Jennifer A. Byrnes MLS, MPH; Art Papier, MD

# The Impact of Clinical Decision Support Systems on Quality of Care

## Introduction

The information available on the diagnosis and treatment of diseases grows exponentially every year. Although great strides have been made in understanding disease processes, it has become a challenge for clinicians to remember the thousands of knowledge relationships that are illuminated as a result of this research. When faced with a disease that is rare or outside the purview of their speciality, this challenge is intensified. It is estimated that, on average, each outpatient visit generates at least one clinical question that the clinician cannot answer.[1] Clinical decision support systems are one strategy clinicians can adopt to answer such questions.

## Text

A clinical decision support system (CDSS) is defined as any computer program designed to help health professionals make clinical decisions; this includes any type of clinical data or medical knowledge that is intended to provide decision support. CDSSs can be further classified as tools for information management, focusing attention and providing patient-specific recommendations.[2] Information management systems assist in managing and retrieving clinical knowledge and may function similarly to an online textbook. Clinicians are required to interpret the information presented and use their judgement to make clinical decisions. Tools for focusing attention are typically referred to as reminder systems. These reminders can flag an abnormal lab value or notify a clinician that a drug they just prescribed through their computerized physician order entry (CPOE) system has a serious interaction with a preexisting prescription. Other uses for reminder systems include vaccination reminders or screening test prompts. Tools that provide patient-specific recommendations use logic to suggest a differential diagnosis or help narrow the range of diagnostic possibilities. This logic can be simple, such a Boolean logic, or highly complex, such as Bayesian analysis.[2]

Until recently, most CDSSs could not answer the question, "What am I looking at?" Visually-based diseases can present unique diagnostic challenges, and they can have rare, complex and unusual presentations. A visually based CDSS known as VisualDx assists clinicians with patient-specific clinical questions using a combination of images and text. Users are able to enter visual findings such as the morphology of a skin lesion, body distribution, or X-ray abnormalities. Other relevant signs and symptoms can be entered as well as additional pertinent information, such as occupation and recent travel. VisualDx allows users to construct a differential diagnosis and then view image stacks showing the spectrum of presentations, including classic and rare presentations, variations in severity and different skin types. The accompanying text provides a synopsis, diagnostic and management pearls, and therapy information. The system uses combinatorial logic and, therefore, results are weighted equally, presenting both common diseases and rarer ones that may be overlooked. By not using probabilistic logic to construct the differential, clinicians still must exercise their judgment in determining the diagnosis.

A common diagnostic conundrum for many clinicians, especially in the emergency room, is the patient presenting with fever and a rash. Using VisualDx, (Figures 1-5) we can construct a differential diagnosis by entering the following findings:

1. Vesicular/pustular rash
2. Widespread distribution
3. Patient appears systemically ill
4. Hypotension

In this scenario, VisualDx allowed the user to rapidly diagnose a potentially life-threatening disease. Failure to correctly diagnose acute meningococcemia or toxic

Figure 1. Step 1: Select morphology (vesicular/pustular)

