

Integrating strategies for improving diagnostic reasoning and error reduction

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ABSTRACT

Errors of diagnostic reasoning contribute significantly to patient harm. Students, novice diagnosticians, and even experienced clinicians often have difficulty understanding or describing the processes of diagnostic reasoning. Inappropriate use of cognitive heuristics and poor logical reasoning by novice or experienced diagnosticians may result in missed or delayed diagnoses. Reduction of diagnostic errors through knowledge acquisition, self-reflection, and check lists has individually demonstrated some improvements in diagnostic reasoning. Implementing the diagnostic and reasoning tool (DaRT), a method of reasoning which integrates the evidence-based strategies of knowledge acquisition, metacognition, and logical reasoning skills throughout the patient encounter, results in improvement in diagnostic reasoning in advanced practice nurses. Use of the DaRT in one university setting resulted in significant improvement in advanced health assessment skills and diagnostic reasoning abilities as demonstrated by improvements of 28–55% end-of-program Health Education Systems Incorporated scores. Translation into practice settings may further support the use of this multiple-modality tool.

Keywords: Diagnostic reasoning; dual processing; illness scripts; logic; metacognition.

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Diagnostic reasoning is the ability to integrate multiple data sources and thinking strategies during a patient encounter to accurately identify diagnoses and implement appropriate management plans. It is a cultivated skill that health care providers and novice diagnosticians must master. Historically, models of diagnostic reasoning have relied on the belief that knowledge of diseases, effective patient communication, and accurate data acquisition result in correct diagnoses. The gap from knowledge and understanding to expert diagnostic reasoning in a practice setting was often bridged through trial and error, student-provider mentoring, or student/novice observations and replications of respected role models (Sundberg & Olson, 2020). Former strategies for acquiring the skills of diagnostic reasoning in a world of increasing health and illness complexity unfortunately resulted in many diagnostic errors and potential harm to patients. The Institute of Medicine (2015) estimates that 5% of all outpatient visits result in a diagnostic error. Singh et al. (2014) agreed, estimating that one out of every 20 outpatient visits result in a diagnostic

error. Given that in 2016, there were 883.7 million outpatient visits, and diagnostic errors occurred approximately 44 million times per year in outpatient settings across the United States (U.S. Department of Health and Human Services, 2016).

Research regarding errors in clinical reasoning has focused on problems of dual process thinking, cognitive biases, and knowledge deficits (Evans & Stanovich, 2013; Norman et al., 2017). Dual process thinking, in which fast, intuitive-like decisions are compared against slower, conscious, analytical decision making, has been cited as one possible area for study of errors in clinical judgment. Historically it was recognized that intuitive, fast, almost instinctual clinical decisions were laden with potential for erroneous decision making due to the inclusion of heuristics and inappropriate, yet unconscious, use of cognitive biases, which are known to result in inaccurate diagnoses. **Table 1** outlines some of the common heuristics used during a patient encounter.

Cognitive biases occur during any or all of the stages of a patient-provider encounter. Whether occurring during data acquisition, data processing, or clinical management, cognitive biases can eliminate, introduce, minimize, or inflate important information or generate inaccurate application of information. **Figure 1** depicts the process of a patient encounter paired with the most likely cognitive heuristics that occur and result in an inaccurate diagnosis. Errors in data acquisition occur during the

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Table 1. Cognitive biases and heuristics impacting diagnostic reasoning

