



Trainee Uncertainty around Intervening When Patients Decompensate

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Background: Trainees in acute care specialties often grapple with the decision to perform an invasive procedure in a rapidly decompensating patient, for whom the benefits and risks are inherently uncertain. The difference between trainees who know when to act and when to seek supervision and those who do not is often linked to individual trainee psychological and cultural perceptions of uncertainty. But how much comfort with uncertainty relates to the situational context rather than the trainee traits is underexplored.

Objective: The objective of this study was to explore trainee actions around decompensating patients and assess the degree to which invasive intervention and supervision seeking depend on situational certainty or individual trait-based perceptions of uncertainty.

Methods: A total of 41 internal medicine residents completed a survey to measure anxiety related to uncertainty using the Physicians' Reactions to Uncertainty (PRU) tool and to measure uncertainty avoidance using the Values Survey Module (VSM)

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before responding to 14 written emergency situations. Half of the scenarios contain sufficient diagnostic certainty to warrant aggressive intervention, and half lack sufficient diagnostic clarity to offset the risk of intervention. Mixed multivariable modeling was used to identify the relationship between planned invasive intervention, situational uncertainty, and trait-based perceptions of uncertainty measured in the PRU and VSM.

Results: Trainees' first actions were appropriate in 60% of cases. Multivariable modeling suggested that situational certainty was more predictive of upfront intervention (odds ratio [OR], 30.5; $P < 0.0001$) than trait-based PRU (OR, 1.22; $P = 0.05$) and VSM (OR, 1.73; $P < 0.0001$). Similarly, situational certainty was more predictive of reduced supervision seeking (OR, 0.20; $P < 0.0001$) than trait-based PRU (OR, 2.03; $P < 0.001$) and VSM ($P =$ not significant).

Conclusions: Situation-specific certainty was more strongly correlated with invasive intervention in cases of decompensated patients than individual trainee traits. Focusing on trainee contextual understanding of procedural risk–benefit ratios in decompensating patients holds more promise for improving trainee actions and supervision seeking than tackling their perceptions around uncertainty.

Keywords:

medical education; uncertainty; supervision; medical decision making

Managing uncertainty is fundamental to medical decision-making, particularly when timely invasive intervention is required (1–5). Clinicians frequently decide under time pressure and uncertainty whether to invasively intervene in rapidly decompensating patients. Waiting to collect more information to reduce uncertainty may jeopardize the benefit of invasive intervention. Therefore, the balance between benefit and risk of invasive intervention may change over time as information becomes available. A link between clinician willingness to invasively intervene and comfort with uncertainty is suspected (5, 6), particularly among trainees who have the added complexity of deciding whether to delay action to seek supervisory input or support (7, 8). Some trainees manage this balancing act well, whereas others struggle. Supervisors and program directors have often wondered whether resident ability to act or withhold

action is a result of their comfort with uncertainty and whether some trainees are better suited to making these decisions and to the specialties that require them.

At the core of this question is whether uncertainty around invasive intervention relates more to the situation or individual. Early explorations framed uncertainty as a character trait (9–14). Clinicians with low tolerance to uncertainty could be predisposed to excessive testing, and highly tolerant clinicians might expose patients to harmful therapies without convincing diagnostic evidence (3, 15). In this arm of research, Gerrity and her team conducted a robust program to develop the Physicians' Reactions to Uncertainty (PRU) tool (12, 15, 16). The PRU tool is able to grade physicians on four different subscales, one of which focuses on anxiety related to uncertainty (12). A higher score on this subscale indicates greater clinician

anxiety related to uncertainty (16). The presumption was that high anxiety related to uncertainty would lead clinicians to excessively test and delay management or reassurance.

An alternate approach emerged from sociology, identifying uncertainty as a cultural and developmental variable (17, 18). Cultural differences in the approach to uncertainty are well described as a component of the Values Survey Module (VSM) (19). The VSM compares cultures using six dimensions, one of which is uncertainty avoidance. Increasing scores of uncertainty avoidance reflect the degree to which uncertainty and ambiguity are perceived as threatening within society. Yoo and colleagues adapted the instrument to allow for a reliable comparison of individuals' cultural values (19). Using the VSM to understand clinician differences is not without precedent. Malone and colleagues noted less uncertainty avoidance with increasing age and among faculty when compared with residents (20).

