Concurrent versus Post-Encounter Hypothesis-Driven Precepting

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RC

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cHDP	concurrent Hypothesis Driven Precepting
HDP	Hypothesis Driven Precepting
HDPE	Hypothesis Driven Physical Exam
pHDP	post-encounter Hypothesis Driven Precepting
RLQ	right lower quadrant pain
TTUHSC	Texas Tech University Health Sciences Center

SUMMARY

A study of the role of concurrent Hypothesis-Driven Precepting (cHDP) versus post-encounter Hypothesis-Driven Precepting (pHDP) on clinical reasoning was carried out in a standardized patient setting. Thirty-nine second year medical students were randomized into cHDP or pHDP groups. The students watched an online tutorial on lower abdominal pain in reproductive age women focusing on four possible diagnoses. They then participated in a small-group live standardized patient (SP) encounter. The cHDP group was exposed to concurrent precepting in the form of diagnostic timeouts during the interview while the pHDP group was only exposed to a hypothesis-driven debrief after the encounter was completed. Reasoning skills were assessed immediately after the SP session (T1). Reason skills were again assessed one week later (T2) in the context of three video SP encounters.

Most measures of clinical reasoning did not differ between groups. Post-encounter HDP sessions had very short SP encounters with interviews lasting a mean of 3.3 minutes, but lasted longer overall with interview and debriefs lasting 18 minutes vs 15 minutes for cHPD. Furthermore, pHDP interviewers asked only rote history questions, without exploring the presence of clinically discriminating findings to rule alternate diagnostic hypotheses in or out. Concurrent HDP also provided better linkage of findings to diagnoses at T1.

Both cHPD and pHDP are effective in addressing clinical reasoning, but cHDP provides more opportunities for scaffolding, addressing faulty data gathering through diagnostic timeouts that allow the instructor to recognize and correct clinical reasoning issues in real time. It promotes more complete data gathering and prevents premature closure, the most common cognitive error, by encouraging metacognition and redirection early on.

I. INTRODUCTION

Teaching clinical reasoning to medical students is a difficult undertaking, yet it is one of the most important tasks assigned to medical school faculty, especially because diagnostic errors are some of the major determinants of patient outcomes. Graber et al. (2005) divided cognitive diagnostic errors into three categories: faulty knowledge, faulty data gathering, and faulty synthesis. Cutrer et al. (2013) cited the same three categories, labeling faulty synthesis as faulty processing and adding a fourth category, faulty metacognition. While there is ample literature addressing knowledge acquisition, Graber et al. (2005) noted that very few diagnostic errors are directly attributable to inadequate knowledge. Therefore, more emphasis needs to be placed on data gathering, processing and metacognition.

Data gathering is often taught through problem- and case-based learning, despite the fact that the literature does not support this approach. Nendaz et al. (2000) found that fourth- and sixth-year medical students (from a six-year curriculum), internal medicine residents, and general internists were able to identify the most relevant information in vignettes revealing all of the essential features of clinical teaching cases, but were unable to gather similar critical information if provided with only a chief complaint.

Faulty synthesis or processing is the most common category of diagnostic error, according to Graber et al. (2005) who also noted that the most frequent cause of error within the synthesis category was premature closure - the clinician's tendency to focus on a single diagnosis and not fully address the other diagnoses in the differential. This error often works in tandem with anchoring, where a clinician "fixates" on specific information early in the data gathering process and assigns that information more importance than subsequent data.

Metacognition, the clinician's ability to step back and review their thinking process (Vygotsky, 1980; Fox and Riconscente, 2008), is also essential to critical thinking and is referred to by Schon (1983) as "reflection *in* action." In the context of the clinical encounter, such redirection or metacognition can directly impact data gathering and reasoning. In contrast, "reflection *on* action" or reflection that occurs after the encounter, offers opportunities to learn from the past but the application of that learning lies in the future when it may or may not be retained or used.

The literature offers several ways to address these issues. To improve data gathering, Cutrer et al. (2013) advocate starting with a chief complaint rather than a full vignette, forcing the learner to formulate questions and gather information. Direct observation of the process whereby learners formulate questions and gather information allows the instructor to facilitate reasoning strategies and address errors in clinical reasoning as they occur. This real-time feedback addresses data gathering as well as data processing and metacognition through scaffolding, an active learning process involving immediate, real-time feedback that prompts students to assess, reorganize, reassess and build their knowledge base, enabling learners to achieve a goal that would have been beyond their scope without assistance (Vygotsky, 1980).

One approach to scaffolding clinical reasoning is the "diagnostic timeout" (Cutrer et al., 2013), during which the instructor interrupts the student interview to identify a working diagnosis and then guides the learner through the data to reconsider other diagnostic possibilities. This provides the learner with guided self-reflection or metacognition, a time to step back and reassess one's diagnostic reasoning, review the gathered data and through scaffolding, rebuild the differential diagnosis, thus avoiding premature closure.

The Hypothesis Driven Physical Exam (HDPE) (Yudkowsky et al., 2006; 2009; Nishigori et al., 2011) applies scaffolding to modify the traditional head-to-toe assessment of physical exam skills. This modification is useful because the head-to-toe assessment discourages critical reasoning by promoting a rote approach regardless of clinical context (Uchida et al., 2014). In HDPE, the learner is provided a differential diagnosis based on the chief complaint and then asked to select diagnostic maneuvers to rule each of the diagnoses in or out, (Yudkowsky et al., 2009). Thus, HDPE prompts the learner to "anticipate, elicit and interpret the … findings associated with the main diagnostic possibilities relevant to given cases" (Yudkowsky et al., 2006, p. 1141).

While HDPE focuses mainly on the physical exam, data gathering aspects of history-taking continue to be taught in a manner very similar to the head-to-toe exam. Students often memorize a rote sequence of questions to explore pain or other presenting complaints, without active hypothesis testing. The goal of the traditional approach is the recognition of a pattern or illness script that may lead to a diagnosis—but may also lead to faulty data gathering, poor synthesis, or inefficient metacognition.

