INTRODUCTION: Clinical reasoning encompasses the process of data collection, synthesis, and interpretation to generate a working diagnosis and make management decisions. Situated cognition theory suggests that knowledge is relative to contextual factors, and clinical reasoning in urgent situations is framed by pressure of consequential, time-sensitive decision-making for diagnosis and management. These unique aspects of urgent clinical care may limit the effectiveness of traditional tools to assess, teach, and remediate clinical reasoning.

METHODS: Using two validated frameworks, a multidisciplinary group of clinicians trained to remediate clinical reasoning and with experience in urgent clinical care encounters designed the novel Rapid Evaluation Assessment of Clinical Reasoning Tool (REACT). REACT is a behaviorally anchored assessment tool scoring five domains used to provide formative feedback to learners evaluating patients during urgent clinical situations. A pilot study was performed to assess fourth-year medical students during simulated urgent clinical scenarios. Learners were scored using REACT by a separate, multidisciplinary group of clinician educators with no additional training in the clinical reasoning process. REACT scores were analyzed for internal consistency across raters and observations.

RESULTS: Overall internal consistency for the 41 patient simulations as measured by Cronbach’s alpha was 0.86. A weighted kappa statistic was used to assess the overall score inter-rater reliability. Moderate reliability was observed at 0.56.

DISCUSSION: To our knowledge, REACT is the first tool designed specifically for formative assessment of a learner’s clinical reasoning performance during simulated urgent clinical situations. With evidence of reliability and content validity, this tool guides feedback to learners during high-risk urgent clinical scenarios, with the goal of reducing diagnostic and management errors to limit patient harm.

DISCUSSION

Clinical reasoning encompasses the process of data collection, synthesis, and interpretation to generate a working diagnosis, facilitating management decisions. The bulk of research on teaching and assessment focuses on diagnosis, namely the process by which a differential diagnosis is generated and narrowed through data gathering. Recently, Cook et al. described management reasoning as a necessary companion to diagnostic reasoning, accounting for patient preferences, societal values, logistical constraints, and resource availability when making testing and treatment decisions for patients. Urgent clinical situations, those in which the patient’s clinical condition is rapidly declining, require accelerated decision-making with respect to both diagnosis and management.

Errors in clinical reasoning among practicing clinicians are common, estimated to occur in up to 10–15% of hospitalized patient encounters. Learners who struggle with urgent clinical situations may be labeled as not recognizing “sick vs not sick” or as lacking in communication skills or clinical knowledge. Clinical reasoning deficits have been commonly identified among struggling medical trainees described in single-center remediation programs. The University of Colorado reports that clinical reasoning was the primary deficit in 25–30% of residents and 40–45% of medical students referred to their remediation program over a 6-year period. Over a 4-year period, the University of Virginia identified that 34% of learners referred to a Graduate Medical Education (GME) remediation program struggled with clinical reasoning. A true estimate of prevalence data is difficult to establish as validated clinical reasoning assessment tools have limitations.

Dual-process theory is a commonly understood cognitive model for clinical reasoning wherein decision-making occurs through a combination of system 1 (heuristic processes) and system 2 (analytical processes). Urgent clinical situations are contextualized well with dual-process theory, requiring heuristics and efficient analytic reasoning for time-sensitive diagnosis as well as rapid assessment, stabilization, and management prior to the determination of a diagnosis. To improve clinical reasoning in urgent situations, algorithms for specific
clinical scenarios have been developed to facilitate management reasoning and improve patient outcomes. For example, the Advanced Cardiovascular Life Support algorithms guide management in “code” situations and offer a method for analytical diagnosis while the patient is being resuscitated (e.g., the H’s and T’s). However, the majority of urgent clinical situations do not reach this final common pathway, and as such, require nuanced clinical reasoning without aid from established algorithms for management and diagnosis.

Situated cognition theory (SCT) provides an attractive optic for the assessment of clinical reasoning performance relative to the myriad interacting factors impacting formative evaluation in urgent clinical situations. Rencic et al. proposed a conceptual framework that considers six clinical reasoning performance assessment elements: the clinician or assesseee, patient, rater, assessment method, task, and environment. Through this conceptual lens, direct observation of clinical reasoning performance offers the most authentic assessment, but requires rigor to identify and manage the numerous interacting factors that influence clinical reasoning performance. Assessment of clinical reasoning in urgent clinical situations, characterized by high acuity or decompensation of a patient’s clinical status, is particularly challenging due to the unplanned nature and multitude of uncontrollable factors that may have distracting or detrimental effects, including the subjugation of educational goals for the urgent provision of care. A simulated patient encounter that offers an urgent patient care situation in a high-fidelity simulation environment therefore offers an ideal surrogate model, allowing for control of many factors across each of the six assessment elements.