However, neither of these approaches identifies the degree to which uncertainty is a function of a particular clinical situation (1, 6, 21) rather than a resident trait, nor do these approaches link uncertainty to supervision seeking. This is particularly relevant for residents embarking on time-sensitive procedures, in which they must balance immediate action against delaying to seek out more information or supervision (8). In a review of critical incidents, resident-vocalized uncertainty was linked to adverse events in up to two-thirds of cases, including delays in escalation of care, procedural complications, and even a cardiac arrest (22). Not surprisingly, residents' uncertainty around procedures related not only to their ability to perform the procedure

but also to whether it was indicated and the immediacy with which it should be performed (22). Although uncertainty increased supervision seeking, residents also described contextual barriers to involving attending physicians—including a sense of situational urgency (22).

This study explores two types of situations involving decompensating patients: situations in which timely invasive intervention is required and situations in which invasive intervention is frequently considered but ill advised. We explore whether appropriate action or restraint is linked to trainee perception of uncertainty. We seek to understand whether appropriate action relates more to situational perception of uncertainty or individual trainee traits, either psychological as defined by the subscale on anxiety related to uncertainty in Gerrity's PRU or sociological as defined by the uncertainty avoidance subscale in Hofstede's VSM. Importantly we explore whether trainees seek appropriate supervision in the setting of uncertainty and whether this is a function of the situation or the trainees themselves.

OBJECTIVE

Our research goals are to 1) measure situational and trait-based perceptions of uncertainty among internal medicine trainees applying to a cardiology program and 2) assess to what extent these perceptions relate to trainees recognizing the need for timely invasive intervention and seeking appropriate supervision. *A priori*, we hypothesized that both situational and trait-based perceptions of uncertainty would be relevant. However, we did not have an *a priori* hypothesis around the magnitude and relative importance of situational uncertainty versus trait-based

uncertainty measures at predicting invasive intervention and supervision seeking.

METHODS

Study Design

We conducted an exploratory study using an online survey platform with applicants to a cardiology residency program as a convenience sample representing trainees interested in an invasive specialty.

Trainees were exposed to a series of cases around decompensating patients so that we could assess the extent to which certainty related to the situation or related to character traits measurable on PRU or VSM.

The study consists of four components, as shown in Figure 1: 1) measurement of anxiety related to uncertainty using the PRU subscale (range, 5–30) (16); 2) measurement of uncertainty avoidance using the Yoo modification to the VSM (range, 5–25) (19); 3) measurement of self-assessed independence for each of seven invasive interventions (self-assess your level of independence for each of the following invasive interventions: I can perform this procedure without supervision, I would want a supervisor around just in case, I would want to be directly supervised, and I am not capable of doing this); and 4) decision-making around 14 written cases of rapidly decompensating patients.

For each of the 14 cases, participants answered three questions:

1. As a measure of situational certainty, they were asked, how certain are you on what to do next from 0 (completely uncertain) to 1 (completely certain)?
2. As a measure of situational action, they were asked, identify which of the following step(s) you would take and order them appropriately: 1) monitor and provide supportive care, 2) collect more information or wait further testing, 3) consult an appropriate service, or 4) perform invasive intervention.
3. As a measure of situational supervision seeking, they were asked, if you are on call overnight, what level of supervision would you seek out? 1) I would manage on my own, 2) I would manage on my own and inform the attending the next morning, 3) I would manage on my own and inform the attending overnight, 4) I would discuss with the attending before managing, or 5) I would ask the attending to come in to help manage.

Participants

We recruited 41 applicants to a cardiology postgraduate training program via email after the admissions process was completed and applicants informed of the results. Residents consented using an online survey and completed the study anonymously online. Residents received feedback on their cultural values, reactions to uncertainty, and case performance as well as a \$100 gift certificate for participating.

Case Construction

Six clinicians (four cardiologists and two general internists) constructed 14 cases of rapidly decompensating patients for whom timely invasive intervention would be considered (*see* Table 1). For each of seven invasive interventions, two cases were constructed: intervention-required cases in which all experts agree that the threshold for definitive invasive intervention outweighs the time delay in pursuing further testing (i.e., in which experts would intervene) and restraint-required cases in which experts would defer invasive intervention (i.e., in which experts would not intervene). Cases were piloted twice with iterative revision to ensure that all experts agreed on when invasive intervention was appropriate.

