (continued)	
Thinking out loud is a strategy that can bring up alternative explanations, even when it may not change management	<i>The senior resident then talks through a timeline of various symptoms and tests related to the pleural effusions (such as prior imaging studies, development of fever, and oxygen saturation values). The senior resident then offers “it is certainly a possibility he has pneumonia,” which is in agreement with what the attending had just proposed. The conversation continues about the possibility of pneumonia, with some uncertainty regarding this diagnosis and pursuing more aggressive treatment. At the end of this discussion, the attending adds “it is reassuring that his CRP and white blood count are going down without us doing anything.” This leads the conversation to a tolerance for continuing with the current therapy and continuing to monitor the patient’s symptoms and labs. It’s interesting that at the end of this conversation, the senior resident remembers that the patient is on a strong antibiotic that would cover the common causes of pneumonia.</i>

Theme 3: Strategies for Dealing with Uncertainty – Actions and Inactions

Creating meaning from uncertainty through social interaction must lead to judgement and decisions in patient care. The behind the scenes work of clinicians seeks answers in two general domains: 1) What is the problem? and 2) How can we help? Creating consensus and meaning as a team is followed by action or inaction addressing the root cause of the problem.

The behavioral response to uncertainty fall along a spectrum (Table D). This ranges from prioritization of various forms of uncertainty to addressing what is most relevant and actionable. For example, identifying what is important and “knowable”, choosing a “wait and see” approach, or acting swiftly to diagnose and treat are all options when faced with uncertainty. In addition, casting off uncertainties that are not applicable, or not knowable, focuses attention on those which the medical team can address.

As the sense of urgency progresses from stable to unstable, the tolerance for uncertainty also wanes. “Watch and wait” strategies are chosen in situations of relative stability. In such situations, not enough information may be present for the team to take action. This is a commonly occurrence in the hospital, as many processes take time (diagnostic tests, gathering information from the EMR, receiving feedback from consults). As the awareness of instability/criticality increases, less tolerance for uncertainty occurs. When facing unstable or “red flag” moments, uncertainty is not tolerated and immediate action is taken. Asking for input, advice, and help from other healthcare professionals occurs when the clinical uncertainty raises questions outside the scope of the internal medicine team.

Table D: Examples of Reducing Uncertainty Through Implicit and Varied Actions and Inactions	
Interpretation	Representative Field Note Excerpt
Separating need-to-know vs. nice-to-know	<i>The attending says “we have a few more things to investigate today.” Implying that they are not going to know the root cause of this right now, and that we probably should move on. These facts aren’t exactly vital to her current condition.</i>
Waiting to take action until additional information is received	<i>The attending deliberates on the patient’s AKI and is evaluating the continued need of the Foley catheter. The AKI is improving. The attending says she wants to give more albumin to the patient via the IV, and she wants to see how her kidneys respond. The decision is made to keep the Foley catheter in until this afternoon’s labs have been drawn. The nurses and team are present and silently acknowledges the attending’s decision.</i>
Watchful waiting can be an action when the diagnosis remains unclear and the patient is improving, and is accompanied by considering alternative explanations.	<i>The senior resident then talks through a timeline of various symptoms and tests related to the pleural effusions (such as prior imaging studies, development of fever, and oxygen saturations). The senior resident then offers “it is certainly a possibility he has pneumonia” agreeing with the attending. The conversation continues about the possibility of pneumonia, with some uncertainty regarding this diagnosis and pursuing more aggressive treatment. At the end of this discussion, the attending adds “it is reassuring that his CRP and white blood count are going down without us doing anything.” This leads the conversation to a tolerance for continuing with the current therapy and continuing to monitor the patient’s symptoms and labs. It’s interesting that at the end of this conversation, the senior resident remembers that the patient is on a strong antibiotic anyway that would cover for many of the common causes of pneumonia.</i>
Uncertainty may be perpetual, and sharing it among medical staff is reassuring, but not resolvable	<i>After hearing the general plan from the team, this consultant physician takes two steps closer into the circle of the group and looks around very quickly as if hoping no one else is listening in, and says in a hushed voice “I don’t know what’s going on with her.” Medical team agrees that they also don’t know what is “going on” with her. I presume this to be the diagnosis of her generalized fatigue. She says “we have done an extensive workup and have found nothing, yet the patient is complaining of fatigue.” We had already heard of the presentation on this patient from the intern, and had a plan for how to address the patient’s concerns and those of her family.</i>
The management direction is clear, some uncertainty remains, but is limited	<i>The team then discusses the next steps in clarifying the diagnosis, and the attending offers a description of the medical process. “Most colon cancers are a single type called adenocarcinoma, but there is a need to clarify this with an invasive diagnostic test because of its importance for treatment. While you’re in hospital we’re going to do a colonoscopy to get a small piece of the tumor.” To describe and set expectations, the attending offers a clear timeframe. He says a sample will be taken of the tumor and looked at under microscope and the patient will be called in a week, after her discharge from hospital, to clarify the diagnosis and schedule the next steps in management.</i>
Immediate action is taken with “red flag” situations, uncertainty is not allowed to linger.	<i>A 70-year-old female was admitted with acute onset back pain and urinary retention. This situation is characterized by how uncertainty is dealt with swiftly by pursuing objective information in the form of imaging because of “red flag” symptoms of a serious condition that needs to be ruled out immediately, despite a “gut feeling” against this. I ask the resident how she decided to order the urgent MRI? She responded “urinary retention is one of the red flags of back pain” suggesting that this one piece of information is all that is needed to prompt ordering the test. Note that she did discuss scanning the patient’s bladder and found 300ml (normal to high value), to ensure there was urine there — giving an objective finding to the subjective description of retention of the patient.</i>
Asking for input, advice, and help from other healthcare professionals occurs when the question lies outside the scope of the internal medicine team.	<i>The attending says “in my experience with small cell this is something you don’t want to let the sunset come down on. Or at least something you have to move swiftly on.” The challenging aspect for this diagnosis is the necessary component of having a pathologist read the slide, and it’s the weekend where no pathologist is available until Monday. Attending urges contacting the hematology and oncology department, which is staffed on the weekend, to see if they have a recommendation.</i>

Theme 4: Understanding the Impact of Uncertainty on the Patient

Patient-provider interactions demonstrated varied reactions to and multidimensional manifestations of uncertainty. In the patient room, new information from additional verbal history and physical exam findings can cause immediate reevaluation of the clinical understanding of diagnosis and therapeutic plan. This occurs through the process of communicating the team’s constructed clinical meaning and plan (often created outside the room or at the bedside). New uncertainties may arise quickly through discussion and examination of the patient, and must get communicated, acted upon, or ignored as irrelevant. The strategies employed by the clinical team are reflexive and adaptive to preferences of the patient. Such findings may pivot the meaning and planned clinical management of disease (Table E). In these ways patients’ perceptions and teams’ observations test, pivot, challenge, and share the interpretive challenge of uncertainty in real time.

The primary voices acknowledging uncertainties are the patient and the attending physician. In patient-provider communications, eliciting patient preferences can occur through provider questioning or may be offered by the patient. An example of the latter is a disgruntled patient’s reaction to their disease or multiple competing recommendations from multiple specialists. In such situations, identifying shared goals between the patient and the healthcare team is a demonstrated successful strategy.