Diagnostic Error	Definition
Anchoring heuristic	A mental short cut that resolutely focuses on an initial piece of information to make decisions
Availability heuristic	A mental short cut that relies on the ease of recalling similar cases to make decisions
Clinical inertia error	A reluctance to use aggressive evidence-based interventions due to patient concerns of harm
Commission bias	The penchant to do, or to be seen as doing, something—even if that activity is not supported by evidence
Confirmation bias	Purposeful selection and filtering of data that support a given preferred diagnosis <i>and</i> the disregarding of inconsistent, noncontributing data
Contextual error	Failure to identify and incorporate patient attributes and environment into management as doing so would complicate the process
Extrapolation error	Generalizing management experiences from one well-studied population to another without thorough evaluation
Familiarity principle	A preference for something (diagnosis, test, or treatment) due to familiarity
Framing effect	A decision-making process that is based on how the problem is framed or perceived according to past contextual factors (words, situations, and environment)
Frequency gambling error	The proclivity to choose a benign diagnosis even when ambiguous presentations occur
Information bias	A belief that the more evidence, regardless of quality or value, one acquires the better the diagnosis
Need for closure	The act of making a diagnosis even when the diagnosis is not definite
Overconfidence bias	The inclination to act on incomplete information or inaccurate intuitions and hunches
Omission bias	A propensity toward inaction based on the principle of nonmaleficence
Outcome bias	A proclivity to make decisions that tend to have better outcomes or results, leading to minimization of diagnoses
Overconfidence effect	Occurs when a subjectively overconfident person makes clinical judgements, which are greater than the objective precision of those judgements
Premature closure ^a	Acceptance of a diagnosis prior to sufficient data being obtained and verified.
Representativeness heuristic	An inclination to look for the prototypical presentations of a disease and thereby overlook atypical presentations
Self-serving bias	The inclination to claim more responsibility for accomplishments than for failures
Sutton slips	The tendency to focus only on the obvious instead of entertaining less likely diagnoses
Unpacking principle bias	The inability to uncover all relevant information through incomplete data acquisition by patient or provider
Zebra retreat	The inclination to retreat from a rare disease, even though data ostensibly support it

Note: Casella, 2018; Croskerry, 2013; O'Sullivan & Schofield, 2018.

^aPremature closure is the most common cognitive error in diagnostic reasoning.

investigation and discovery phase of subjective and objective data gathering. Errors in the assessment processing pertain to the stage of the patient encounter in which data are subsequently prioritized, organized, synthesized, and compared with known illness scripts. Within this context, plausible assessments are discerned and are confirmed or refuted through data driven diagnostic

choices. Errors in management occur as clinicians endeavor to alleviate the symptoms or the cause of the disorder but result in inappropriate interventions based on the utilization of a cognitive bias.

Cognitive errors may be isolated to a specific component of the patient-provider encounter and yet have considerable effects on patient outcomes. That said,

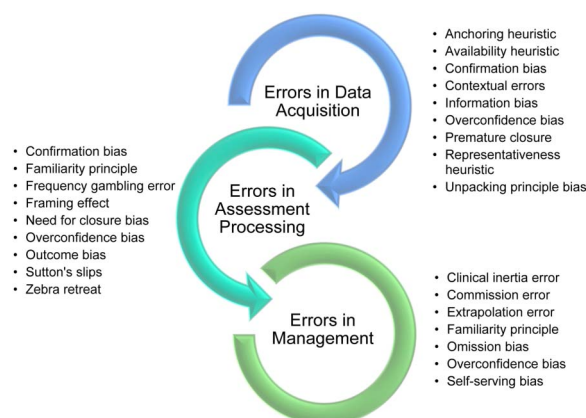


Figure 1. Cognitive bias and heuristics within the patient encounter. Cognitive errors that may occur during various components of the patient-provider encounter or relationship are depicted.

cognitive biases may also occur throughout the encounter. For example, overconfidence bias, a bias in which one's judgement of self and self-abilities exceeds reality, is a cognitive bias that can negatively affect any portion of the patient-provider relationship. From an educator or mentor perspective, overconfidence bias is a troubling heuristic and one that requires growth in self-awareness and humility. The most common and potentially harmful cognitive biases in diagnostic reasoning are premature closure often coupled with an anchoring heuristic (Etchells, 2015; Mayer, 2019). Clinicians focus or fixate on a cogent piece of information (anchoring) and fail to investigate further for other possible diagnoses (premature closure).

Because of the inclusion of faulty cognitive heuristics, integration of the patient information in the diagnostic reasoning process may result in missed or erroneous diagnoses. Efforts to reduce cognitive bias during clinical encounters have focused on the integration of provider time-outs, check lists, and systematic thinking strategies with limited success (O'Sullivan & Schofield, 2018). Dual thinking error-reduction strategies hypothesize that an emphasis on decreasing the use of fast intuitive thinking and replacing or augmenting it with rational slower thinking would decrease diagnostic errors. Although there is some face validity to this approach, research indicates that the relationship between intuitive and analytical methods of cognition is multifactorial and interrelated (Norman et al., 2017). The relationship is not as linear or as simple as focusing merely on increasing analytical reasoning above intuition in the patient encounter.