This study introduces and explores a Hypothesis Driven Precepting (HDP) approach, applying the conceptual framework and principles of HDPE to promote effective history data gathering, processing and metacognition. HDP may take place either *during* a patient or standardized patient (SP) encounter, referred to as concurrent Hypothesis Driven Precepting (cHDP), or *after* the encounter, referred to as post-encounter Hypothesis Driven Precepting (pHDP). Concurrent Hypothesis Driven Precepting focuses on improving clinical reasoning through real-time diagnostic timeouts that interrupt the student interviewer to allow reassessment of the differential diagnosis and promote metacognition. Like HDPE, cHDP prompts the learner

to “anticipate, elicit and interpret” findings (Yudkowsky et al. 2006, p. 1141). During cHDP, the instructor stops the interview as soon as the SP states the chief complaint and engages the interviewer in a dialogue, asking questions such as, *What do you think is going on? What is your differential diagnosis? What would help you differentiate between diagnosis A and B? What will your next two questions be? What would you expect the answers to be if the correct diagnosis is A?*

This real-time questioning forces the learner to establish a hypothesis or differential diagnoses early on, compare and contrast disease scripts, select discriminating questions, and anticipate answers. Driven by the instructor, subsequent stops occur when critical information is revealed or very high or low discriminating questions are asked. The learner can also stop the exercise and ask for help. Other students observing can interact with the interviewer and instructor by asking and answering questions as well as providing feedback. In essence, cHDP promotes early hypothesis development in the data-gathering phase followed by scaffolding to help the learner compare, contrast and fine-tune disease scripts within the differential diagnosis. The real-time precepting also guards against premature closure by assuring that the entire list of potential diagnoses is considered.

By contrast, pHDP takes place after the encounter but follows the same HDP format, asking the students to list the possible diagnoses, review the data that were gathered through the interview process and then compare and contrast the diagnoses in relation to the data. This encourages learners to recall what they were anticipating with their line of questioning, what they were trying to elicit, what they could have elicited, and what they interpret from the responses.

Learners must remember the content as well as the process that supported critical thinking over an extended period of time. There is disagreement in the cognitive psychology literature on the effect of timing of feedback. The principles of *classical and operant conditioning* (Renner, 1964) posit that feedback functions to reinforce correct responses: the closer the feedback to the event, the greater the effect. Providing immediate feedback should improve retention, while delaying feedback should reduce the effect. However, the *spacing hypothesis* (Smith and Kimball, 2010), based on memory theory, sees delayed feedback as offering an additional learning opportunity spaced in time. In this regard, cHDP provides immediate feedback, while pHDP provides somewhat delayed, spaced feedback.

The purpose of this study was to compare clinical reasoning outcomes of students experiencing the encounter-embedded scaffolding offered by cHDP versus the post-encounter debriefing of pHDP. We hypothesized that cHDP would be more effective than pHDP at promoting clinical reasoning tasks, and that the benefits of cHDP over pHDP would persist in a delayed retention challenge.

II. METHODS

Ethical approval was obtained from the University of Illinois and Texas Tech University Health Sciences Center (TTUHSC) Institutional Review Boards. Preclinical medical students at TTUHSC were recruited to participate in the study during a spring intersession selective. The latter half of the second preclinical year of medical school (M2) was targeted to assure all students had participated in TTUHSC's School of Medicine's Development of Clinical Skills Course, where basic interviewing techniques are taught in the traditional rote questioning method, without additional focus on clinically discriminating questions or critical decision making. Exclusion criteria included repeating Year 2 or extensive prior health care experience (nurses, EMTs, etc.). Enrollment in the Family Medicine Accelerated Track program was also an exclusion since the studied techniques are employed in that program's curriculum. The students were randomized into one of two groups, concurrent hypothesis driven precepting (cHDP) or post-encounter hypothesis driven precepting (pHDP). The two groups were further randomized into subgroups of 6 or 7 students each to keep group sizes comparable to those used for similar medical school activities. The result was three cHDP subgroups (c1, c2 and c3) and three pHDP subgroups (p1, p2, and p3). A $25 gift card was provided as an incentive.

An online classroom tutorial on lower abdominal pain in reproductive age women (*https://www.youtube.com/watch?v=NP3On8Pk7OM)* was developed that reviewed the most prominent clinical features of appendicitis, ectopic pregnancy, ruptured ovarian cyst, and pelvic inflammatory disease. The tutorial was based on a text (Beckmann et al., 2013) and recent peer-reviewed articles on abdominal pain (Campion et al., 2015; Cartwright and Knudson, 2008; P. S. Kruszka and Kruszka, 2010; McCormack, 1994; Ross, 2014) and established the features that would be taught and assessed. Three SP scenarios (ectopic pregnancy, ruptured ovarian cyst,

and appendicitis) were developed based on the clinical information presented in the tutorial. Note that pelvic inflammatory disease was not developed into a test scenario but was included in the tutorial to prevent the students from establishing the last diagnosis by the process of elimination.

The cases were checked for clinical accuracy by three TTUHSC board-certified obstetrician gynecologists who also established the grading rules based solely on the clinical information presented in the tutorial. The differential diagnosis and the skills and knowledge required with any one of the scenarios were applicable to the other two cases as well; thus, from a learning standpoint, these could be considered "near transfer" cases. The cases were Scenario A: right lower quadrant pain (RLQ) pain - ectopic pregnancy, Scenario B: RLQ pain - ruptured ovarian cyst, and Scenario C: RLQ pain – appendicitis. Scenario A was conducted as a live SP encounter (SP Scenario A) on Day 1 and as a videotaped interview with a different SP (Video Scenario A) on Day 8. Scenarios B and C were implemented as videotaped interviews only, on Day 8.