Interpretation	Representative Field Note Excerpt
Pivot in decision making, because of a previously unknown fact	<p><i>This patient presented with dyspnea likely because of a fluid collection from heart failure and was requiring a substantial amount of oxygen. The attending physician touches the back of his hand to the lower leg and the foot, then requests the team to do likewise. The attending physician says the patient’s extremities feel cold and begins talking more quickly about management decisions. There is a strong urge to figure out the definitive diagnosis and management plan for this patient, because “being wet [in the lungs] and having cold extremities is a worrisome place to be.” The decision for the next test isn’t exactly clear, but the urgency to pursue it is suddenly palpable.</i></p> <p><i>The senior resident then walks in saying that the “radiology report said that there are some cortical changes possibly suggestive of osteomyelitis.” This is regarding the 5th metatarsal, which was apparently recently amputated. The attending then takes a look at the foot by uncovering the feet of the patient. [...] After a brief visual inspection, he looks worried and says “we’re probably going to need to cover this [with antibiotics].” Suggesting the need for an antibiotic change from what was just told to the patient. “This looks like a strep infection,” says the attending. The attending then asks the senior resident, “so do you want to consult ID and Ortho on that then?” [...] “This toe might need to come off,” says the attending to the patient. “I’m sorry about that.”</i></p>
Testing the plan of the team because of patient uncertainty	<p><i>The patient is lying in his bed and has an IV going into his wrist. Immediately upon the team entering the room, he addresses everyone saying “I want to be a part of the decision-making process around here, because sometimes I feel like things get ordered without my knowing and my prior experiences with some of these things is not good. It would be helpful if I were talked with about it.” ... The team has uncertainty about why he had bacteria in his blood. [Later I asked why a blood culture was first ordered, and a resident replied “shot gun effect” implying the need to run several diagnostic tests without knowing exactly what they were looking for because it was an urgent situation.]</i></p>

(Continued)

Table E (continued)	
Challenging the team's decisions because the patient is hearing multiple perspectives and is frustrated	<i>This situation is tense. The patient's mother references a great number of doctors with differing opinions and multiple hospital stays. She and her daughter are frustrated because of a lack of answers. The mother asks "What are the goals here?" The senior resident responds "The goals here are to maximize your nutritional status." He then talks about how recovering means making sure the body has adequate nutrition. The family asks "How long will this last?" The resident responds that this is going to be a lifestyle change for the patient, and it might last until the pancreas can recover some function or a surgical procedure occurs.</i>
Sharing the decision making with the patient	<i>Again addressing the patient, the attending says that he is reassured by the negative blood cultures and the improvement in symptoms, yet does not know whether the infection came from the swelling and warmth in the tissue near his left clavicle, or from the toe, or if the infection spread from his neck area to his toe.</i> <i>After hearing much of the history, the attending physician takes over the conversation and says "it sounds like these symptoms you're experiencing fall in line with other small bowel obstructions you had in the past. Is this correct?" The patient nods in confirmation, and the attending reassures the patient (and team) and looks at the team as if to communicate that the patient's perception is important. The attending physician presses on and asks the patient how long her symptoms of small bowel obstruction have lasted in the past. The rest of the team looks on, and the residents are distracted with looking information up on their phone or on the computer. Then in the hallway outside of the patient's room the attending remarks "sounds like she typically resolves [her symptoms] in two to three days." The patient expresses worry that this is another small bowel obstruction and might get worse, and the attending decides that she should stay in the hospital one more night.</i>

QUALITATIVE INTERVIEW ANALYSIS

In-depth semi-structured qualitative interviews were performed with residents ($n = 7$) and attending physicians ($n = 8$). Of those who completed the interview, 53% were female, and 12% attended medical school outside the United States. Six themes were identified (Table F). In what follows below, each theme is introduced and described, followed by representative quotations to illustrate the theme.

Table F: Semi-Structured Interview Themes

Theme	Sub-heading
Acknowledging Uncertainty	<ul style="list-style-type: none">• <i>From classroom to frontline patient care</i>• <i>From trainee to attending physician</i>
Awareness of uncertainty is multi-dimensional	<ul style="list-style-type: none">• <i>Theoretical knowledge translates to real-world knowledge</i>• <i>Uncertainty is situationally specific</i>
Challenges with Uncertainty	<ul style="list-style-type: none">• <i>Anxiety due to uncertainty</i>• <i>Desire for certainty</i>• <i>Communication of uncertainty to patients</i>
Ways of Dealing with Uncertainty	<ul style="list-style-type: none">• <i>Inaction versus action</i>• <i>Functional or adaptive strategies</i>• <i>Less functional or maladaptive strategies</i>
Impact of Uncertainty in the Learning Environment	<ul style="list-style-type: none">• <i>Culture of medical training</i>• <i>The need to save “face”</i>• <i>Authority construct</i>• <i>Role modeling in the learning environment</i>• <i>Embracing uncertainty is not a part of the formal curriculum</i>
Desire for Culture Change	<ul style="list-style-type: none">• <i>Pervasive desire to shift culture</i>• <i>Tension between desire and reality</i>

Theme 1: Acknowledging Uncertainty

From classroom to frontline patient care

Recognizing uncertainty becomes prominent in clinical training and practice, especially when recognizing many presentations in the clinical setting don't fit a pattern. Attending and resident physicians both acknowledge uncertainty through the effortful process of attempting to categorize and label diseases learned in the classroom to the imperfect real world of clinical practice. Immersion in the patient care environment and applying learned “ideal” patterns of disease to the real world of hospital medicine is when uncertainty is recognized and appreciated.

Resident: I think, maybe as a med student...I wasn't dealing with [uncertainty] so closely. It was more like, I was trying to learn about all these diseases and looking stuff up, and trying to fit everything into a little box, but now as a resident, I've realized there's a lot of things that don't fit a pattern and we're not going to figure out why something is wrong. (75NIS)

In the clinical environment, the cognitive success of achieving the correct answer, gained through immediate feedback (as on a standardized multiple choice exam for example), is not realized. Instead, when uncertainty, especially diagnostic uncertainty, is recognized it may be perceived not as a natural part of medicine, but rather as a lack of personal knowledge. The process of going from medical student to resident includes learning to create parity between personal knowledge of disease and inherent uncertainties of the diagnostic process.

Resident: I don't think I ever learned it in medical school, honestly. Because in medical school ... you're always taught that there's like ... at least when you're taking tests and multiple-choice, that there's a right and a wrong answer. It wasn't until, I probably learned it more as a resident, that not all patients present like the textbook presentation, which I kind of knew a little bit about when I was doing my clinical rotations as third and fourth year, but I learned ... I think it hit me more when I was a resident. ..., it probably wasn't until more this year when I started becoming a new senior that I became more accepting of diagnostic uncertainty, because as an intern, and I think as a medical student too, when there's diagnostic uncertainty I think automatically you wonder whether or not it's your own lack of knowledge. That you missed something somewhere. (21MED)

From trainee to attending physician

Comfort with uncertainty changes over time with increased experience and feedback. This growing comfort allows more vocal acknowledgement of uncertainty, especially among attending physicians.

Attending: All of that stuff [academic knowledge/memorizing diseases], I'm pretty comfortable with. That's different than it would have been in residency and I'm more comfortable now even saying “I don't know, but I'll look it up.” That's even changing since I've become an attending. (04KEN)

Although with time physicians understand that the goal is not to strive for eliminating uncertainty but rather to gain comfort with it, there remain deep-rooted fears related to medico-legal complaints and being sued.