Scoring

Two binary scores were created: immediate intervention (scored 1 if the

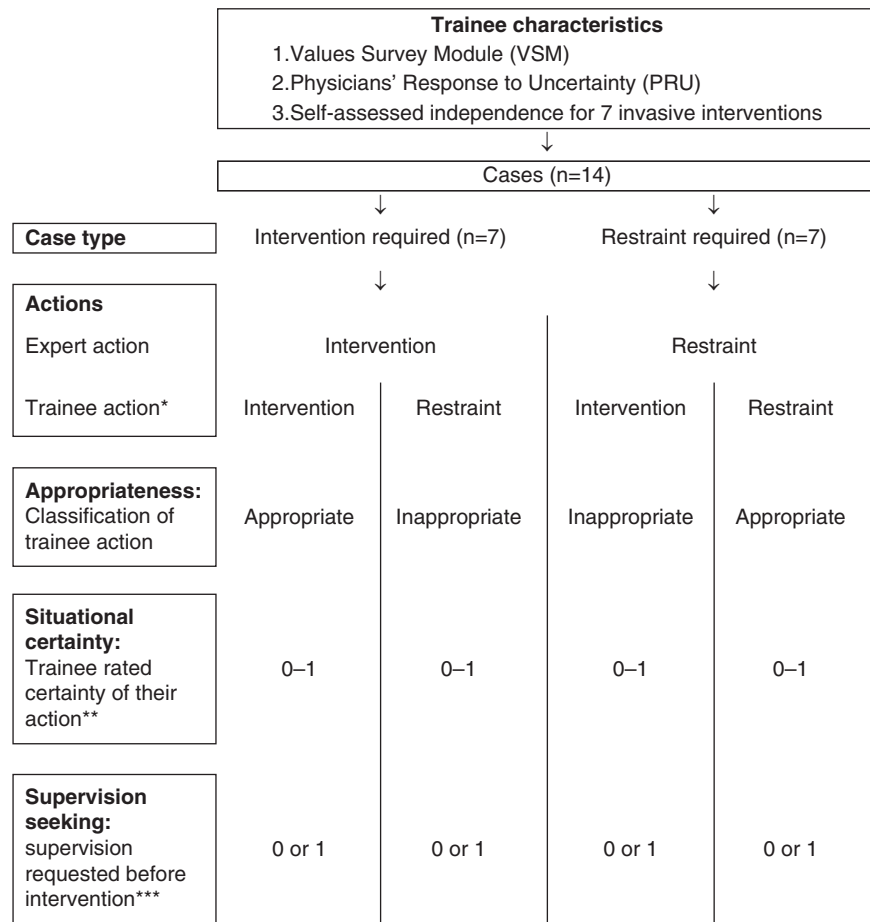


Figure 1. Study design. *Trainees were asked, identify which of the following step(s) you would take and order them appropriately: 1) monitor and provide supportive care, 2) collect more information or wait further testing, 3) consult an appropriate service, or 4) perform invasive intervention. Trainee action was classified as “Intervention” if “perform invasive intervention” was listed and as “Restraint” if it was not. **Trainees were asked, how certain are you on what to do next? This was measured on a continuous scale from 0 (completely uncertain) to 1 (completely certain). ***Trainees were asked, if you are on call overnight, what level of supervision would you seek out (with five different options)? This was scored 0 if the trainee selected 1) I would manage on my own, 2) I would manage on my own and inform the attending the next morning, or 3) I would manage on my own and inform the attending overnight; it was scored 1 if the trainee selected 4) I would discuss with the attending before managing or 5) I would ask the attending to come in to help manage.

first action was to perform the invasive intervention) and supervision (scored 1 when participants chose to discuss with the attending before acting or withholding action—i.e., a 4 or 5 on the ordinal scale for situational supervision seeking).

Outcomes Assessment

We identified appropriateness of invasive intervention based on whether a trainee did what an expert would do (i.e.,

recommending invasive intervention for intervention-required cases and not recommending invasive intervention for restraint-required cases), as shown in Figure 1.

Analysis

We created two binary logistic regression models in SPSS (IBM version 26), one for each scored outcome: immediate intervention and situational supervision (23).