T1: Day 1

Participating students were presented with the clinical information needed to complete all of the scenarios through the online classroom tutorial on lower abdominal pain in reproductive age women. A brief 12 item online quiz was administered after the tutorial to highlight key clinical features of the four diagnoses presented in the video. The quiz allowed for multiple attempts at answering each question, but did not allow the student to proceed to the next question until the correct answer was selected.

Immediately after the quiz, students participated in a live SP encounter where the tutorial's clinical information could be applied. The students were advised that the exercise was

restricted to history taking. No physical exam, labs or imaging could be requested. A single standardized patient was used to decrease portrayal variability between groups. After learning the case, the SP was trained for an hour by the investigator (RC) who outlined the intent of the study, reviewed the scenario with emphasis on uniform answers, and thus confirmed that the SP could portray the patient case accurately and consistently during all three encounters.

Each of the three cHDP and three pHDP subgroups included six or seven students. To conduct the SP interview, one student in each group was randomly selected to serve as the interviewer, with the remaining five or six students serving as observers. This random interviewer selection was designed to avoid bias that could have been introduced by having students with the most experience or confidence in patient interactions volunteering or being selected by peers to do the primary interaction with the SP. The interviewer interviewed the SP portraying Scenario A: RLQ pain – ectopic in the TTUHSC simulation center.

In the cHDP subgroups, the instructor provided concurrent precepting throughout the encounter using diagnostic timeouts, stopping the interviewer after the SP stated the chief complaint and after critical information was obtained. The interviewer was asked to compare and contrast the potential diagnoses based on the information and to formulate the next question focusing on discriminating data. A whiteboard was used to keep track of the discussion. The student observers were present in the interview room and could take notes as well as actively engage with the interviewer, instructor and SP by giving feedback and asking or answering questions. The group session was limited to 20 minutes.

In the pHDP subgroups, the interviewer completed the interview with no interruptions. The student observers were present in the interview room and could take notes but could *not* engage with the interviewer or SP during the interview. Each pHDP subgroup participated in

post-encounter debriefing that used a focused hypothesis-driven format at the end of the encounter, starting with the chief complaint and systematically developing the differential diagnoses and justifications based on the anticipated findings. Again, a whiteboard was used to keep track of the discussion. All members of the group, including interviewer and observers, could participate in the debrief. The combined encounter and debrief time was limited to 20 minutes. For added standardization, a single investigator (RC) debriefed all groups.

After each group session in both cHDP and pHDP interview formats, the interviewing and observing students had 15 minutes to complete the Differential Diagnosis and Justification Form based on Chamberland et. al (2015), which was scored for diagnostic accuracy (the ability to select the best diagnosis), justification (the ability to link findings to a diagnosis) and discrimination (the ability to compare and contrast key features and select one diagnosis over the other) as measures of clinical reasoning. Table I shows the content and scoring system for the Differential Diagnosis and Justification Form which was solely based on the content of the online tutorial.

Students also completed a survey in which Likert Scales were used to assess the disruptive nature of the cHDP and to gauge how challenging it was to attend to the clinical reasoning aspect of the case for both cHDP and pHDP (Table 1, Q7 and Q8). Open-text questions asked the learners to describe what they liked best about the precepting, what was most effective in helping them develop their clinical reasoning, what they liked least, and how they would change the precepting to help them develop their clinical reasoning more effectively.

TABLE I

DIFFERENTIAL DIAGNOSIS AND JUSTIFICATION FORM FOR ECTOPIC PREGNANCY*

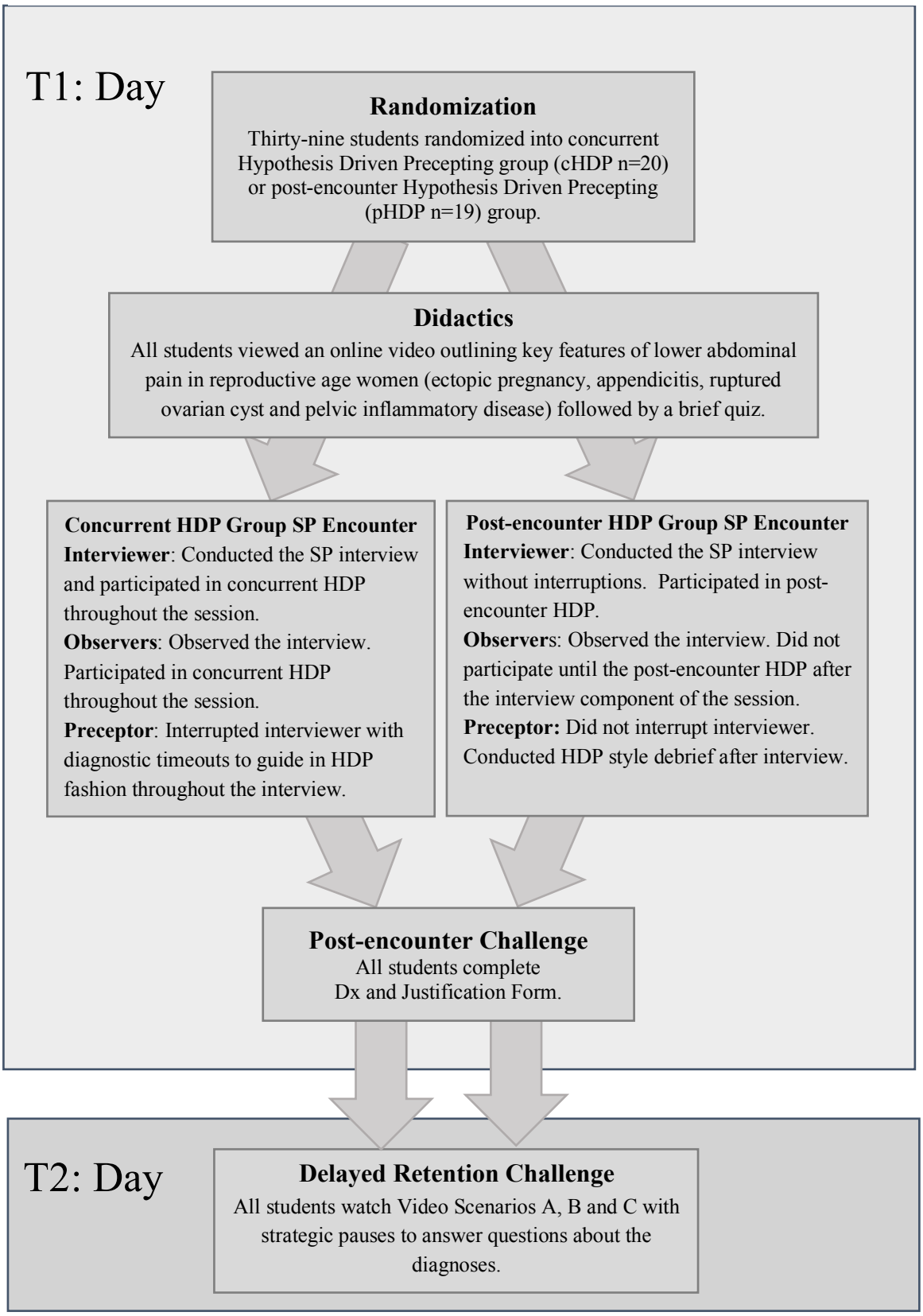
Question to student					Clinical Reasoning Indicator	Max Points	Correct
Q1	What is the most likely diagnosis?				Diagnostic Accuracy	1	1 point
Q2	What are the main findings supporting this diagnosis?				Justification	5	multiple justifications 1 point each
Q3	Given what you already know, what findings would best help you to discriminate between ectopic and appendicitis? Compare and contrast.				Discrimination	5	1 point per similarity 1 point per difference.
Q4	Between ectopic and ruptured ovarian cyst?				Discrimination	3	1 point per similarity 1 point per difference
Q5	Between appendicitis and ruptured ovarian cyst?				Discrimination	5	1 point per similarity 1 point per difference
Q6	Between ectopic and PID?				Discrimination	5	1 point per similarity 1 point per difference
Sample anticipation question (T2 only)	What two questions can you ask to help you exclude PID?				Anticipation	2	1 point per question
Q7	How challenging was it to attend to the clinical reasoning aspect of the interview? (cHDP and pHDP)						
	Not at all challenging.	Somewhat challenging	Challenging	Very challenging	Extremely challenging		
Q8	Were the interruptions disruptive? (cHDP only)						
	Not at all disruptive	Somewhat disruptive	Disruptive	Very disruptive	Extremely disruptive		