Attending: There was uncertainty, and you document that uncertainty. I think what people don't realize is they fear uncertainty because, "Oh my god, I'm going to be a bad doctor because I haven't made the diagnosis." That's not the case ... "I'm going to be sued because there's uncertainty." So that's not the case. You're going to be sued if you did something unreasonable. You're not going to be sued if you've dealt with uncertainty, or if some things were uncertain. That's part of medicine. That's not ... No reasonable doctor will argue against you, right? You're going to be sued if you didn't do due diligence around the uncertainty. You didn't talk to the right people. You didn't consult the right folks, or you didn't make a paper trail around the uncertainty. So once you realize that, that the standard for you as a professional is not that you will not have any uncertainty. The standard is that you will do what any reasonable physician [...] would do to mitigate that uncertainty and get to the root and get to a clear answer. That's the key. So once you realize that it makes life much easier. Because then you're not afraid of uncertainty. (11KVI)

Theme 2: Awareness of uncertainty is multi-dimensional

Theoretical knowledge translates to real-world knowledge

There is a general shift from “book/boards” knowledge to real world medical practice. Seasoned physicians have an awareness and tolerance for uncertainty that is built up through experience over time. This is in contrast to the reflections on what it was like as a medical student entering the clinical practice of medicine for the first time.

Attending: Medical students ... the uncertainty is new to them, and they're used to a multiple choice test where there's one answer. So I talk a lot about what it means to be an internist, when, it's really you're a detective, finding out which of the multiple medical problems that a patient has could be playing a role in a given symptom, and I try and reassure them that uncertainty is part of everyday life (11GRA)

Attending: Because medicine and health care is gray, not black and white. People almost never present as the textbook, they present in variation. There always could be multiple things going on so you're always making your best educated judgment based on the history, the physical, the last findings, any imaging findings, but there's not a ton of times that you are 100% certain that that's what's going on. (51GRE)

Uncertainty is situationally specific

Uncertainty is context and situation specific, and attention given to it depends on the urgency of the clinical situation. Sometimes the most acute awareness of uncertainty is around how to work as a team effectively and interact with other colleagues to move the care of a patient along.

Attending: Uncertainty in medical diagnoses, I feel like I struggle with that, ... you struggle with it every day in medicine ... but I feel like the discomfort I have with [diagnostic uncertainty] it is not as much as I have with kind of systematic points of uncertainty, how to work within your team and with all of these specialists, and more of a developing a cohesive plan kind of uncertainty than I do with the... "What exactly is happening with this patient and we need to figure it out now!?" Because the urgency is there and I feel that, but that doesn't cause me as much lost sleep and brain space, but rather it's the, "Okay how do we navigate this situation? Does it make sense?" (04KEN)

Theme 3: Challenges with Uncertainty

Anxiety due to uncertainty

Tolerance and comfort with uncertainty competes with stress in the lives of resident and attending physicians. Feeling stuck or paralyzed is common for physicians, but knowing how and when to act appropriately to resolve uncertainty, or where to turn to for advice are voiced as common challenges.

Resident: It takes a level of confidence and a level of just being able to do things to be able to survive, because if you persevere about everything and if you aren't comfortable doing things even though you don't know everything, then you can be paralyzed, like you can't really do anything because it takes so long, because you can't know everything. If you keep trying to know everything, you can't do anything. I think I'm sort of going here and there. I think it's a lot of things and I think a lot of it is cultural. (26TER)

Desire for certainty

Participants spoke of their desire to be sure about a diagnosis, and the distress that ensues when they are not sure what is going on with a patient. They also spoke of the high and low of emotions that are triggered when parts of the diagnosis or treatment plan they felt to be certain turn out to be wrong. Participants also cited concerns about missing something and the desire to better understand and explain unexpected patient events.

Resident: How can I improve for the next time? How can I catch on? And I've had that happen where it has fried my mind. I've lost patients before because I didn't know what was going on and then having a patient coming in who has similar-ish presentation, and the first thing I'm saying is, "Well, it could be this because I've seen that before." And it wasn't. But it made us look at that and then when we

knew that it wasn't that for sure, it was like, "Oh, okay, thank God." But I still don't know... (72NOR)

Attending: For me I feel anxious because I want to know what's going on with my patient. But that's hard. Because this is the hardest part, I think, in many ways, because we all can be sure about the diagnosis and we've all done this, including me, where you're just sure of the diagnosis, you don't even think about anything else and then the patient doesn't do as well as you'd expect when you're treating them for that ailment and then you've got to go back and rethink it and realize you were wrong. (51GRE)

Communication of uncertainty to patients

A central question for providers is how uncertainty should be communicated with patients. It feels like the job of the physician is to provide patients with answers. When that is not possible in the hospital setting, it can be uncomfortable for the patient and the physician.

Resident: I know that it's sometimes hard allowing people to leave the hospital without an answer, especially if they seem uncomfortable with not having an answer, and often it seems like they're uncomfortable with not having an answer. If they're uncomfortable, the likelihood that the entire hospitalization is going to repeat itself over and over and over again increases a lot. (26TER)

Theme 4: Ways of Dealing with Uncertainty

Inaction versus action

Once the primary problem diagnosis is established, this is typically followed by a choice of action or inaction, as opposed to indecision. In this process, continuing feedback is important.

I don't think we necessarily got to a diagnosis or anything, but at least we kind of came up with a plan for where do we go as opposed to everyone doing their own thing and putting their recommendations in, and some kind of conflicted, so it was kind of nice to just sit down and say, "Let's try this. If this doesn't work, then this ... If this works, then that ... " and kind of form a little decision tree which was nice. (59BRA)

Functional or adaptive strategies

More functional/adaptive strategies for dealing with uncertainty recognize the importance of cognitive processes, and utilizing the resources available to address and mitigate the risk of uncertainty. This includes 1) thinking ahead and contingency planning 2) taking time to carefully consider possible causes and if no clear answer emerges using safety-netting strategies to “buy time” for further clarification; 3) intentionally embracing uncertainty to benefit the thinking

process and open up the discussion of the problem (i.e. avoid cognitive biases and premature closure); and 4) seeking help through formal and informal methods. All these strategies can help alleviate stress and worry in the face of individual uncertainty.

Resident: I think I try to think a couple steps down the path of what the information would give if we pursued additional testing for example and if we sought after an answer and the patient would be appropriate for that treatment then maybe that's worth chasing. If we would chase it down several steps and there would be no practical gain, then I don't usually ... I don't necessarily push harder to gain more information. (04KEN)

Attending: I think at our institution we do a good job of embracing that, maybe even using it as an opportunity so, you know, talk about the differential, talk about what things are more likely, less likely, and using that uncertainty almost to keep from anchoring on something too soon. (74MIL)

Less functional or maladaptive strategies

Less functional or maladaptive strategies fall to biases and culture. Past experiences can influence future behavior/thinking when a pattern is established. In these situations choices seem automatic. Cognitive bias (e.g. anchoring bias, confirmation bias, and recency bias) in the face of uncertainty are examples of faulty thinking. These often have ties to cultural attributes.