Herein, we describe a novel tool for formative assessment and feedback of learner performance during urgent clinical situations that require rapid, time-sensitive diagnostic and management reasoning. This behaviorally anchored tool, known as REACT (Rapid Evaluation Assessment of Clinical Reasoning Tool), was designed by content experts based on domain-specific frameworks to guide feedback to learners during urgent clinical scenarios. REACT was named to represent the rapid patient care situation in a high-fidelity simulation environment and as such, requires nuanced clinical reasoning without aid from established algorithms for management and diagnosis.

METHODS

In 2016, the Committee on Seeking Competence through Help (COACH) was formed. COACH is a unique peer support program at the University of Virginia (UVA) aimed to help medical learners who are referred for, or who request, help with clinical performance. Since its creation, COACH has worked with more than 100 trainees in 14 different departments with generally positive outcomes. Subsequently, UVA School of Medicine implemented a clinical remediation program employing the same framework and much of the same personnel. In 2018, a subcommittee was formed to focus on strategies to identify and coach learners who struggle with clinical reasoning. This group, composed of primary care and specialist clinician educators from internal and hospital medicine, emergency medicine, pediatrics, anesthesiology, family medicine, critical care, and obstetrics and gynecology, met monthly to review struggling learners, discuss best practices in clinical reasoning assessment and remediation, and review the clinical reasoning literature. The subcommittee serves as a pool of clinical reasoning coaches, available as needed, to provide one-on-one coaching to struggling trainees and students. To address an identified need, the group began a joint effort in late 2020 to design an evidence-based tool to assess and provide formative feedback to learners during urgent patient care situations.

The REACT tool (Fig. 1) was designed by a multidisciplinary group of clinician educators from the COACH subcommittee with expertise in teaching and assessing clinical reasoning across both undergraduate medical education (UME) and GME. REACT was named to represent the rapid patient evaluation required during urgent clinical scenarios. The group met on four occasions to design the tool, first identifying evidence-based domains of diagnosis and management reasoning specific to urgent patient care situations and then associating a range of behavioral anchors with each domain. The group began with two validated frameworks: (1) the Society to Improve Diagnosis in Medicine’s (SIDM) Assessment of Reasoning Tool (ART) to assess clinical reasoning during oral presentations and (2) the Association of American Medical College’s (AAMC) Entrustable Professional Activity 10 (EPA 10) designed to formatively assess a learner’s recognition of patients requiring urgent care. A priority of the group was to design a tool applicable to learners in a variety of clinical settings consistent with patient care provided by multiple specialties.

Thammasitboon et al. and SIDM developed and validated the Assessment of Reasoning Tool (ART) to facilitate clinical teaching for oral presentations and clinical reasoning, specifically assessing the learner’s proficiency in the domains of data gathering, interpretation, synthesis, and metacognition. This behaviorally anchored tool provides a general framework for assessing and correcting errors in clinical reasoning. Observing a learner in the context of a clinical scenario allows for the assessment of nonverbal and tonal cues, which vary depending on situational stressors. In contrast, the AAMC designed a toolkit for assessing a range of clinical competencies among learners in real-world settings. These core competencies, termed EPAs, include validated proficiencies expected of medical students prior to starting residency. EPA 10 focuses on “recognizing a patient requiring urgent or emergent care and initiating evaluation and management.” This toolkit introduces a standard set of behaviors expected in the management of urgent clinical scenarios.

A pilot study was performed at UVA during the 2021 Intern Readiness Course (IRC) for 87 fourth-year medical students who are preparing to transition into internal medicine,
psychiatry, family medicine, emergency medicine, or anesthesi- 
a residencies. A core goal of the IRC is to provide fourth-
year medical students with the skills to appropriately respond 
and manage common urgent clinical situations such as 
hypotension, chest pain, hypoxemia, or altered mental status. 
Much of this education is accomplished through simulated 
scenarios with manikins. Each student plays the role of an 
intern in at least two unique case scenarios, and the scenario is 
curated by a nurse with relevant clinical experience. At the 
conclusion of the simulation, students are immediately led 
through debriefing exercises with a clinician who directly 
observed the simulation. The simulations for the 2021 IRC 
were recorded. Table 1 provides a description of each case. An 
independent, multidisciplinary group of clinicians with no 
additional training in the clinical reasoning process observed 
these recordings and scored each medical student’s performance 
using REACT. A scoring system was added to the 
behavioral anchors in order to analyze the tool’s performance 
for internal consistency across raters and observations. RE- 
ACT scores were generated using a 3-point scale for each 
behavioral domain, with a maximum total score of 15 and a 
minimum score of 5.