* Adapted from Chamberland et al. 2015

T2: 8 Days Later

The students reconvened one week later to assess delayed retention. In a classroom setting, all students watched three video interviews of standardized patients: Video Scenario A: RLQ pain – ectopic pregnancy (different SP than in the live encounter), Scenario B: RLQ pain – ovarian cyst, and Scenario C: RLQ pain - appendicitis. The videos had strategic pauses during which the students were prompted to answer questions related to their differential diagnosis. Questions assessed diagnostic accuracy, discrimination, and justification as well as anticipation, by which learners were expected to demonstrate skill in anticipating findings in their suspected diagnosis. The Methods Flow Chart in Figure 1 illustrates the study activities.

Figure 1. Methods Flow Chart



III. DATA ANALYSIS

Transcripts of the encounters were reviewed for content and to assure that the precepting followed similar hypothesis-driven approaches in both conditions. Total word counts as well as Interviewer and PI word counts for each encounter were obtained to calculate percent of words used interviewing, precepting and in group discussion. De-identified and group-blinded responses to the SP encounter and three video challenges (Differential Diagnosis and Justification forms) were scored by a single rater (RC). Students' combined scores on the forms were calculated for each of the two days of testing by summing up all of the points for each day. In addition, subscores for diagnostic accuracy, justification and discrimination were calculated for T1 and each of the three scenarios for T2 along with anticipation subscores for the T2 scenarios. Ten percent of the responses were coded by a second person (SW) to establish the reliability of the scores. Means and standard deviations were reported for the T1 and T2 combined scores as well as each subscores.

Quantitative data were analyzed using SPSS. One-way ANOVAs were used to evaluate differences between cHDP and pHDP subgroups as well as participants' assessments of the disruptive nature of cHDP and any difficulty they reported in the experience of developing a coherent clinical reasoning throughout the interview. Independent samples t-tests were used to compare the dependent variables (diagnostic accuracy, discrimination, anticipation and justification) across groups, using an alpha of .05 per test; a correction for multiple comparisons is also reported. Qualitative survey data were analyzed by extracting themes and noting frequency of comments.

IV. RESULTS

Forty students were recruited and randomized into concurrent Hypothesis Driven Precepting (cHDP) or post-encounter Hypothesis Driven Precepting (pHDP) groups. Thirty-nine students completed both days of the study (cHDP n=20, pHDP n=19). Each group included three subgroups: c1 (n=6), c2 (n=7), c3 (n=7), p1 (n=7), p2 (n=6), p3 (n=6).

Transcripts of the encounters confirmed that participating students in both concurrent and post-encounter precepting sessions were able systematically to compare and contrast appendicitis, ovarian cyst, ectopic pregnancy and pelvic inflammatory disease to eliminate the less likely diagnoses from among a differential diagnosis. Word counts indicated that the student interviewer uttered on average 19% (SD 5%) of the words spoken in cHDP sessions (mean (SD) across the three cHDP groups), versus 14% (6%) during pHDP. The preceptor spoke on average 67% (3%) of the words in the cHDP sessions, versus 74% (10%) during pHDP. The cHDP observers contributed 9% (3%) of the words versus 8% (5%) for the pHDP groups. SPs uttered 5% (1%) and 4% (2%) of the words for cHDP and pHDP respectively. Thus, the interviewers talked more and the preceptor spoke less during cHDP, while the SP participation was similar and the observers contributed equally to both discussions.