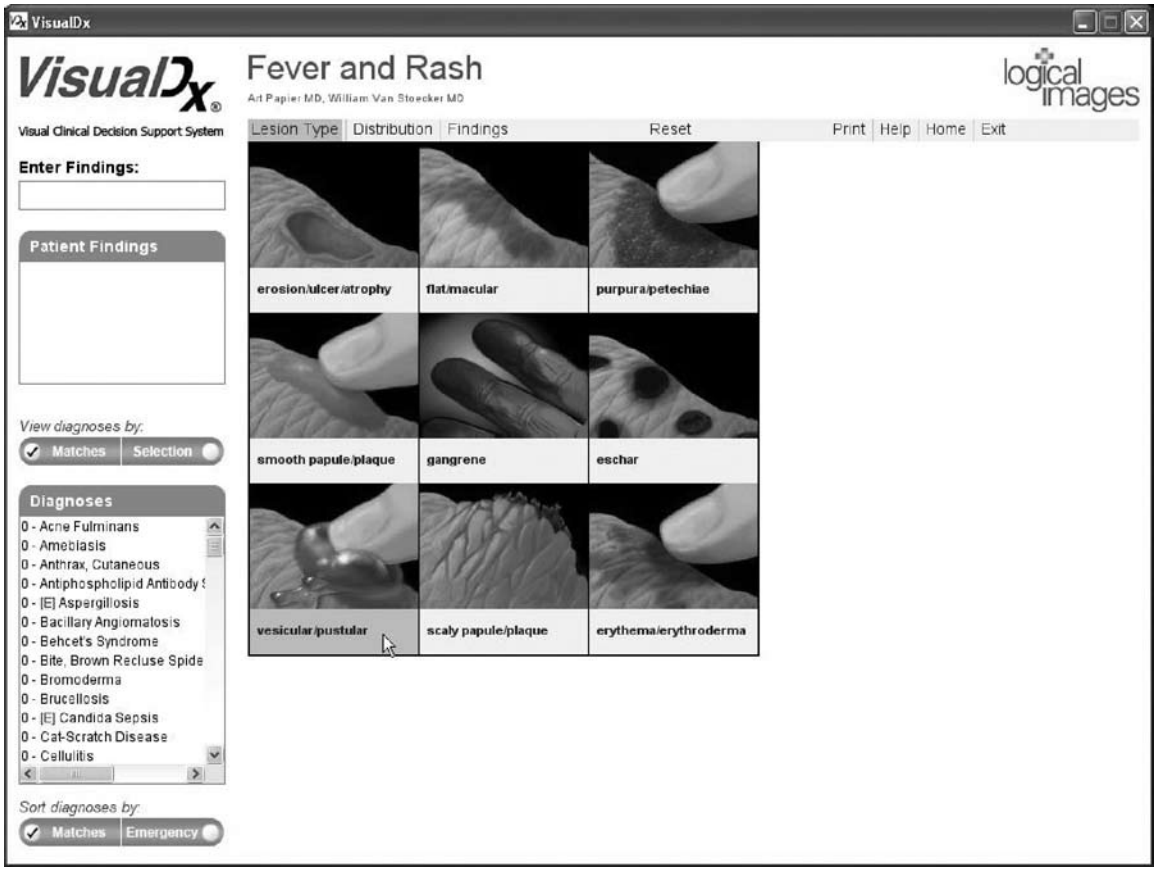



Figure 2. Step 2: Select distribution (widespread)

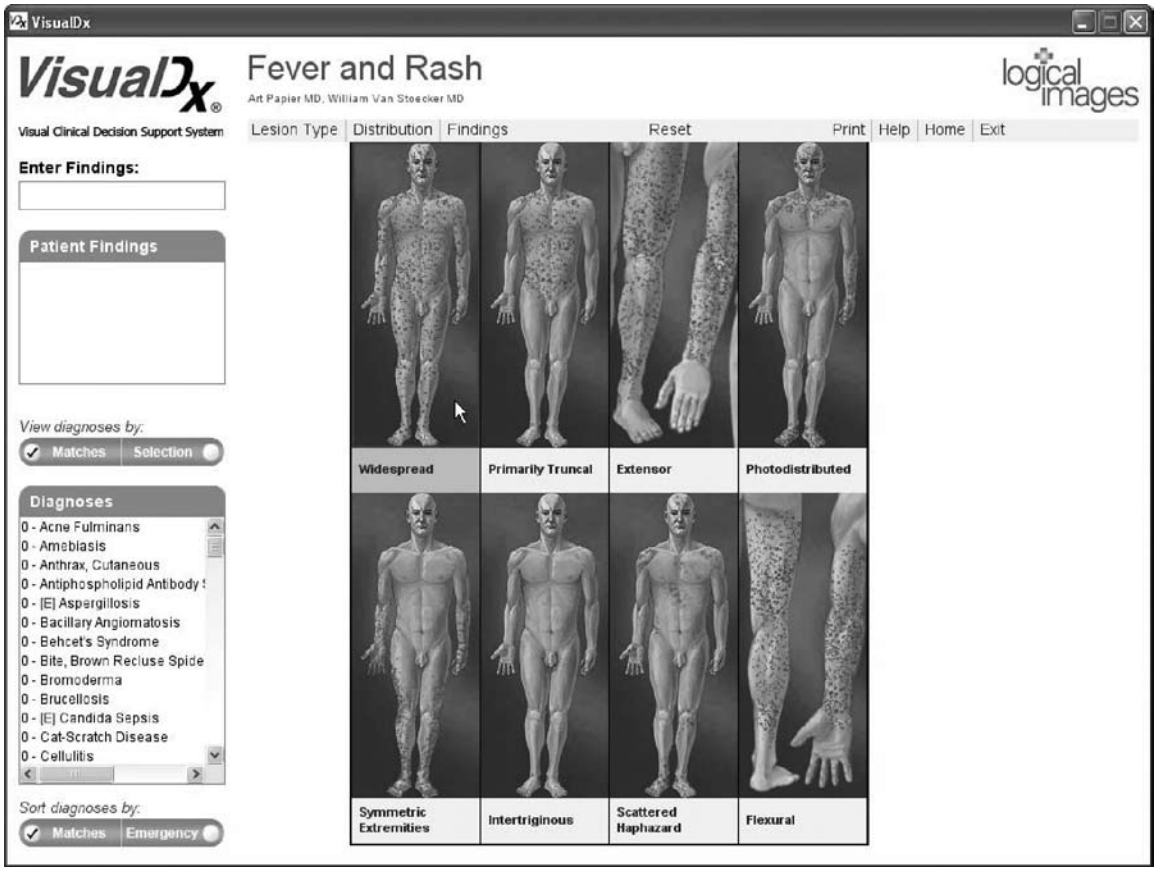
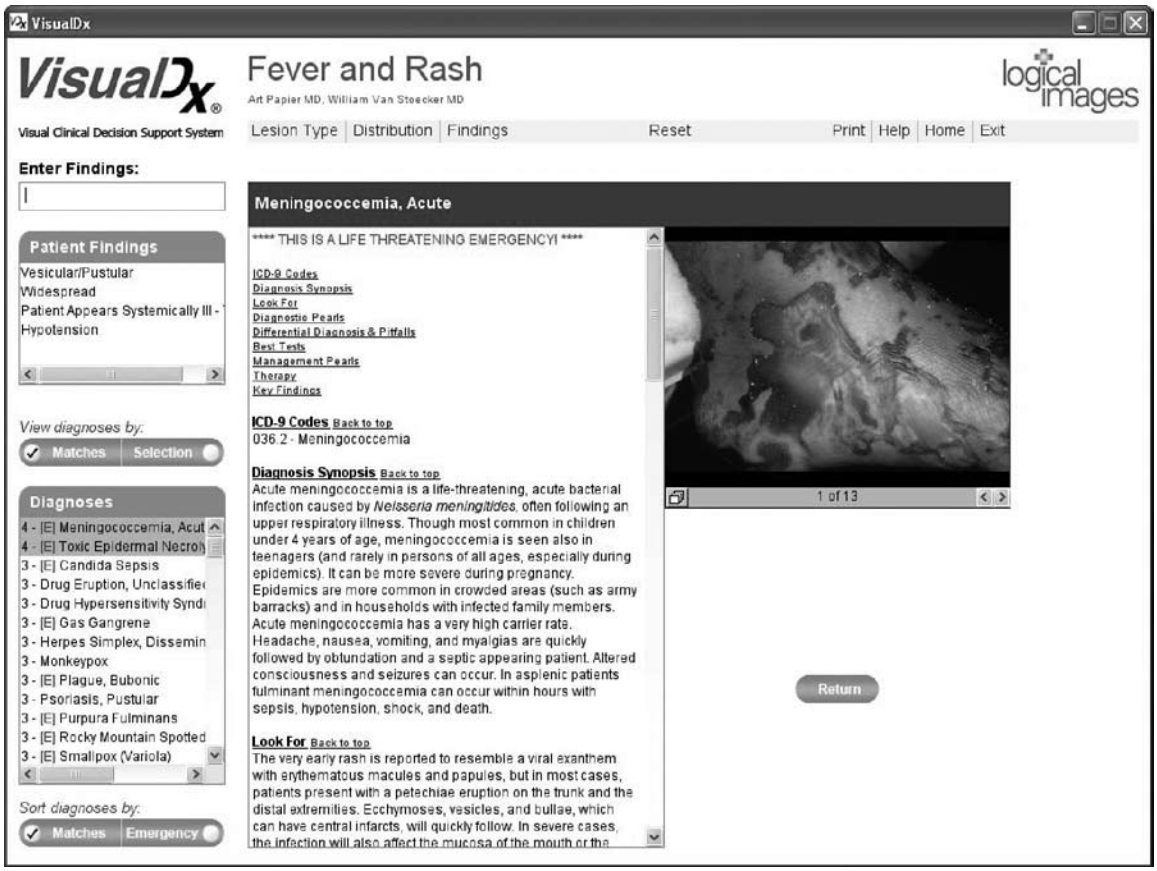