Resident: I've lost patients before because I didn't know what was going on and then having a patient coming in who has similar-ish presentation, and the first thing I'm saying is, "Well, it could be this because I've seen that before." And it wasn't. But it made us look at that and then when we knew that it wasn't that for sure, it was like, "Oh, okay, thank God." But I still don't know... (72NOR)

Attending: The danger is to anchor everything down in one diagnosis anyway and I think you can watch residents and staff do that all the time. Usually, there's this person, he always comes in with this... (51GRE)

Theme 5: Impact of Uncertainty in the Learning Environment

Culture of medical training

The culture of medical training (structure of learning environment) and external pressures impacts tolerance of uncertainty and whether individuals feel at peace with not having an answer versus feeling distressed when facing uncertainty. Again, personal/cultural attributes affect one's tolerance of uncertainty.

Attending: ...there's a certain type [of] people who are very structured, they've grown up in the wealth of a structured environment, everything is to the "T", you know. So I find that that's a unique ... Western society, it's very unique. This level of control that human beings have on their lives. Let's put it that way. ... So I have never struggled with uncertainty personally. I mean, I do struggle but not to that extent. I'm more kind of, "Yeah, we'll play it by ear." That kind of a situation. It's tough. (11KVI)

The need to save "face"

Hiding individual uncertainty is a behavior taken in emotional response to the threat of a situation. Sometimes circumnavigating one's individual uncertainty saves "face" when there is potential for repercussion. Physicians of all training levels want to be seen as competent, and vocalizing their uncertainty leaves them vulnerable to being perceived by others as incompetent, and also to other real, negative social consequences.

Resident: Because personally I know that a lot of my medical school education and intern year is just trying to act like I know what I'm talking about even when I'm uncertain. I'll admit that I don't want to acknowledge what I don't know. Because part of it is that I don't want to be embarrassed in front of my attending, I don't want to be embarrassed in front of my senior or the other med students, and I think this is just something that goes on past residency per se even. (15POR)

Attending: I think that it was ... well I even got my hand slapped a few times for not knowing something, like, "you really should have known the max heart rate this morning" or something that seemed kind of small. I developed ... I guess because I felt like it probably saved face most of the time, but someone would ask a question and I'd just say "yeah, yeah, okay, yeah" and whatever seemed to be the answer they were looking for and if it was something important, I would correct it, but there was a lot of times, I remember, when my default was just to say, "yeah" and to try to come across like I knew something. (11KVI)

Authority construct

The medical culture and learning environment is deeply hierarchical. Communicating further up or further down the hierarchy of medicine can cause a feeling of being judged and lead to feelings of insecurity. This can be between colleagues of the same level (i.e. among attending physicians or among residents) or between levels (i.e. resident to attending communication).

Resident: I think everyone's afraid of being judged. I think everyone's scared that they're going to be deemed incompetent, right? This is a very ... This field, even though it should be a team sport, often doesn't feel like a team sport. I'm not quite sure why other than that medical school things are super competitive, so everybody gets used to trying to be the person who knows all the answers and has the highest test scores. I think some of that just bleeds through to your entire career and your entire life. (26TER)

Role modeling in the learning environment

Observing quality interactions of attending physicians dealing effectively with uncertainty is comforting. Being open with learners, acknowledging the uncertainty. Sharing the thought process during an uncertain situation and sharing worries/concerns about uncertainty. When the teacher speaks about being open with/role model for the student. Setting the stage for a safe learning environment where uncertainty is voiced takes conscious effort.

Resident: It was when I saw staff that I admired a lot also embrace the diagnostic uncertainty, then I became more comfortable knowing about ... accepting that there's diagnostic uncertainty. So, it's like a lot of times it was attendings and staff who I respected a lot, who had good medical knowledge, who were comfortable with saying that we don't always know the answers, we don't always know the diagnosis, and especially we don't always know the diagnoses right away. And that's, it was more when I saw it modeled by people that I respect and admire a lot that I started becoming more accepting of it. (21MED)

Embracing uncertainty is not a part of the formal curriculum

There is interest among residents and attending physicians in promoting a “safe environment for uncertainty” where being open about one’s own uncertainty is allowed and individuals can speak their mind and “think out loud” together about uncertainty. Role modeling how to “work with uncertainty” is often sought where we engage and embrace moments of uncertainty. However, uncertainty is not a part of the formal curriculum. Training to become a physician is reductionist, which simplifies and oftentimes eliminates uncertainty by giving the false impression of “one right answer” (e.g. evaluation based upon single best answer multiple choice testing). Training in recognizing, tolerating, and embracing uncertainty should be part of the formal curriculum.

Resident: I wish that there was a more formal way of teaching that there's diagnostic uncertainty. Or at least making sure that we all get that training in some way, at some point. I wish I'd learned it more in medical school but even earlier on in my residency, I wish I had maybe a workshop during orientation or at the beginning of my, somewhere in the beginning of my intern year. Being more accepting of diagnostic uncertainty. Because I even know people in my own residency class, and even the class ahead of me, that they are probably still not as accepting of diagnostic uncertainty or just the uncertainties of medicine. And there is ... right now I don't know of any formal training that people get that. (21MED)

Attending: I think there needs to be more explicit recognition. I think the textbooks, when you read the textbooks, it's all about one disease, one XYZ. You don't really get into the fog of war situation. It's all you go to the chapter, read the chapter on coronary artery disease, and angina. The next chapter is aortic aneurysms. So it's all clear. The real fun of this is when you see a patient where the disease hasn't read the textbook, right? (11KVI)

Theme 6: Desire for Culture Change

Pervasive desire to shift culture

A cultural tension exists between the expectation that "competency is certainty" and growing recognition that uncertainty is pervasive in medical practice and dealing with it should be part of the formal curriculum. We're battling an uphill battle of the ideal physician and certainty being equated with competency. Medical training itself plays a role in building this discomfort, given the cultural myth of the "all-knowing ideal physician" and certainty being equated with competency. This contributed to discomfort with uncertainty, and this culture may even seep into other parts of medical trainees' lives.

Attending: So I think we need as an educational system to be more vocal. It needs to be okay. I think there's a cultural thing which equates uncertainty to ignorance or malpractice or kind of this ego thing or sticking to a diagnosis. Or if I'm uncertain, then I will try to alleviate that by sticking to one, the diagnosis I have, or the management plan I have, without acknowledging that you become black and white. Because you just hate that. You don't want to go into the gray. You don't want to acknowledge the gray. (11KVI)

Tension between desire and reality

A parallel push for complete knowledge is in tension with an unwillingness to voice uncertainty for worry of not fulfilling the ideal role of a physician. There is a mismatch of what our perceptions of the ideal physician are versus the reality and lived experience of clinicians.

Resident: I think that some of your questions pointed this out, there's this culture, a storm's a comin' there's a cultural shift where we want to acknowledge what we don't know. We want to acknowledge our uncertainty, while at the same time there is still an expectation that we know everything, that you should know everything. I think creates a lot of tension, because of course we want to acknowledge when we don't know things. I think that everyone would acknowledge that, everyone would say, yes, if you're uncertain about something let us know. (15POR)

SURVEY RESULTS

A total of 49 individuals completed the survey in the study period. Of this sample, 35 responses (71%) originated from residents and 14 (29%) from attending physicians. The resident response rate is estimated at 58% of those eligible during the study window. This number represents the percentage of unique residents available during the study period. The resident sample had a mean age of 29 ($SD = 2$), a gender breakdown of 49% female (Table 1). For attending physicians, a 43% response rate was achieved. The attending sample had a mean age of 40 ($SD = 8$), 4 were females (29%), and a mean of 7.9 years since graduation from medical school ($SD = 6.3$). Within the sample, a proportion of respondents attended medical school outside the United States. The United States graduates comprised 11 (79%) of the attending responses and 29 (81%) for residents.