Table 1. Cases constructed around diagnoses for which invasive intervention would be considered

Case	Suspected Diagnosis	Invasive Intervention
1 and 2	Pericardial tamponade	Pericardiocentesis
3 and 4	Pneumothorax	Chest tube
5 and 6	Bradycardia	Temporary pacemaker
7 and 8	Massive pulmonary embolism	Thrombolysis
9 and 10	ST segment elevation myocardial infarction	Angiography
11 and 12	Large pleural effusion	Thoracentesis
13 and 14	Sepsis	Vasopressors

Each model treated each participant as a subject for repeated measures. Covariates included the PRU uncertainty subscore, the VSM uncertainty avoidance index, and situational certainty. PRU and VSM subscores were both converted to z -scores to allow for ease of interpretation of the odds ratios (ORs) within the model. Two cofactors were introduced into the model: 1) self-assessed independence for the specific invasive intervention (scored as 1 for “I can perform this procedure without supervision” and scored as 0 for all other responses) and 2) intervention-required case type (scored as 1 when experts would perform invasive intervention and scored as 0 when experts would demonstrate restraint). Only the main effects of all variables were examined and reported as ORs. Receiver operator curves were constructed for each model to provide a c -statistic based on the area under the curve measurement.

Sample Size Calculation

Given our balanced design with repeated cases by participant, with an anticipation of upfront intervention close to 50% given the case design, we estimated a minimum number of cases required of 140 to achieve power >95% for identifying large effects (ORs, ≤ 0.25 or > 4) (24) but

planned to recruit as many participants as possible within two application cycles to maximize the power of the models to detect smaller effects.

The study was approved by the Hamilton Integrated Research Ethics Board protocol number 7544.

RESULTS

The 41 residents who responded to the survey had completed their internal medicine training at 15 different institutions, 39 in Canada and 2 in the United States. Ten associated with female gender, 28 with male, and 3 preferred not to disclose. Anxiety related to uncertainty PRU subscores ranged from 6.6 to 27.4 (mean, 16.8; standard deviation, 5.1), consistent with broader reported samples of physicians (16). Uncertainty avoidance VSM subscores ranged from 4 to 52 (mean, 23.6; standard deviation, 9.9), also consistent with prior reports (19). Both met criteria for normal distributions based on statistical testing (Kolmogorov–Smirnov and Shapiro–Wilk P values for both were > 0.05). Self-assessed independence for each invasive procedure varied with wide standard deviations: $95 \pm 22\%$ for initiating

vasopressors, $65 \pm 48\%$ for thoracentesis, $30 \pm 46\%$ for administering thrombolytic, $20 \pm 41\%$ for administering transvenous pacing, $10 \pm 30\%$ for pericardiocentesis, and $5 \pm 22\%$ for chest tube insertion.

Invasive Intervention

The initial action was appropriate in 60% of cases and series of actions appropriate in 63%. Invasive intervention was suggested as the first action 39% of the time and suggested somewhere in the list of actions 69% of the time (Table 2). When examining cases in which invasive intervention was called for, participants did so 49% of the time as their first action and 83% of the time as one of their proposed actions. When examining cases in which restraint was required, participants appropriately did not perform invasive intervention upfront 70% of the time and avoided intervention at all 44% of the time.

Situational Certainty

Situational certainty ranged from 0–100%, averaging $71 \pm 19\%$, with a negatively skewed, platykurtic, nonnormal distribution (skew, -0.76 ± 0.12 ; kurtosis, 0.69 ± 0.20 ; Kolmogorov–Smirnov and Shapiro–Wilk, both <0.001).

Predictors of Immediate Intervention

Binary logistic mixed modeling correctly classified 67% of cases with c -statistic of 0.73 ($P < 0.0001$). Situational certainty strongly predicted immediate intervention (OR, 30.5; $P < 0.0001$; Table 3), as did intervention-required case type (OR, 2.34; $P < 0.0001$). Self-assessed independence with the invasive intervention increased the odds of preceding with immediate intervention (OR, 2.02; $P < 0.0001$). Higher VSM scoring for uncertainty avoidance was associated with immediate intervention (OR, 1.73; $P < 0.0001$), as

was higher PRU scoring for anxiety related to uncertainty (OR, 1.22; $P = 0.051$).