Determination of optimal sample size for the study utilized 
estimates based on minimizing measurement error, both in 
the number of observations and the number of raters used. 
Cronbach’s alpha was used to assess the internal consistency 
across the group of raters. Inter-rater reliability for the overall 
rating score among the group of raters was assessed using the 
weighted kappa statistic. All analyses were performed using 
SPSS v28.

| Learner Function | Specified Task | Assessment of Behaviors |
|------------------|---------------|------------------------|
| Collecting       | Data gathering | History and exam reflect potential diagnoses |
|                  | - recognition of urgent or emergent clinical scenarios | o History and exam reflect potential diagnoses |
|                  |              | o Logical history and exam for potential diagnoses |
|                  |              | o Questions assessed likelihood of specific diagnoses |
|                  |              | o Full recognition of emergency contextual clues |
| Interpreting     | Diagnostic reasoning | o Prioritization on pertinent positive and negative findings |
| Managing         | Management reasoning | History and exam reflect potential diagnoses |
| Communicating    | Patient-centered care | o History and exam reflect potential diagnoses |
| Reflecting       | Metacognition | o History and exam reflect potential diagnoses |

The UVA Institutional Review Board reviewed this project and determined that it met the criteria for exempt review (ref # 4234).

## RESULTS

REACT is comprised of four learner functions essential to the 
clinical reasoning process during urgent patient care: data 
collecting, interpreting, managing, and communicating. A 
fifth learner function, reflecting, highlights the centrality of 
metacognition in effective clinical reasoning. For each function, 
specified tasks are described. A range of exemplar behavioral anchors are described for each function to allow for 
formative feedback.

Seven raters comprising clinicians from internal and hospital 
tedicine, obstetrics and gynecology, pediatric critical care, 
emergency medicine, and anesthesiology scored 41 recorded 
scenarios representing 41 individual students. Each rater 
scored the same 41 case scenarios in full. Internal consistency 
as assessed by Cronbach’s alpha was measured for the 
summed overall rating (score) for the 41 video clips and was .86, a value considered sufficient for high-stakes assessment. 
Due to the ordinal nature of the ratings, a weighted kappa statistic was used to measure inter-rater reliability which for 
overall ratings was .56, generally interpreted as a moderate 
degree of agreement. Supplemental Table 1 provides 
domain-specific weighted kappa data and Supplemental Ta-
ble 2 provides descriptive statistics of domain-specific scores for individual raters.
DISCUSSION
To our knowledge, REACT is the first tool specifically designed for formative assessment of a learner’s clinical reasoning performance during simulated urgent clinical situations. Built on the strength of validated instruments specific to clinical reasoning and clinical urgency, REACT was thoughtfully designed by a multidisciplinary group of clinician educators with expertise in teaching and assessing clinical reasoning across the spectrum of UME and GME education. This approach provides evidence of content validity and our analysis demonstrates both moderate inter-rater reliability and a high degree of internal consistency of REACT to assess clinical reasoning performance in simulated urgent clinical situations. This was notably achieved with no additional rater training or standard setting and among a population of clinician educators from multiple medical specialties. This finding is a particularly intriguing observation in contrast to guidelines informing best practice for direct observation of clinical skills in medical education, recommending both rater and frame of reference training.28

SCT indicates that numerous potential variables may influence clinical reasoning performance in urgent clinical situations. Variables include those intrinsic to the clinician such as years of experience or training, as well as variables intrinsic to the patient or clinical scenario.