Table 1: Characteristics of Survey Respondents

	N	Age (mean +/- SD)	Gender (% female)	Years Since Graduating Medical School (mean +/- SD)	Attended Medical School in the United States (%)
Attending Physicians	14	40 (8)	4 (29%)	10.9 (6.3)	11 (79%)
Resident Physicians	35	29 (2)	17 (49%)	2.1 (0.9)	29 (81%)

Comparing Sample Data to Literature Sources

Given the use of validated measurements, our study sample is compared with published values for each of the three separate validated scales (Table 2). The mean response to each subcategory of the PRUS survey falls closely in line with that previously published (Martha S. Gerrity et al., 1995). Our total sample mean is comparable in values for *anxiety due to uncertainty* (18.0 [4.3] vs. 18.8 [4.7]), *concern about bad outcomes* (9.7 [2.9] vs 9.5 [3.1]), and *disclosing uncertainty with physicians* (4.5 [1.9] vs. 4.4 [1.9]). There is no comparable reference range for *disclosing uncertainty to patients*. Our study sample does not show a notable difference from previous published data on reaction to uncertainty as measured by this scale.

On assessment of our study population for signs of burnout, our sample demonstrated less burnout in comparison to published data for the 2-item Maslach Burnout Inventory (MBI). Our sample had a burnout rate of 29%, which is below that published in the literature (30-55%) (Shanafelt et al., 2015). Because this rate is relatively low, and our sample small, we utilized a summative numeric variable for the responses instead of a categorical variable. This choice enables a more powerful analysis between the three validated scales used in our study. Our study sample had an average summative burnout score of 6.5 ($SD = 2.9$, median = 6, range 2 – 13).

Scores on the Educational Climate Inventory (ECI) demonstrate a more mastery oriented learning environment in comparison to data published from undergraduate medical education. The average score for the ECI in our sample was 65.4 ($SD = 6.2$), which is above the multi-center average in undergraduate medical education of 56.8 ($SD = 9.5$). A higher score on the ECI and its' subscales are suggestive of a more positive, or mastery-oriented, learning environment. For each of the three subscales of the ECI, our sample had scores above those published for undergraduate medical education. This included the subscales of competitiveness and stress, centrality of learning, and passive learning and memorization (see Table 2).

Table 2: Resident and Attending Responses to Validated Scales and Comparison with Published Literature (two tailed *t*-test)

	Total Sample (mean, <i>n</i> = 49)		Residents (mean, <i>n</i> = 35)		Attendings (mean, <i>n</i> = 14)		<i>p</i> -value	Literature	
		SD		SD		SD		Reference	SD
Physicians' Reaction to Uncertainty Scale [^]									
<i>Anxiety due to uncertainty</i>	18.0	4.3	19.0	3.6	15.6	5.0	0.01*	18.8	4.7
<i>Concern about bad outcomes</i>	9.7	2.9	10.6	2.6	7.6	2.8	<0.01*	9.5	3.1
<i>Reluctance to disclose uncertainty to patients</i>	7.1	2.1	7.6	1.7	6.1	2.6	0.02*	N/A	
<i>Reluctance to disclose uncertainty to physicians</i>	4.5	1.9	4.7	2.0	4.0	1.5	0.26	4.4	1.9
Maslach Burnout Inventory (2 item) Sum [*]									
<i>Summative Variable</i>	6.5	2.9	7.1	2.9	4.9	2.0	0.01*	N/A	
Educational Climate Inventory Total Score ^{††}									
<i>Competitiveness and Stress</i>	65.4	6.1	66.1	6.0	63.8	6.6	0.25	56.8	9.5
<i>Centrality of Learning</i>	18.5	2.1	18.4	2.2	18.6	1.8	0.87	16.8	3.7
<i>Passive Learning and Memorization</i>	34.0	3.8	34.5	3.3	32.9	4.6	0.18	30.2	4.9
<i>Passive Learning and Memorization</i>	12.9	1.8	13.1	1.9	12.4	1.4	0.16	9.1	2.1

SD = Standard Deviation

[^] Marzha S. Gerrity, White, DeVellis, & Dittus, 1995^{*} West et al., 2009. Note use of a summative variable as opposed to a categorical variable for measuring burnout. Our sample had an average 29% rate of burnout.^{††} Krupat et al., 2017. Note that published values for this scale are for medical students (UME); this is its first use in GME and CME populations

Comparing Attending Physicians to Residents

Significant differences are measured between residents and attending physicians in our sample, most notably in the Physicians' Reaction to Uncertainty Scale (PRUS) (Table 2). On the PRUS scale, attending physicians rated themselves as having less anxiety due to uncertainty than residents (15.6 [5.0] vs. 19.0 [3.6], $p < 0.05$, respectively), less concern about bad outcomes (7.6 [1.7] vs. 10.6 [2.6], $p < 0.05$), and as less reluctant to disclose uncertainty to patients (6.1 [2.6] vs. 7.6 [1.7], $p < 0.05$). While residents had a higher rating for reluctance to disclose uncertainty to physician colleagues, this difference was not statistically significant (4.7 [2.0] vs. 4.0 [1.5]).

Our assessment of physician wellness, as rated by summative responses to the 2-item MBI demonstrate a significant difference between attending physicians and residents. Residents have significantly higher symptoms of burnout than attending physicians (7.1 [2.9] vs. 4.9 [2.0], $p < 0.05$ respectively). Residents experience greater anxiety from uncertainty than attending physicians, respectively scoring 19.0 [3.6] and 15.6 [5.0] (Table 2, $p = 0.01$).

Does Anxiety due to Uncertainty Correlate with a Stressful Learning Environment & Burnout?

We correlated scores for anxiety due to uncertainty (PRUS subscale) with symptoms of burnout and ratings of the learning environment (Table 3). Within our sample, a higher score for anxiety due to uncertainty had a statistically significant correlation with increased symptoms of burnout ($r = 0.51$, $p < 0.01$) and perceiving the learning environment as more competitive and stressful ($r = -0.41$, $p < 0.01$).

When our sample is divided into resident and attending physicians, many but not all of these findings remain. Residents again demonstrate that greater symptoms of burnout and perceptions of a more stressful learning environment correlate with greater anxiety due to uncertainty ($r = 0.45$, $p < 0.01$). For attending physicians, only total scores for the ECI

suggestive of a performance oriented learning environment correlate with increased scores for anxiety due to uncertainty ($r = -0.63, p = 0.02$).

Table 3 : Anxiety due to Uncertainty (PRUS subscale) and correlations with Meslach Burnout (2-item) and Educational Climate Inventory

	PRUS Anxiety Subscale (<i>n</i> = 49)		Resident Sample (<i>n</i> = 34)		Attending Sample (<i>n</i> = 14)	
	Correlation Coefficient (<i>r</i>)	<i>p</i> -value	Correlation Coefficient (<i>r</i>)	<i>p</i> -value	Correlation Coefficient (<i>r</i>)	<i>p</i> -value
Meslach Burnout Inventory (2-item)						
<i>Summation Variable</i>	0.51	<0.01*	0.45	<0.01*	0.49	0.08
Educational Climate Inventory Total Score	-0.32	0.03*	-0.28	0.09	-0.63	0.02*
<i>Competitiveness and Stress</i>	-0.41	<0.01*	-0.45	<0.01*	-0.43	0.13
<i>Centrality of Learning</i>	-0.21	0.13	-0.11	0.53	-0.60	0.53
<i>Passive Learning and Memorization</i>	-0.17	0.23	-0.21	-0.23	-0.46	0.09

* significant at <0.05

PRUS = Physicians' Reaction to Uncertainty Scale

Does the Reluctance to Disclose Uncertainty Relate to the Learning Environment & Symptoms of Burnout?