Supervision Seeking

Participants sought supervision before deciding on management in 38% of cases, including 43% of cases in which experts would intervene and 33% of cases in which experts would not intervene (Table 2). When a participant did not feel independently capable of performing the intervention in question, they sought supervision before deciding on management in 54% of cases. In contrast, when participants felt independently capable of performing the intervention, they sought supervision before deciding on management in only 18% of the cases.

Predictors of Seeking Supervision

Binary logistic mixed modeling correctly classified 71% of cases with c -statistic of 0.77 ($P < 0.0001$). Situational certainty predicted reduced supervision seeking (OR, 0.20; $P < 0.0001$; Table 4), as did self-assessed independence for the invasive procedure (OR, 0.20; $P < 0.0001$). Intervention-required case type increased supervision seeking (OR, 2.56; $P < 0.0001$). Although the anxiety related to uncertainty measured by PRU was associated with supervision seeking, the OR was more modest (OR, 2.03; $P < 0.0001$). VSM uncertainty avoidance subscores were not associated with seeking supervision.

DISCUSSION

This study sheds a unique light on how uncertainty translates into trainee action and supervision seeking. Low situational certainty was associated with avoiding invasive intervention and increased supervision seeking. Conversely, high situational certainty was associated with

Table 2. Trainee pursuit of invasive intervention and supervision seeking in cases in which experts would perform invasive intervention and withhold invasive intervention

Participant Action*	Cases in which Experts Would Perform Invasive Intervention Upfront (i.e., Intervention-required Case Type) (n = 287)	Cases in which Experts Would Avoid Invasive Intervention (i.e., Restraint-required Case Type) (n = 287)	All Cases (n = 574)
Invasive intervention			
Performs invasive intervention first	49% (140)	30% (85)	39% (225)
Performs invasive intervention at some point	83% (237)	56% (160)	69% (397)
Appropriateness			
Appropriateness of first action	49% (140)	70% (202)	60% (342)
Appropriately intervened or withheld intervention over all actions	83% (237)	44% (127)	63% (364)
Supervision seeking			
Seeks supervision before deciding on management	43% (122)	33% (94)	39% (216)

*All numbers expressed as % (n).

invasive intervention, even when it was not warranted. Although much has been written about uncertainty as a personality trait (14), this study finds much more support for uncertainty as a situational factor, suggesting that uncertainty is intertwined with contextual cues and situation-specific knowledge or expertise related to prior experiences. This echoes similar research in other cognitive domains of clinical reasoning (e.g., problem solving, communication, and professionalism), in which context often trumps character in predicting performance (25–29). It also reinforces the findings of qualitative work that describes multiple forms of uncertainty organized around

the clinical context and the potential actions a clinician could take (1, 6).

This is not to say that measurements of the individual have no relevance. The prioritizing of invasive intervention over other actions did relate to psychological and sociological measures around the perceptions of uncertainty, suggesting some individual trait-based influence in balancing information seeking and action. Surprisingly, anxiety related to uncertainty and cultural avoidance of uncertainty both increased the chance of acting upfront, albeit to a smaller extent than situational factors. This paradoxical link between anxiety related to uncertainty and low tolerance to uncertainty with

Table 3. Predictors of immediate intervention in a binary logistic regression model

Model Term	Model Coefficient (95% Confidence Interval)	T Value	P Value	Odds Ratio (95% Confidence Interval)
Intercept	-2.92 (-3.85 to 1.99)	-6.157	<0.0001	0.05 (0.02 to 0.14)
Situational certainty	3.42 (2.23 to 4.61)	5.637	<0.0001	30.5 (9.27 to 101)
Anxiety related to uncertainty subscale (PRU)	0.20 (0 to 0.39)	1.955	0.051	1.22 (1 to 1.48)
Uncertainty avoidance subscale (VSM)	0.55 (0.33 to 0.76)	5.028	<0.0001	1.73 (1.4 to 2.14)
Self-assessed independence with the invasive intervention	0.70 (0.32 to 1.09)	3.569	<0.0001	2.02 (1.37 to 2.96)
Intervention-required case type	0.85 (0.46 to 1.25)	4.251	<0.0001	2.34 (1.58 to 3.48)

Definition of abbreviations: PRU = Physicians' Reactions to Uncertainty; VSM = Values Survey Module.

invasive intervention may reflect concern for bad outcomes (a related construct in the Gerrity tool) (16) or repercussions of inaction in situations in which there is a sense of clinical urgency. Similarly, supervision-seeking behaviors did relate to general measures of anxiety around uncertainty and were not associated with uncertainty avoidance. Rather, supervision seeking reflected the circumstances of the situation, echoing the shared experience of many supervisors that trainees routinely seek out supervision when they are unsure (8) or have higher levels of anxiety related to uncertainty.