The World Health Organization (2016) identifies inadequate clinical training or knowledge deficits as a probable cause for diagnostic errors and recommends that enhancing knowledge or education should be highlighted as the primary method of decreasing medical

errors. In support of this hypothesis, the acquisition of increased knowledge within one's field demonstrates a small yet measurable improvement in diagnostic accuracy especially when coupled with metacognitive practices (Norman et al., 2017). Because of this, researchers, practitioners, and educators have eagerly sought to develop strategies to improve diagnostic reasoning.

Reducing knowledge deficits through illness script formation

Diagnostic reasoning is a dynamic and complex issue. One method of helping students and novice diagnosticians integrate knowledge from the sciences, psychosocial sciences, and patient information is the use and integration of illness scripts within the patient encounter. Illness scripts generally contain the categories of epidemiology, time course, clinical presentation, pathophysiology, diagnostics, and management. Scripts may be brief or extensive depending on the characteristics of the disease or disorder. As illustrated in **Figure 2**, illness scripts are a comprehensive tool used to describe knowledge organization and relational constructs of various forms of data. Through illness script formation and use, all clinicians, including students and novice diagnosticians, can obtain, compare, and contrast acquired information in the clinical setting.

The first component of an illness script, epidemiology, includes the definition, etiological causes, demographics, incidence, risk factors, and exposures, which constitute a given disorder. The second component of an illness script, time course, describes the duration and pattern of symptoms.

The third component, the clinical presentation portion of the illness script, is perhaps the most important aspect of the script because it represents a clinician's ability to consider both subjective and objective data and relate it to known manifestations of a disorder. In this section, the typical and atypical signs and symptoms are listed. From

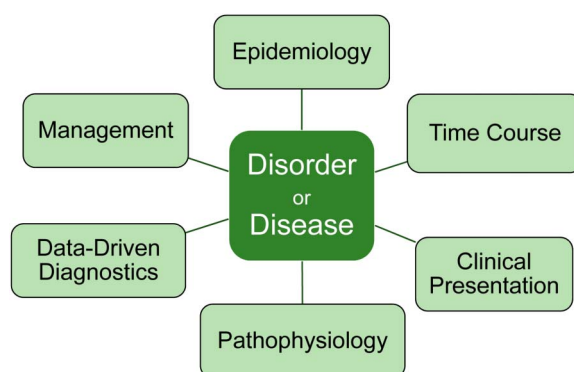


Figure 2. Components and considerations of a diagnostic illness script. Six elements contributing to the knowledge, understanding, and relationships of a particular disorder or disease are illustrated.

this extensive list essential or “must have” features are identified. These patient symptoms or physical findings literally must be present in order for the diagnosis to be possible. This aids the diagnostician in retaining diagnostic possibilities, even though there may be an atypical presentation. In addition, rejecting features are identified within the clinical presentation section.

Rejecting features are those signs or symptoms, which if present, would eliminate that disorder from consideration. Rejecting features are helpful in distinguishing between similar disorders. For example, a rejecting feature of acute bronchitis would be pulmonary consolidation. Consolidation is a finding found in pneumonia but not found in bronchitis. So, if consolidation were to be present in the patient encounter, one could confidently eliminate the diagnosis of bronchitis from consideration thus narrowing the diagnostic hypotheses.

The fourth component of an illness script centers on the pathophysiology of a disorder. Here, the script expands on the etiology of the disorder and explains the cellular changes and how these changes initiate and perpetuate the symptomatology. It is here, in the pathophysiology section, that clinicians understand not only the mechanism of the disorder and how and why the manifestations of the disease are created but also the future implications of that disorder. As clinicians understand the cellular and system changes that occur because of a specific disorder, clinicians are able to make logical and data-driven diagnostic decisions, which will then support or refute their clinical suspicions.

The final component of an illness script, management, completes the script. Management of a disorder is an evidenced-based dynamic process. It entails patient education, preventive measures, pharmacotherapeutics, referrals, and consultations.

Illness scripts, metacognition, and data acquisition

As previously underscored, increasing scientific knowledge among clinicians has improved diagnostic reasoning (Norman et al., 2017). But improvement in knowledge or understanding alone does not necessarily eliminate errors. By integrating self-reflection and repetitive metacognition strategies into the routine of data acquisition within a patient setting, diagnostic reasoning can be improved (O’Sullivan & Schofield, 2018). Metacognitive practices are also important strategies during clinician education to foster, develop, and evaluate diagnostic reasoning both in the educational setting and in practice residencies or early independent practice environments (Kosier et al., 2019).