Student interviews of the SP in the pHDP groups were very short, lasting on average only 3.34 minutes (SD = .58) before the debriefing component began. These interviews tended toward the rote questions based on the OLDCARTS mnemonic frequently taught to preclinical students (Onset, Location/radiation, Duration, Character, Aggravating factors, Relieving factors, Timing and Severity) and sexual history. A menstrual history was obtained in two of the subgroups. None of the interviewers in the pHDP groups asked about clinically discriminating features such as fever or migration.

Inter-rater reliability was 98% exact agreement for scoring written responses as calculated on 10% of responses. A one-way ANOVA indicated no significant differences in Day 1 total clinical reasoning scores between cHDP subgroups, $F(2, 17) = 2.89$, $p = .08$, or between pHDP subgroups, $F(2, 16) = .49$, $p = .62$; therefore, data were combined across the three cHDP subgroups and across the three pHDP subgroups for the remainder of the analyses.

Independent samples t-tests indicated that the cHDP and pHDP groups differed significantly on the following variables (Equal variances were assumed if the significance on Levene's Test for Equality of Variances was above .05):

1. Day 1 Justification scores were higher for cHDP: cHDP mean score = 4.55 (SD 0.74) versus pHDP mean 3.58 (1.14), $p = .005$
2. Day 8 Anticipation scores were lower for cHDP: cHDP mean score 6.70 (SD 2.92) versus pHDP mean 8.79 (SD 2.46), $p = .024$
3. Duration of the cHDP sessions (M = 14.8 minutes, SD = 2.67) was significantly shorter than the duration of the pHDP sessions (M = 17.9 minutes, SD = 0.69), $p < .001$.

While we deemed a critical alpha of .05 for each test to be suitable for the above analyses, we additionally applied the Holm-Bonferroni Sequential Correction for readers who may consider a stricter alpha more suitable. Duration of the cHDP encounters versus the pHDP encounters remained significantly lower even after making this correction, $p < .001$; see Table II.

TABLE I

INDEPENDENT T-TEST RESULTS FOR CHDP VERSUS PHDP DAY 1 AND DAY 8

	cHDP (N=20) Mean (SD)	pHDP (N=19) Mean (SD)	Cohen's *d*	*p*	P corrected For Multiple Comparisons[1]
Duration (min)	14.8 (2.67)	17.9 (0.69)	1.58	.000	.000
Day 1 Max Points 24	18.6 (3.1)	16.95 (3.62)	0.48	.144	1.000
Day 1 DA Max Points 1	1 (0.00)	0.84 (0.36)	0.60	.083	.830
Day 1 DIS Max Points 18	13.05 (2.94)	12.53 (3.17)	0.17	.605	1.000
Day 1 JUS Max Points 5	4.55 (0.74)	3.58 (1.14)	0.99	.005	.060
Day 8 Max Points 76	44.05 (11.41)	48.47 (9.20)	0.42	.204	1.000
Scenario A Ectopic Max Points 26	13.60 (4.41)	15.63 (3.54)	0.45	.132	1.000
Scenario B Ovarian Cyst Max Points 24	13.90 (3.97)	14.42 (4.21)	0.12	.701	1.000
Scenario C Appendicitis Max Points 26	16.55 (4.10)	18.42 (3.15)	0.50	.130	1.000
Day 8 ANT Max Points 14	6.70 (2.92)	8.79 (2.46)	0.75	.024	.264
Day 8 DA Max Points 5	4.40 (0.73)	4.53 (0.75)	0.17	.608	1.000
Day 8 DIS Max Points 41	23.25 (7.93)	25.42 (5.82)		.350	1.000
Day 8 JUS Max Points 16	10.40 (2.63)	11.05 (2.39)		.436	1.000

ANT - Anticipation
DA – Diagnostic Accuracy
DIS – Discrimination
JUS – Justification

[1]Correction for Multiple Comparison with Holm-Bonferroni corrections (Holm, 1979)

On the survey at the end of the T1 activities, an ANOVA showed that all cHDP subgroups agreed that concurrent precepting with start/stops was only minimally disruptive: *Mean* = 1.9 out of 5 (*SD* .91). An ANOVA also showed no significant difference between groups in the degree of challenge participants experienced in attending to the reasoning aspect of the interview: cHDP mean 1.55 (SD .51); pHDP mean 1.58 (SD .61).

Responses to the open text survey questions (see Table III) indicated that both the cHDP and pHDP groups appreciated the hypothesis-driven format. The cHDP group liked best the step by step process and immediate feedback, and felt the most effective components in helping develop their clinical reasoning were the video before the SP encounter and the guided questioning. They commented that what they liked least were the interruptions during the encounter, and they would improve the precepting by decreasing the number of interruptions.

The pHDP group liked best comparing and contrasting the differential diagnoses and felt that articulating the differences among possible diagnoses was the most effective way to develop their clinical reasoning. They liked least that only one student got to do the interview, and they would change the format to allow more students the opportunity to interview.

TABLE II

DAY 1 OPEN TEXT SURVEY RESPONSES

	cHDP (N=20)	pHDP (N=19)
What did you like best about the precepting?	• Step by step process and guided thoughts (13 students) • Real world applicable (4) • MD involvement (4) • Group discussion (3) • Instant feedback (2) • Video introduction to diagnoses (1)	• Working with ddx, compare and contrast and ruling out (13 students) • MD involvement (2) • Video introduction to diagnoses; being interviewer; interactive; engaging; group setting (1 each)
What was most effective in helping you develop your clinical reasoning?	• Guided questioning (8) • Video before SP encounter (4) • Whiteboard use for ddx (3) • MD involvement (3) • Group discussion (2) • SP encounter (1)	• Compare and contrast (8) • Ddx (8) • Whiteboard use for ddx (6) • Debrief (4) • Video Intro to diagnoses (2) • Interviewing; group setting (1 each)
What did you like least?	• Interruptions (7) • Repetitive (2) • Diagnoses too clear cut (2) • Not being interviewer; disorganized; not enough time after video to learn; group setting (1 each)	• Only one interviewer (7) • Not being interviewer (2) • Video intro was too fast or unable to rewind (2) • Unable to help interviewer (2) • Intro video; not knowing final dx; quiz after intro video; being observed (1 each)
How would you change the precepting to better help you develop your clinical reasoning?	• Decrease interruptions (4) • Repeat with different student; students make whiteboard chart; ask "why" questions; discuss video as group; student led discussion; bigger ddx; interactive learning module (1 each)	• More students get opportunity to interview (2) • Limit number of questions; provide ddx chart with intro video; more time to review video; add confounders; watch video on own time; fewer observers; handout (1 each)