This has far-reaching implications for postgraduate training. It suggests that the dominant approach of problematizing action or inaction as an individual character trait may be less fruitful than specific training in the management of relevant

clinical situations. In invasive specialties, trainees who are able to act without outward uncertainty or anxiety are often valued. This presumes that this ability is an inherent trait, amenable to measurement and potentially used for recruitment. This orientation is not substantiated by the data. Rather, these data raise the possibility that certainty in action is specific to situations and may incorporate a variety of situation-specific factors (1, 22). Moreover, in the context of this study, individual perceptions of uncertainty actually increased rather than decreased the probability of invasive intervention. This is worth exploring in future research, as it suggests the possibility that managing uncertainty may be an outcome of training acquired through increasing levels of situational knowledge and expertise, shifting the focus from recruiting appropriate

Table 4. Predictors of supervision seeking in a binary logistic regression model

Model Term	Model Coefficient (95% Confidence Interval)	T Value	P Value	Odds Ratio (95% Confidence Interval)
Intercept	-0.79 (-1.61 to 0.02)	-1.918	0.056	0.45 (0.2 to 1.02)
Situational certainty	-1.63 (-2.7 to 0.56)	-2.997	0.003	0.20 (0.07 to 0.57)
Anxiety related to uncertainty subscale (PRU)	0.71 (0.39 to 1.03)	4.302	<0.0001	2.03 (1.47 to 2.81)
Uncertainty avoidance subscale (VSM)	-0.2 (-0.41 to 0.01)	-1.849	0.065	0.82 (0.66 to 1.01)
Self-assessed independence with the invasive intervention	-1.61 (-2.04 to 1.19)	-7.468	<0.0001	0.20 (0.13 to 0.31)
Intervention-required case type	0.94 (0.52 to 1.36)	4.404	<0.0001	2.56 (1.68 to 3.89)

For definition of abbreviations, see Table 3.

action-oriented trainees to early educational experiences that foster the development of appropriate situational certainty. Interestingly, among cases in which experts would not perform invasive intervention, participants often recommended intervention at some point in their list of actions. Understanding this preference for intervention even when not warranted and how this is effectively combated is clearly important. Two potential approaches could help combat this bias toward action even when not required: 1) interventions to enhance supervision-seeking behaviors to provide supervisors an opportunity to advocate for restraint and 2) focused educational interventions to make explicit the cues experts use to identify situations in which restraint is advised.

Limitations

Important limitations to this work should be noted. The PRU was originally

designed 30 years ago, and although still relevant, may miss some of the nuance of evolving practice patterns. Although situational certainty may predict invasive intervention in decompensating patients, this cannot be extrapolated to less acute contexts in which time pressures and risks may not be as salient in the psychology of residents. Similarly, we assume that residents would act in practice as they respond to written cases. However, many situational factors may confound this extrapolation, including patient perspectives on procedural risks and benefits, access to more senior trainees who could act as supervisors and sounding boards for decisions, allied health professionals such as nurses who may play the same role, and familiarity with the environment and equipment that may bolster trainee comfort in attempting procedures. Finally, applicants to cardiology programs may differ systematically in their approach to

invasive intervention, limiting the generalization of these findings to other resident subsets.

Conclusions

In conclusion, uncertainty around pursuing invasive intervention is bound up more in the context of the situation rather than the psychological traits or cultural traits of trainees. This leaves open the possibility that content-specific training

could improve decision-making around timely intervention and should reduce the focus that supervisors, educators, and program administrators place on the psychology and cultural aspects of uncertainty management as it pertains to invasive intervention in the decompensating patient.

Author disclosures are available with the text of this article at www.atsjournals.org.

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