Developing diagnostic reasoning is an iterative process that involves possibilities and probabilities, knowledge organization, and patient-provider relationships. This is accomplished through deductive reasoning

(general to specific), inductive reasoning (specific to general), and abductive reasoning (inference to the best explanation). Deduction, or the act of developing a premise and searching for findings which lead to a possible conclusion, is coupled with inductive reasoning or the ability to take specific data and then generate candidate lines of reasoning. Donner-Banzhoff (2018) identifies inductive foraging as a helpful method to include patient report and patient information into the clinical reasoning process. Diagnostic reasoning uses both deductive and inductive logic to ascertain probable and possible diagnoses through data collection and organization. Inductive processes lead to possibilities. Possibilities, however, may seem endless within the health care environment, especially in primary care. Possibilities can be narrowed to data-driven plausibilities through abductive reasoning. Abductive reasoning, in which probable diagnoses can be generated from inductive and deductive reasoning, help focus the diagnostic possibilities to diagnoses of plausibility. That is, the designated diagnosis is the best explanation based on the data at hand (Gilliam, 2019; Soldati et al., 2017).

Diagnostic and Reasoning Tool development

Errors in diagnostic reasoning are the primary cause of patient harm and successful malpractice claims (Sweeney et al., 2017). Methods to mitigate errors in diagnostic reasoning have historically focused on cognitive methods of data integration, or reduction of heuristics, or employment of meta-cognitive practices. One newly developed tool, the diagnostic and reasoning tool (DaRT), integrates each of these error-reduction strategies into a single model. Because the transition from traditional nursing roles into advanced practice roles requires a higher level of diagnostic reasoning, the DaRT was developed and implemented as a teaching-learning strategy by the faculty chair of the advanced assessment and diagnostic reasoning course in a private Midwestern graduate nursing program. Students enrolled in this course were nurses who were seeking to become family nurse practitioners and psych mental health nurse practitioners.

Evidence-based components related to improvement in diagnostic reasoning were addressed and integrated into the multifaceted strategy to enhance novice diagnostic reasoning processes. Components of illness script formation were developed and incorporated across graduate core courses so that by the time students entered their advanced health assessment and diagnostic reasoning course, factors relating to epidemiology, time course, and pathophysiology were solidly in place. During the advanced assessment and diagnostic reasoning course, clinical manifestations and data-driven diagnostics were added to script formation, and the DaRT was deployed. Simulated case scenarios aided students in

practicing the gathering, synthesis, and hypothesis-building techniques of diagnostic reasoning. Repetitive reminders and scheduled stops for reflection and review of logical reasoning skills within an objective clinical scenario examination helped students to reduce cognitive bias. As students transitioned from case-based scenario to student practice, the DaRT was applied and completed through evidence-based management approaches across 500–600 clinical hours.

Figure 3, the DaRT, illustrates the integration of illness script knowledge, patient information, process invoked metacognition, along with deductive, inductive, and abductive reasoning to derive plausible, best evidence-supported clinical diagnoses.

Diagnostic and Reasoning Tool application

The patient enters the clinical setting, and a provider–patient relationship is formed. “What brings you to the office today?” starts the formal investigation. The broad deductive reasoning processes become activated when the patient says, “I have this horrible cough and I can’t sleep at night.” Through deduction, the clinician formulates broad possibilities including multiple systems and begins the investigation by collecting subjective data. As data are acquired through the history of present illness, possibilities are narrowed as known rejecting features, and essential features of previously developed illness scripts are evaluated. Inductive reasoning enters as symptoms are grouped together and arranged in various supporting roles. Simultaneously, self-reflective practices are occurring in which the provider is purposefully deliberating whether sufficient subjective data have been obtained to make an accurate diagnosis. The clinician then moves to the objective collection of data through systematic and specific physical examination. That information is amalgamated with previously gathered data until the evidence points toward a refined list of diagnostic possibilities. It is then, at the assessment stage of the clinical encounter, that abductive reasoning is employed. The diagnostician reflects on the epidemiology, time course, subjective clinical information, and physical examination findings of the patient. The diagnostician compares those findings to the various diagnostic suspicions and their illness scripts, “What is the most plausible diagnosis?” The diagnosis which answers that question is determined to be the best diagnosis, given the facts, that explains the patient’s condition.