Number of responders in parentheses; each student able to give multiple answers

V. DISCUSSION

This study compared the impact of concurrent versus post-encounter hypothesis-driven precepting (cHDP versus pHDP) on clinical reasoning in the context of a standardized patient encounter in which students applied didactic knowledge to a patient presenting with abdominal pain. Immediate impact (Day 1 or T1) on the same case as well as delayed impact (Day 8 or T2) on two near-transfer cases were explored. While the two approaches did not differ significantly based on the measures of clinical reasoning studied, we found that cHDP was more time efficient than pHDP.

Both cHDP and pHDP sessions were limited to 20 minutes in order to provide equivalent time-on-task. However, there was no lower time limit imposed, and sessions ended when the debriefing came to a natural close. Despite very brief pHDP SP interviews averaging less than 3.5 minutes, the pHDP sessions lasted significantly longer, about 18 minutes compared to 15 minutes for cHDP. A shorter session is a meaningful advantage in the real world where teaching and feedback time are limited, allowing time for more scenarios, variations on the current scenario, or other tasks.

The transcripts of the interviews and the qualitative data provided several insights. The didactic knowledge that students gained from the video, which described four diagnoses related to abdominal pain and emphasized discriminating findings, was not sufficient to evoke effective clinical reasoning during the patient encounter. The transcripts of the pHDP interviews show that the students proceeded with rote questions about pain and women's health, settled quickly on a diagnosis based on only a small number of matching features, and neglected to elicit the presence of clinically discriminating findings such as migration or the presence of fever. Without

scaffolding and real-time feedback, novice interviewers may be especially vulnerable to premature closure, concentrating on one diagnosis without ruling out the other. Students engaged in "reflection *on* action," may have realized that they failed to gather needed information only during the post-encounter discussion, when the patient was no longer available.

On the other hand, cHDP allows for more opportunities for scaffolding, addressing faulty data gathering through the diagnostic timeout (Cutrer et al., 2013) which allows the instructor to recognize and correct clinical reasoning issues in real time. It promotes more complete data gathering and prevents premature closure, the most common cognitive error, by encouraging metacognition and redirection early on (Graber et al., 2005). Through scaffolding facilitated by the preceptor, students are encouraged to think critically during the encounter, to alter the line of questioning in order to elicit more information, to fill in gaps directly from the patient, and to learn within the context of the scenario. Real-time feedback during the cHDP encounter is needed to encourage "reflection *in* action," prompting learners to consider alternate diagnoses, to collect enough information to compare and contrast diagnoses, and to rule them in or out while still in the presence of the patient.

Additionally, Day 1 Justification scores were significantly higher for cHDP, and Day 8 Anticipation scores were significantly higher for pHDP. In the context of this initial study, these findings suggest directions for future research on the effect of the two approaches on students' reasoning processes. Day 1 Justification scores reflect the students' ability to link the actual history findings of the patient to a diagnosis. Higher scores in the cHDP group may be due to students eliciting more of the salient history findings as a result of the scaffolding provided by the concurrent precepting, in contrast to the brief, rote histories obtained by the pHDP groups. On the other hand, higher Day 8 Anticipation scores for the pHDP groups might be the result of

rote recall of the (theoretical) findings associated with each of the diagnoses, as these were systematically reviewed during the post-encounter debrief. While these findings were not strong enough to meet a strict familywise critical alpha criterion, they seem worth consideration in subsequent studies.

The qualitative data generated by participants' open-text comments supported the use of the hypothesis-driven method, both concurrently and after the encounter. Although the cHDP group noted on the short answer questions that they disliked the interruptions, their responses on the Likert-scale question indicated that they found those interruptions to be minimally disruptive and that the step-by-step process helped guide their thoughts. Participants also cited the guided questioning as the most effective component to help develop their clinical reasoning.

One of the potential drawbacks of cHDP is that the learner may become overly reliant on real-time feedback and coaching. The Guidance Hypothesis, a motor theory centering on the effect of varying amounts of feedback on the learning of a novel skill (Pringle, 2004), recognizes the need for frequent feedback for novices, but warns that feedback must be withdrawn as learning progresses or the learner may become overly dependent on the feedback with resultant negative effects on learning. The preceptor's role within cHDP easily allows them to taper and individualize feedback as the learner progresses.

Limitations of the study include the small number of participants, which limited statistical power for several of the clinical variables. Other measures of clinical reasoning, including direct observation of SP encounters after cHDP and pHDP experiences, could provide additional insights. Future research could focus on whether learners can apply the hypothesis-driven focus of both cHDP and pHDP in the context of subsequent SP interviews, incorporating HD reasoning strategies into their own data gathering by considering more diagnoses and asking

more clinically discriminating questions. A key question is whether the HDP approach will help avoid premature closure in future encounters. Another is whether the optimal timing of the debriefing may differ for novices versus intermediate learners.

A strength of the study was that the setting emulated real-life learning scenarios. Both cHDP or pHDP can be readily applied in medical school settings, whether in simulated or actual encounters. It also limited cognitive overload by limiting the differential diagnoses.