Table 1 Description of Clinical Cases Requiring Rapid Evaluation

| Case                      | Patient description                           | Objectives                                                                 |
|---------------------------|----------------------------------------------|-----------------------------------------------------------------------------|
| Asthma exacerbation       | 67-year-old female with sudden onset shortness of breath | • Recognize tachycardia, tachypnea, and hypoxia                             |
|                           |                                              | • Identify asthma exacerbation as a most likely diagnosis                    |
|                           |                                              | • Initiate management for asthma exacerbation                               |
| Ruptured ectopic pregnancy| 28-year-old female with nausea, vomiting, and lower abdominal pain | • Demonstrate an organized approach to a patient with hypotension           |
|                           |                                              | • Recognize ectopic pregnancy as a possible cause of abdominal pain and hypotension |
|                           |                                              | • Call for obstetric consultation and initiate hypovolemic shock management |
| Myocardial infarction     | 72-year-old female with slight pressure in her epigastrium | • Recognize acute coronary syndrome may present atypically in female patients |
|                           |                                              | • Obtain EKG and call “STEMI” alert                                         |
|                           |                                              | • Initiate management of acute coronary syndrome                            |
| Transfusion reaction      | 45-year-old male with dizziness, nausea, abdominal pain, and shortness of breath | • Recognize hypoxia, hypotension, tachycardia, and fever as possible reactions to transfusion |
|                           |                                              | • Stop the blood transfusion and initiate management of possible transfusion reaction |
| Anaphylaxis               | 70-year-old female with dizziness, shortness of breath, and pruritis | • Recognize hypotension and tachycardia                                     |
|                           |                                              | • Identify anaphylaxis as a potential etiology with recent antibiotic administration |
| Septic shock              | 76-year-old male with altered mental status  | • Initiate a care plan for the decompenating patient                        |
|                           |                                              | • Recognize fever, hypotension, tachycardia, and altered mental status      |
|                           |                                              | • Prioritize septic shock as the most likely diagnosis                      |
|                           |                                              | • Initiate stabilization management for septic shock                        |
| Cardiac arrest            | 57-year-old male with shortness of breath and chest pain | • Create a differential for acute chest pain and shortness of breath       |
|                           |                                              | • Recognize PEA arrest and create a differential for the causes             |
| COVID-19 pneumonia        | 65-year-old female with cough and fever      | • Initiate management for cardiac arrest                                    |
|                           |                                              | • Recognize symptoms of hypoxia and fever as potential viral pneumonia     |
| Heart failure exacerbation| 58-year-old male with hypotension and chest pain | • Initiate management of worsening hypoxia                                 |
|                           |                                              | • Demonstrate an organized approach to a patient with hypotension          |
|                           |                                              | • Collect an organized history to determine potential causes               |
|                           |                                              | • Initiate appropriate management for hypotension                           |
| Hypertensive emergency    | 52-year-old male with confusion              | • Demonstrate an organized approach to a patient with altered mental status |
|                           |                                              | • Recognize hypertensive emergency and hypertensive encephalopathy         |
|                           |                                              | • Initiate management of hypertension and recognize risks of rapid blood pressure reduction |
| Acute alcohol withdrawal syndrome | 52-year-old male with agitation    | • Recognize alcohol withdrawal syndrome and ensure patient and staff safety |
|                           |                                              | • Demonstrate understanding of behavioral emergency medications            |
| Hypoglycemic seizure      | 46-year-old female with altered mental status | • Initiate management of alcohol withdrawal syndrome                        |
|                           |                                              | • Demonstrate an organized approach to a patient with altered mental status |
|                           |                                              | • Consider hypoglycemia on the differential                                |
|                           |                                              | • Initiate glucose replacement therapy                                       |

EKG electrocardiogram
STEMI ST elevation myocardial infarction
PEA pulseless electrical activity
the patient, the rater, the clinical reasoning task, and the environment. For example, urgent clinical encounters can in part be defined by the need for early management and an accelerated response to dynamic information. Although these variables exist uncontrolled in authentic urgent clinical situations, implementation of REACT in a simulated urgent clinical situation affords an environment in which control over many of these variables generates an opportunity to isolate and measure variables of interest.

REACT, in fact, was not designed to directly assess the myriad relationships and interactions between variables that might affect the performance of clinical reasoning in urgent clinical scenarios. Rather, REACT is focused on the empirical tasks essential to the formative assessment of clinical reasoning performance in urgent clinical situations. It is therefore our hypothesis that REACT may not perform as well in authentic, real-life urgent clinical situations where the rapid interactions may at times compete with the educational goals, threatening the ability to achieve educational goals and objectives. In simulated urgent clinical situations, where educational goals maintain primacy, the numerous factors surrounding the clinician, patient, rater, assessment method, task, and environment are all controllable and modifiable. In a limited way, REACT provides a tool to isolate and study variance attributable to individual factors, creating an understanding of how each is associated with clinical reasoning performance. Such analysis may inform other potential relationships and interactions in non-urgent clinical environments.

Future directions include the study of REACT as a tool to predict the need for remediation among different levels of learners and as a summative assessment tool before and after clinical reasoning coaching. This includes the creation of a quantitative system with performance thresholds for scoring in learning, and as a summative assessment tool before and after predicting the need for remediation among different levels of learners in non-urgent clinical environments.

CONCLUSION

REACT is a novel tool designed for formative assessment and feedback of a learner’s clinical reasoning performance during urgent clinical situations. This tool can reliably serve as a guide to clinician educators in their assessment of learners and may assist in the identification of learners who struggle with clinical reasoning skills in high-risk urgent clinical scenarios, with the goal of reducing diagnostic and management errors. A study of validity in other learner populations is necessary to determine the broadest application for this formative assessment instrument.

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Declarations:

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