A cautionary note remains to be sounded. The current identified diagnosis might be the most plausible given the data, but others may also be correct because insufficient data were obtained as a result of cognitive bias, incomplete or invalid information, and incomplete or inadequately interpreted physical assessment findings. It is also possible that future data acquired through

diagnostics could reveal conflicting or rejecting data. Consequently, it is important that the provider remain humble and receptive to further information that might call for an adjustment to their initial diagnostic conclusion.

Diagnostic and Reasoning Tool effectiveness methodology

A retrospective descriptive study investigating whether the concepts and deployment of the DaRT leads to improved Advanced Practice Registered Nurse (APRN) student understanding and application of diagnostic reasoning in a graduate nursing program located in the Midwest was devised (Institutional Review Board #2019-20-079). The developer of the tool was the faculty chair and primary instructor of the advanced assessment and diagnostic reasoning course both before deployment and after deployment of the DaRT. Each course throughout the curriculum was standardized across sections with identical assignments, grading rubrics, and examinations, thus reducing the confounding variable of multiple instructor influences. End-of-program Health Education Systems Incorporated (HESI) scores of 252 Family Nurse Practitioner (FNP) students were tracked over a 6-year period. Scores of postprogram HESI examinations of students who did not have the benefit of using the DaRT strategy for acquiring diagnostic reasoning skills were compared with those who had been instructed on the tool and had practiced the reasoning processes throughout their clinical practicums.

Health Education Systems Incorporated examinations, including the end-of-program FNP APRN examination, have strong reliability coefficients (KR-20 between 0.90 and 0.94), superior content validity, and excellent predictive validity for successful passing of national APRN certification examinations (Elsevier Education, 2018; Wilson & Goodman, 2015). Within the end-of-program FNP examination, two subscales that reflect knowledge application related to diagnostic reasoning were identified: Advanced Practice Nurse (APN) clinical concepts physical assessment and the APN domains of practice assessment of acute and chronic illness. Average scores were grouped into two categories. Students who had no exposure or experience with the components of the tool were placed in the “before DaRT” category (2014–2016) ($N = 116$). Students who had learned and integrated the components of the tool into their academic education, and clinical experiences were labeled the “after DaRT” group (2017–2020) ($N = 136$). Average scores in these two subscales were then compared using a two-tailed two-sample t -test. A statistically significant increase in physical assessment scores ($p = .0152$) and scores in assessment of acute and chronic illnesses ($p = .0108$) in students who used the DaRT, as