This study compared the use of concurrent and post-encounter hypothesis-driven precepting to foster clinical reasoning. Both approaches were effective; HDP is easy to implement, is well accepted by learners, and lends itself to tapering as the learner gains experience. Concurrent HDP uniquely scaffolds reflection-in-action, encouraging novices to compare and contrast alternate diagnoses and avoid premature closure. Both are useful additions to the toolbox of faculty who wish to promote the clinical reasoning skills of their learners.

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APPENDICES

Appendix A

TEXAS TECH UNIVERSITY
HEALTH SCIENCES CENTER

INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS
FWA # 00006767 LUBBOCK/ODESSA IRB #00000096

NOTIFICATION OF INITIAL APPROVAL

December 13, 2016

STUDY TITLE: Concurrent versus Post-Encounter Hypothesis-Driven Precepting (MHPE 1)
IRB #: L17-041
PRINCIPAL INVESTIGATOR: Robert Casanova, MD
RISK ASSIGNMENT: Expedited/Minimal
APPROVAL DATE: 12/13/2016
NUMBER OF SUBJECTS AT THIS SITE: 100
SUBMISSION REFERENCE #: 069319
TYPE OF REVIEW: EXPEDITED
REVIEW PERIOD: 12 Months
EXPIRATION DATE: 12/12/2017
(based upon date recommended for approval)

SPECIFIC INFORMATION PERTAINING TO THIS APPROVAL

Documents reviewed and approved include:
IRB Application version 1.1
Thesis Proposal cHDP versus pHDP v1.0 11.20.16
Consent/HIPAA form version 1.1 dated 12/20/2016
Recruitment Script
Appendix A Eligibility Checklist
Appendix B Recruitment Email
Appendix C Methods Flow Chart
Appendix D Online Tutorial and Quiz
Appendix E Scenario A- RLQ Pain Ectopic
Appendix F Prompts for cHDP
Appendix G pHDP template
Appendix H Differential Diagnosis and Justification Forms
Appendix I Video Scenario A- RLQ Pain - Ectopic Script and Coding Form
Appendix J Video Scenario B- RLQ Pain - Ovarian Cyst Script and Coding Form
Appendix K Video Scenario C- RLQ - Appendicitis Script and Coding Form
Exemption Letter

Recommendation: This research has been reviewed by the TTUHSC Lubbock/Odessa IRB using the expedited review procedure. The board has determined that the research satisfies the criteria for expedited review in accordance with 45 CFR 46.110(b)(1) because it presents no more than minimal risk to subjects and meets expedited review criteria of category 5--*research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for non-research purposes (such as medical treatment or diagnosis)*, category 6--*collection of data from voice, video, digital, or image recordings made for research purposes*, and category 7--*research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies*. There is a vulnerable population targeted for enrollment-students. Students are informed that participation is voluntary and will have no affect on their grades.

The board finds that the PI has adequately addressed all stipulations; therefore, this research satisfies the requirements for approval in accordance with 45 CFR 46.111. Continuing review is required every 12 months.

Approval Period: This approval is for a period of 12 Months. You should receive electronic notification 30 days prior to the expiration of this project's approval. *However, it is your responsibility* to insure that a Continuing Review Submission Form has been submitted by the required time.

Study Personnel Currently Approved to Conduct the Research: Catherine Lovett, RN, MSN, CCRC, CCRP, Eneko Larumbe Zabala, PhD, Josephine Rene Resendez, MA

Appendix A (continued)

Consent and/or HIPAA: The currently approved and stamped consent form(s) and/or HIPAA form must be used when enrolling subjects. You are responsible for maintaining signed consent forms for a period of at least three years after study completion.

Reporting: The principal investigator must report to the IRB any serious problem, adverse effect, or outcome that occurs with frequency or degree of severity greater than that anticipated. In addition, the principal investigator must report any event or series of events that prompt the temporary or permanent suspension of a research project involving human subjects.

Modifications: Changes or modifications in a research project **must have approval** by the IRB prior to initiation. When modifications are deemed necessary to prevent immediate harm to a subject, changes or modifications must be reported to the IRB within 24 hours.

Study Completion: If this project is completed within the approval period, you are required to submit a Study Update indicating "Final Closure". The study project is considered completed when:

1. Investigators will not contact subjects for further information related to this project
2. Access to subject health care records are no longer required for information related to this project
3. All IRB requests for information have been completed and no longer require an investigator response
4. A summary report has been completed. This must be attached as a Supporting Document in the Study Update submission.

CLINICAL TRIAL REGISTRATION

ClinicalTrials.gov is a directory of federally and privately supported research trials designed to test the effect of experimental drugs, devices, and procedures for many diseases and conditions.

If this project is a clinical trial, the sponsor is required to register the trial at ClinicalTrials.gov prior to the enrollment of the first participant. Also, please note that if Medicare might be billed for any items or services utilized in this study, registration at Clinicaltrials.gov is mandatory. The 8-digit number assigned by ClinicalTrials.gov is required on Medicare claims submitted after January 1, 2014, for items or services provided in clinical trials. If the trial has not been registered by the study sponsor, it may be the Principal Investigator's responsibility to register the trial. For more information on registering a clinical trial, please consult the ClinicalTrials.gov website, http://prsinfo.clinicaltrials.gov. Chad Copeland (chad.copeland@ttuhsc.edu) is the TTUHSC administrator for registration of clinical trials.

GENERAL INFORMATION

The Texas Tech University Health Sciences Center Institutional Review Boards are duly constituted (fulfilling FDA requirements for diversity), allows only those IRB members who are independent of the investigator and sponsor of the study to vote/provide opinion on the study, has written procedures for initial and continuing review, prepares written minutes of convened meetings, and retains records pertaining to the review and approval process; all in compliance with requirements defined in 21 CFR (Code of Federal Regulations) Parts 50 and 56, and ICH (International Conference on Harmonization) guidance relating to GCP's (Good Clinical Practice).

The Texas Tech University Health Sciences (TTUHSC) Center Policies and Procedures are available for reference on the TTUHSC Human Research Protection Program Website (http://www.ttuhsc.edu/research/hrpo/irb/).