As we have previously shown, the average reluctance to disclose uncertainty is different between residents and attending physicians (see Table 2). Further examining this data, we explored correlations between scores for the reluctance to disclose uncertainty, gender, years since graduating medical school, symptoms of burnout, and ratings of the learning environment (Table 4).

In terms of gender, females were found to have a slight negative, however nonsignificant correlation with the disclosure of uncertainty across the entire sample and when divided into resident and attending physician samples. In this way, females tended to have greater scores for reluctance to disclose uncertainty than males. While this slightly negative correlation existed in our sample, it was not a statistically significant finding ($r = -0.22, p = 0.12$).

More time since graduating medical school correlates with a lower, more favorable, score for reluctance to disclose uncertainty in our sample ($r = 0.40, p < 0.01$). Note that this likely reflects the difference between attending and resident responses, as we know there is a significant difference in mean score between the two groups (see Table 2). This relationship between years since graduating residency washes out when the sample is divided into residents and attending physicians ($r = -0.06, p = 0.73$ and $r = 0.32, p = 0.27$, respectively).

Across our sample, greater reported symptoms of burnout correlate with an increased reluctance to disclose uncertainty ($r = 0.30, p = 0.03$). When parsing the sample into resident and attending physician responses, this correlation does not remain significant. Note that the findings in Table 2 may help explain the significant correlation across our sample, as residents have a significant difference from attending physicians in bivariate analysis.

Perceiving the learning environment as more competitive and stressful strongly correlates with an increased reluctance to disclose uncertainty ($r = -0.44, p < 0.01$). This remains true for residents and for attending physicians ($r = -0.41, p = 0.01$ and $r = -0.67, p = 0.01$ respectively). This trend is seen across the other subcategories of the ECI including the centrality of learning and passive learning and memorization, but do not hold significance across the groupings.

Table 4 : Reluctance to Disclose Uncertainty (PRUS subscale) and correlations with Maslach Burnout (2-item) and Educational Climate Inventory

	Reluctance to Disclose Uncertainty (n = 49)		Resident Sample (n = 34)		Attending Sample (n = 14)	
	Correlation Coefficient (r)	p- value	Correlation Coefficient (r)	p- value	Correlation Coefficient (r)	p- value
Female Gender	-0.22	0.12	-0.05	0.78	-0.42	0.12
Years Since Medical School Graduation	0.40	<0.01*	-0.06	0.73	0.32	0.27
Maslach Burnout Inventory (2-item)						
<i>Summative Variable</i>	0.30	0.03*	0.12	0.49	0.39	0.15
Educational Climate Inventory Total Score	-0.33	0.04*	-0.27	0.11	-0.71	<0.01*
<i>Competitiveness and Stress</i>	-0.44	<0.01*	-0.41	0.01*	-0.67	0.01*
<i>Centrality of Learning</i>	-0.15	0.27	-0.06	0.72	-0.53	0.05*
<i>Passive Learning and Memorization</i>	-0.27	0.06	-0.26	0.12	-0.72	<0.01*

* significant at <0.05
PRUS = Physicians' Reaction to Uncertainty Scale

CHAPTER 4: DISCUSSION

SUMMARY AND PROPOSED DEFINITION AND MODEL OF CLINICAL UNCERTAINTY

The ethnographic and phenomenological components of this study explore clinical uncertainty in terms of individual perceptions and team behaviors in the inpatient learning environment of graduate medical education (GME). Our findings suggest that uncertainty exists as a constant feature in medical practice as evidenced by our observations of clinician behavior, responses to validated surveys, and individual accounts.

In the ethnographic study physicians struggle with uncertainty as they attempt to reconcile incomplete data from multiple sources and form meaningful and best-evidenced care plan for patients and for the teaching of medical trainees. The senior members of the team play a key role in ensuring that pathophysiological underpinnings of disease are understood, and discourage deficiencies where there are uncertainties in knowledge — *epistemic* uncertainty among the team. However, when faced with varied, time-sensitive patient presentations and limited data, acknowledgment of uncertainty may foster reassurance and transparency in relationships between clinicians and patients (acknowledging and processing *aleatoric* uncertainty interpersonally).

Strategies teams in the inpatient setting use to address uncertainty include both actions and inactions (Figure 1). Through a complex and multi-faceted approach of personal reflection, information seeking, and the testing of ideas in social interactions, meaning for uncertainty is created. This process is most characteristic of constructivist learning theory, where new knowledge and meaning is constructed out of fragmented and incomplete information. A team's dialogue creates consensus and constructs meaning through social interaction and a reliance on medical knowledge. Clinical inactions or actions that follow may be adaptive (functional) or maladaptive (nonfunctional). Inactions that are more functional (adaptive) include acknowledging uncertainty among the team and with the patient, yet creating reassurance that a “watch and wait” strategy is appropriate, or establishing “safety net” follow-up plans. Less functional or maladaptive inactions include ignoring or hiding uncertainty to avoid being perceived as incompetent in the eyes of the medical team or the patient. Actions related to uncertainty that are functional (adaptive) include appropriate rule-out of dangerous diagnoses, consideration of alternative diagnoses or therapies, seeking patients' preferences or consent in the face of multiple options, and further clinical action (diagnostic or therapeutic intervention) and follow-up. Less functional (maladaptive) actions include anchoring on a single diagnosis (premature closure), failure to pivot in the face of changing clinical data and/or patient preferences, and excessive resource use (e.g. ordering tests that will not change management).

In our survey results, we demonstrate that the societal perception of the flawless physician is a far cry from the lived experience. In the GME setting of a large academic institution, perceiving the learning environment as more competitive and stressful correlates with anxiety from uncertainty and higher reported symptoms of burnout. While this is the first such correlation demonstrated to our knowledge, previous work has suggested a link between performance orientation and burnout among medical students (Dyrbye et al., 2009). As we have shown, residents do not feel comfortable disclosing and sharing uncertainty with patients, but they aspire and desire to do so better and more often. To a certain extent, much of this may be cultural, but they also potentially appear to be lacking (or not receiving) appropriate education on strategies to do so. This mismatch between desire and reality may be creating intolerance for

uncertainty, conflict and stress, which may be contributing factors to burnout, especially as the environment residents inhabit is rife with uncertainty.

In interviews, we identified a recurring theme that tolerance of uncertainty develops over time and with clinical experience. In these reflections, the tolerance and coping strategies for dealing with uncertainty is understood as a modifiable and learned personality trait and skill among physicians — not a static, unmodifiable personality characteristic. This corroborates previous work that has shown that the tolerance of uncertainty is thought to be a trait, not a state (Mathot, Wright, Kempnaers, & Dingemans, 2012) (Simpkin et al., 2018). Our interviews also pointed to a key awareness and the challenge of uncertainty during transition points in training. For example, those interviewed voiced a mismatch occurring between the classroom environment and the clinical environment, in which textbook descriptions of disease and the real practice of medicine – both in the timeline for how cases are presented (neatly wrapped up textbook cases versus unpredictable and messy real-life cases) and in the immediacy of feedback (instant feedback circuit on answering a multiple-choice question correctly or incorrectly versus often little or no feedback due to shift-work patterns, inconclusive diagnoses, or lack of follow-up).