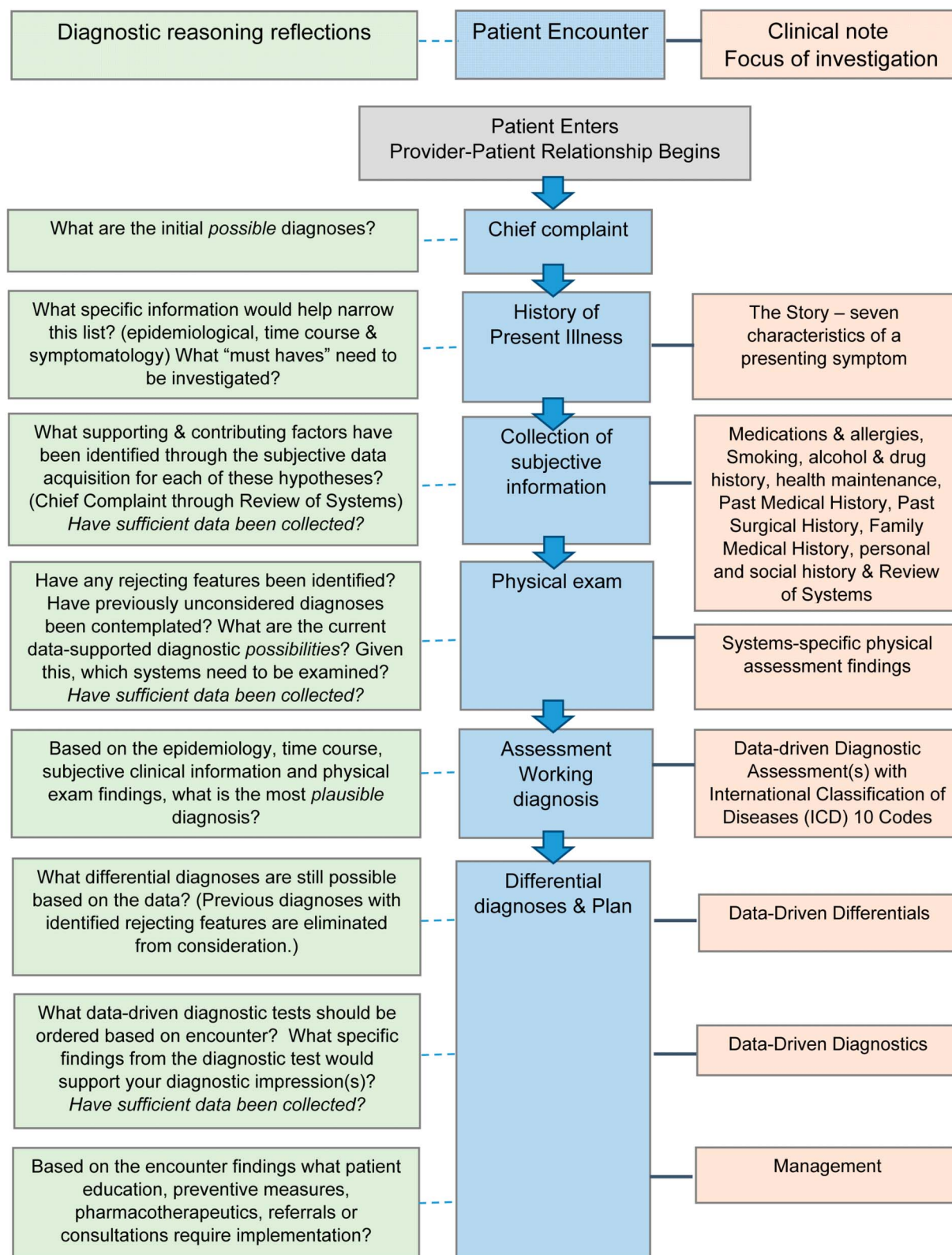


Figure 3. Diagnostic and Reasoning Tool. --- represents logical processes integrated within the reasoning reflections that impact the investigative and evaluative components of diagnostic reasoning within the specific patient encounter are explained. — represents the connection with the reflection and reasoning with the particular phase of patient-provider interaction and the relationship between the particular phase of a patient-provider interaction and the components of investigation typically occurring.

compared with those who had not, was discovered. This finding supports the effectiveness of the tool in improving diagnostic reasoning. Students employing the DaRT, consisting of illness script formation, meta-cognition, and logical reasoning skills, demonstrated superior ability to formulate accurate diagnoses as compared with those whose education did not include the DaRT.

In a retrospective study, it is conceivable that confounding variables impinged on the findings of this study. This study did not address whether the benefits of the DaRT are significant in specialties other than family practice or for non-APRN students. For example, the study did not include end-of-program scores of Psych Mental Health Nurse Practitioner students because HESI did not offer such examinations for this specialty. Cohort demographics, including age, gender affiliation, professional experience, current practice setting, student clinical practice sites, and preceptor diagnostic reasoning skills, were not controlled in this study. Future research including non-APRN providers using control groups and investigating whether demographics and personal practice characteristics effect diagnostic reasoning may further reinforce the effectiveness and generalizability of the tool.

Summary

Students, novice diagnosticians, and clinicians often have difficulty understanding or describing the processes of diagnostic reasoning. This difficulty places the patient at risk for missed diagnoses or delayed diagnoses. By employing the DaRT, an instrument that integrates the evidence-based strategies of knowledge acquisition, metacognition, and logical reasoning skills throughout the patient encounter, diagnostic errors may be reduced. The DaRT can be used as a teaching-learning strategy throughout clinicians' education, practica, and residencies. Preceptors and mentors can also easily implement the DaRT as a method of clinical instruction and diagnostic development, thus contributing to the increased diagnostic reasoning competence of both student and experienced clinician alike.

Competing interests: *The author reports no conflicts of interest.*

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