TTUHSC Lubbock/Odessa Institutional Review Board
3601 4th Street STOP 8146
Lubbock, TX 79430
806-743-4753

Appendix B

UNIVERSITY OF ILLINOIS
AT CHICAGO

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

Exemption Granted

December 5, 2016

Robert Casanova, MD
Medical Education
Texas Tech University Health Center
4436 121st Lane
Lubbock, TX 79424
Phone: (512) 423-8991 / Fax: (806) 743-7799

RE: Research Protocol # 2016-1193
"Concurrent versus Post-Encounter Hypothesis-Driven Precepting"

Sponsors: None

Texas Tech will serve as the lead site for this research study. You are the Assistant Dean for Clinical Sciences Curriculum at Texas Tech. All subjects will be recruited and participate there, and the recruitment and consent documents refer to Texas Tech. Therefore, **please be reminded of the need to obtain prospective IRB approval or an exemption determination at Texas Tech University Health Science Center.**

Dear Dr. Casanova:

Your Claim of Exemption was reviewed on December 5, 2016 and it was determined that your research protocol meets the criteria for exemption as defined in the U. S. Department of Health and Human Services Regulations for the Protection of Human Subjects [(45 CFR 46.101(b)]. You may now begin your research.

UIC Exemption Period:	**December 5, 2016 – December 5, 2019**
Lead Performance Site:	Texas Tech University Health Science Center (see text box above)
Other Performance Site(s):	UIC (see text box above)
Subject Population:	Adult (18+ years) subjects only
Number of Subjects:	Texas Tech: 100; UIC: 0; Total: 100

The specific exemption categories under 45 CFR 46.101(b) are:
(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods; and

Appendix B (continued)

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

You are reminded that investigators whose research involving human subjects is determined to be exempt from the federal regulations for the protection of human subjects still have responsibilities for the ethical conduct of the research under state law and UIC policy. Please be aware of the following UIC policies and responsibilities for investigators:

1. Amendments You are responsible for reporting any amendments to your research protocol that may affect the determination of the exemption and may result in your research no longer being eligible for the exemption that has been granted.

2. Record Keeping You are responsible for maintaining a copy all research related records in a secure location in the event future verification is necessary, at a minimum these documents include: the research protocol, the claim of exemption application, all questionnaires, survey instruments, interview questions and/or data collection instruments associated with this research protocol, recruiting or advertising materials, any consent forms or information sheets given to subjects, or any other pertinent documents.

3. Final Report When you have completed work on your research protocol, you should submit a final report to the Office for Protection of Research Subjects (OPRS).

4. Information for Human Subjects UIC Policy requires investigators to provide information about the research to subjects and to obtain their permission prior to their participating in the research. The information about the research should be presented to subjects as detailed in the research protocol and application utilizing the approved recruitment and consent process and document(s).

Please be sure to use your research protocol number (listed above) on any documents or correspondence with the IRB concerning your research protocol.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact me at (312) 355-2908 or the OPRS office at (312) 996-1711.

Sincerely,
Charles W. Hoehne, B.S., C.I.P.
Assistant Director, IRB # 7
Office for the Protection of Research Subjects

cc: Ilene B. Harris, Medical Education, M/C 591
Rachel P. Yudkowsky, Medical Education, M/C 591

VITA

NAME:	Robert Casanova
EDUCATION:	M.H.P.E., University of Illinois at Chicago, Chicago, Illinois, 2018
	Leadership Education and Development (LEAD) Certificate Program, Association of American Medical Colleges Southern Group on Educational Affairs (SGEA), 2012
	Educational Scholarship and Leadership, Solvay Educational Scholars Program, Association of Professors of Gynecology and Obstetrics (APGO), 2010.
	Residency, Obstetrics and Gynecology, John Peter Smith Hospital, Ft Worth, Texas, 1987
	M.D., University of Texas Health Sciences Center Southwestern Medical School, Dallas, Texas, 1983
	B.S., Tulane University, New Orleans, Louisiana, Major: Psychology, 1979
TEACHING:	Sex- and Gender-Specific Health, Texas Tech University Health Sciences Center (TTUHSC). Co-Director: 2015 - 2017
	Obstetrics and Gynecology Residency Program, TTUHSC Director: November 2012 - February 2016 Associate Director: June 2011 - October 2012
	OB/GYN Junior Clerkship, TTUHSC Director: January 1, 2009 - June 30, 2013 Associate Director: July 1, 2008 - December 31, 2008
	Basic Medical Spanish, TTUHSC Director: 2009 – 2017
HONORS:	Outstanding Clerkship Educator, TTUHSC (2016, 2015, 2014, 2013, 2012, 2011, 2010, 2009, 2008)
	Faculty Clinical Teaching Award, TTUHSC School of Medicine Class of 2012 (2012)
	Best Attending Physician, TTUHSC Department of Family and Community Medicine (2011)

Alpha Omega Alpha Medical Honor Society Faculty Award, TTUHSC (2010)

Best Educator, TTUHSC MS II Class (2008)

Favorite Attending - Family Practice Program, TTUHSC (2008)

President's Excellence in Teaching Award, Association of Professors of Gynecology and Obstetrics (APGO) (2008)

PROFESSIONAL MEMBERSHIP:

Lubbock-Cosby-Garza Medical Society
Socio-Economic & Legislative Affairs Committee

Alpha Omega Alpha Medical Honor Society

Southern Group on Educational Affairs, Association of American Medical Colleges

Sigma Delta Pi National Spanish Honor Society

Association of Professors of Gynecology and Obstetrics

Texas Medical Association

American College of Obstetricians and Gynecologists

PUBLICATIONS:

Aburas, Rehab, Debajyoti Pati, Robert Casanova, and Nicole Gilinsky Adams. 2017. "The Influence of Nature Stimulus in Enhancing the Birth Experience.." *Herd* 10 (2): 81–100. doi:10.1177/1937586716665581.

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