In summary, we feel our descriptive data suggest a definition and model for how uncertainty is perceived and manifested in medicine that differs from the current literature. We propose a new definition of clinical uncertainty below (with an accompanying conceptual model in Figure 1 below). In the practice of healthcare, uncertainty exists both as an individual awareness and an inherent trait of the clinical presentation of an ill patient. For individuals, the awareness of uncertainty is, as we consider it, part of the cognitive processing domain (Anderson & Krathwohl, 2001). With awareness comes an emotional response and the willingness for that individual to act. Subsequently, a behavioral response ensues that is defined by actions or inactions. Importantly, at each of these points, from awareness (cognitive) to tolerance/distress (emotional) and action (behavioral), the medical culture, learning environment, and personal characteristics influence how individuals react to and manage the inherent uncertainties in the practice of medicine.

Proposed definition of clinical uncertainty:

The interpretative challenge of reconciling incomplete information, variable acuity of disease, transitory probabilities, and the potential for critical consequences in order to make time-sensitive clinical decisions that align with patient preferences.

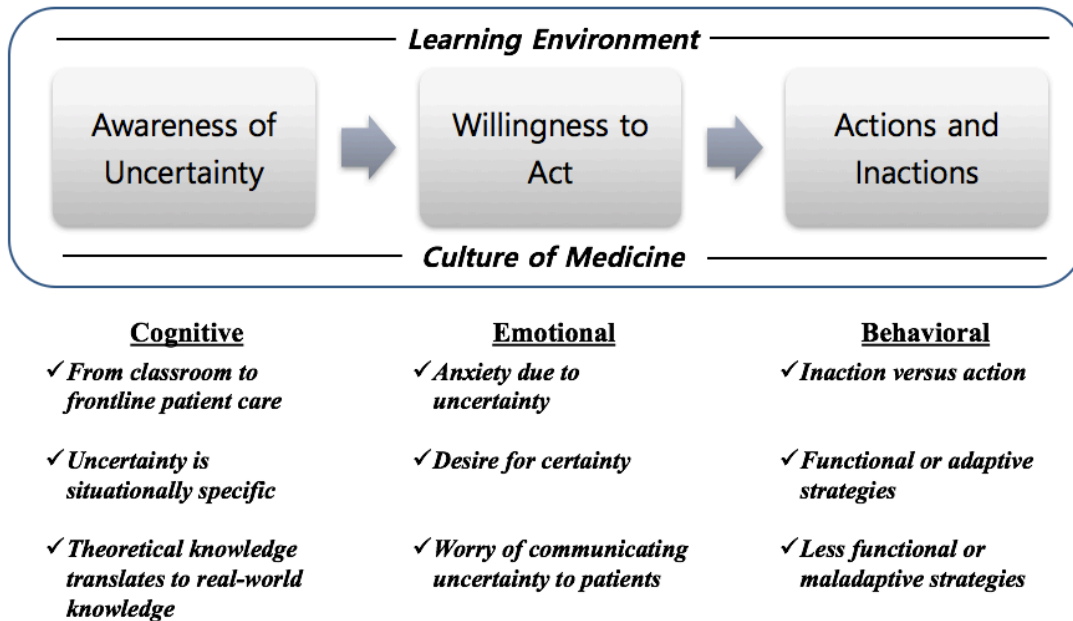


Figure 1: Conceptual model for uncertainty based on study data

THE PROBLEM ADDRESSED

While uncertainty is not something new, it is an inherent part of medicine that has not been thoroughly addressed. Recent literature suggests uncertainty is likely to increase, not decrease, as technology takes over the black and white tasks of medicine (anything for which an algorithm can be written), and humans are left to deal with the uncertain, unpredictable, and messy greyscale space (Simpkin & Schwartzstein, 2016). Uncertainty is generally considered an undesirable and negative characteristic despite its inherent quality in many of life’s processes (Mathot et al., 2012). The perceived anxiety from uncertainty in clinical work has clear links to burnout and low scores for resilience (Simpkin et al., 2018). The daily clinical workflow requires patients receive care that is appropriate, expeditious, and safe. To do so, information must be gathered and evaluated with effective and efficient means that prevent bias, formation of assumptions, and errors in communication that leave patients open to possible delays, misdiagnosis, mismanagement, or even worse, harm. Consequently, how physicians learn to acknowledge, tolerate, and navigate uncertainty is important for ensuring high quality care, patient safety, as well as physician wellness.

IMPLICATIONS

What contributes to tolerance or intolerance of uncertainty?

Our study findings suggest that a greater intolerance of uncertainty goes hand-in-hand with a more competitive and stressful learning environment and increased symptoms of burnout. Various methods of addressing these factors, and further research into the impact of each, may

alleviate key challenges facing medical education and practice. Current dialogue regarding physician wellness identifies the importance of individual and system related actions to mitigate the endemic problem of burnout and depression among physicians (Mata et al., 2015) (Rotenstein et al., 2016). Strategies medical educators use to address anxiety and depressive symptoms among medical trainees should also consider these trainees' tolerance of uncertainty as a measurable trait.

Specific to our study findings, tolerance of uncertainty and behaviors that arise in response to uncertainty appear to be significantly determined by the learning environment and culture of medical practice. Physicians and residents in our study say they have a desire to acknowledge their uncertainties, yet worry about falling short of the idealized flawless model of a physician they believe their colleagues and patients expect. The cultural ideal that equates with ignorance or malpractice negatively impacts the willingness of residents to acknowledge and openly discuss uncertainty in ways that may, in fact, be an opportunity to reduce error and build reassurance and trust with patients.

The structure of evaluation and assessment methods used in medical education may impact how students and residents perceive and respond to uncertainty. In our study, resident and attending physicians call out the challenge of adapting what is learned in the classroom to the clinical environment. This draws the distinction between neatly packaged patient presentations with an instant feedback circuit (such as in multiple-choice questions or standardized exams) versus real-life clinical scenarios where there is little to no feedback possible due to shifting patterns or inconclusive diagnoses. This creates tension between what is understood and rewarded in the classroom setting and what is real, varied, and practiced in the clinical environment. Making changes to this domain will require continued effort on behalf of students, educators, clinicians, and patients to find measurable and meaningful methods of teaching educational content — including introducing students to clinical uncertainty, obtaining quality feedback mechanisms in clinical settings, and ensuring competency and confidence in physician training.

The factors influencing individual perceptions and behaviors in response to uncertainty are not well known. Multiple possible contributing factors including years of clinical experience, cultural and personal factors, and significant past experiences requiring adaptability in management practices (e.g. patient cases with surprising outcomes or errors) may all contribute to an individuals' likelihood of developing tolerance of uncertainty and practicing adaptive management behavior. This raises the question of whether admissions selection for medical school and health professions should be modified to account for personal and experiential factors that are suggestive of high tolerance of uncertainty.

How can we better address uncertainty in the curriculum of medical education?

We need to explicitly embrace uncertainty in clinical practice, and develop better ways to acknowledge its presence in a safe and intentional way earlier in medical training. Residents say they wish they had a more formal introduction to uncertainty earlier in their training. As we have demonstrated, embracing uncertainty can be one trait that is a reflection of mastery in attending physicians. Further, it is important to recognize that accurate and authentic communication of uncertainty is integral to the patient-centered decision making process and can help, in which ensure trust in the therapeutic relationship.

This study has two major implications for medical education: 1) culture influences the safety of expressing uncertainty and the behavioral responses thereto and 2) a formal curriculum addressing uncertainty in medicine at earlier stages of training, including in medical school and during residency, may have positive downstream effects on performance, wellness, and patient quality and safety. This study fits into a broader call for a need for a culture of safety that affects patient care in ways we are just beginning to understand (Aron & Headrick, 2002). Dedicated efforts beginning early in medical training may allow for earlier exposure to the same uncertainties experienced in the lives of practicing physicians. This includes opportunities to demonstrate mastery, as shown in our study, by acknowledging and embracing uncertainties of medicine. Similar to how people learn first to crawl, then to walk, and then to run, further longitudinal studies are needed to understand how to optimize a curriculum that explicitly addresses uncertainty in medical education. Alongside intentional additions to curricula in undergraduate and graduate medical education, faculty development programs will be essential and at the forefront for promoting and role-modelling behavior that acknowledges and embraces uncertainty in adaptive ways.

From our qualitative findings, we show that tolerance of uncertainty is a learned skill gained over the course of physician training and practice, and is not explicitly offered as a part of the medical school curriculum. The opinions gathered from physicians and residents suggest that greater acknowledgement of uncertainty would positively impact patient care and learning. Addressing uncertainty in the medical school curriculum should focus on three components based upon our study findings: a) incorporate a description of the nature and extent of uncertainty in medical practice, b) create a culture where it is safe for individuals to acknowledge uncertainty and say “I don’t know” or “I’m not sure” to supervising physicians and patients and c) allow learners to appreciate the role modeling behavior of experienced clinicians as they grapple, manage, and follow-up in uncertain situations. Therefore, activities in medical education should address the cognitive, emotional, and behavioral challenges of uncertainty.

With increasing use of web-based study tools for national board exams, the value of medical school in the future may favor skill development related to the interpretive challenges and decision-making processes in medicine (McGaghie, Downing, & Kubilius, 2004). Traditionally, the medical school is where knowledge related to clinical medicine was dominantly available (Ludmerer, 2005). Medical professors, physicians, and textbooks were only accessible in this setting. This has changed in recent years with the increasing availability of electronic and web-based learning platforms, where accessibility to medical information occurs anytime and anywhere with an internet connection. However, this presents a challenge in translation to the process and skill of decision-making and effective communication that are so important in the patient care setting. Therefore, exposing learners sooner in supportive and safe learning situations to the realistic interpretative challenges occurring around decision-making in the face of incomplete information may be of benefit.

The curricular approach to uncertainty ideally should use varied and interleaved learning scenarios based upon varied levels of feedback immediacy (Brown, 2014). For example, this may include feedback mechanisms ranging from practice problems where immediate feedback limits uncertainty, to problem-based learning with intermediate feedback and some tolerance of uncertainty, and simulations of clinical scenarios where no immediate feedback exists. Scenarios where communication skills are thought and practiced (i.e. role play) and in which uncertainty may be situationally irresolvable will most closely mimic the clinical setting. While these

teaching methodologies are already incorporated into many US medical schools, further study is needed to explore the influence they have on tolerance and management of uncertainty.

STRENGTHS

The strengths of this analysis lie in the methodological approach. This study used qualitative methods to inductively approach how uncertainty is understood by clinicians in an open-ended ground-up approach, as well as predefined quantitative scales of measurement. The three distinct methods of analysis permitted a comprehensive examination of how clinicians perceive and approach uncertainty in the clinical environment. This enabled us to triangulate uncertainty from three separate angles from agreement on our research findings. In addition, our use of established psychometric instruments allowed for comparison with the general population and other samples of medical students, residents, and practicing doctors. Our sample was representative across graduate medical education and continuing medical education physicians and included residents at all stages of training, and attending physicians with a variety of experience. Ethnography was carried out by a member of the clinical team, providing minimum disruption to the daily routine and proceedings of inpatient academic medicine. All data was kept anonymized during the analysis for both quantitative and qualitative components, limiting the biases related to social desirability.

LIMITATIONS

Our study is limited by single center convenience sampling in the departments of internal medicine and combined internal medicine and pediatric residency programs. This makes our analysis limited in the generalizations we can make about other academic medical centers and other specialties. Although there is no reason to postulate that these relationships would be unique to a single specialty or single geographical area, further studies would need to quantify these relationships across specialties and geographic regions.

Limitations to the qualitative portions of this study include characteristics of the sampling method and sample size. The small sample of participants for the 60-hour ethnography phase is a limitation, although the lack of generalizability inherent in using a small number of respondents was offset by the opportunity to observe people with whose individual behavior the researcher became increasingly familiar. The analytic methods of this part of the study were too rigorous to be applied to a substantially larger sample. Qualitative interviews were conducted with self-selected participants who chose to be interviewed, and thus may not be entirely representative of the wider views of the population of internal medicine resident and attending physicians. The fact that the study achieved saturation indicates a sufficient number of interviews were performed.

We used self-reported scales for the quantitative analysis that are susceptible to participant distortion, but participants were unaware of the specific hypotheses of this study and we have no reason to believe that they would have chosen to participate or not on the basis of whether they were burned out. While our survey sample size represents a sizeable proportion of the resident class, it again is limited by a single center approach with small to moderate numbers. Our methods address this limitation through the use of numeric variables wherever possible as opposed to size-limiting dichotomous variables in the limited sample size. The cross-sectional

design may have masked temporal relationships, and prohibits any causal conclusions from these findings alone. It will be important to identify causal relationships with longitudinal data.

FUTURE RESEARCH

Further research is needed to clarify the role of uncertainty in patient care and patient outcomes and to elucidate its relation to modifiable physician characteristics. This means seeking better scales to accurately measure uncertainty and further understand its true impact on the quality and safety of patient care, and its educational value. This is in addition to more multi-center, multi-specialty, longitudinal studies which seek to understand how acknowledgment and tolerance of uncertainty changes over time for physician trainees. Further inquiry into the ethics and role of using psychometric tools which test for tolerance of uncertainty in the admission screening process for medical school, and whether such tools have predictive value of positive outcomes (both for physicians and patients) is also a subject for future research.

Importantly, further research on how physicians should communicate uncertainty with patients should be explored from both physicians' and patients' perspectives. This would enable a deeper understanding of the tradeoffs in communicating uncertainty and ensuring trust and whether patient outcomes are affected in different contexts/clinical environments. As a follow-up to this study, research with expert clinicians and patients is already underway by members of the study team with the aim of exploring and developing optimal strategies for communicating clinical uncertainty.

CONCLUSIONS

From this multi-method qualitative and quantitative study, it is clear that uncertainty is rife in the practice of medicine in the academic context. Attending physicians and residents experience, acknowledge, and act on uncertainty differently. Perceptions of uncertainty impact clinical management and communication with patients, and intolerance of this uncertainty correlates with symptoms of burnout in our sample. Despite major advances in medicine that seek to make healthcare more efficacious, precise, and efficient, it is clear that how physicians tolerate and manage uncertainty will continue to be a central paradigm in medicine — perhaps more so now than ever as we continuously grow to recognize the significant “greyscale” space of medicine. It is essential, therefore, to embed strategies to embrace uncertainty and communicate about it openly into our educational system and in our healthcare culture if we are to ensure clinical care of the highest quality and safety, preserve in patient and provider relationships, and promote physician wellbeing.

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