Figure 3. Step 3: Add other relevant findings (patient appears systemically ill and hypotension)


Figure 4. Step 4: Side-by-side image comparison

Figure 5. Step 5: View text to learn more




epidermal necrolysis may result in increased morbidity and mortality, significantly compromising the quality of care.

A 1999 IOM report estimated that up to 98,000 of US residents die each year as the result of preventable medical errors.[3] A follow-up report in 2001 recommended using information technology to help transform the healthcare delivery system in addition to the practice of evidence-based medicine stating, "Patients should receive care based on the best available scientific knowledge. Care should not vary illogically from clinician to clinician or from place to place."[4]

As a result of recommendations by the IOM and others, the impact of decision support on the quality of care has become the subject of research. A 2003 systematic review assessed the effects of CPOE (five trials) and CDSSs (seven trials) on medication safety. Of the CPOEs, two showed a marked decrease in serious medication error rates, one showed an improvement in corollary orders (eg, ordering liver function tests for patients on isotretinoin), one showed an improvement in prescribing behaviors (eg, ordering less expensive drugs) and one showed improvement in nephrotoxic drug dose and frequency. Of the CDSS programs, three demonstrated statistically significant improvements in antibiotic-associated medication errors or adverse drug events and one showed an improvement in theophylline-associated medication errors.[5]

A 2005 systematic review of 100 controlled trials assessing the effects of CDSS has provided further evidence. Of the studies meeting inclusion criteria, the CDSS improved performance in 64% of the studies. A breakdown of the type of CDSS was also reviewed. Performance was improved with 40% of diagnostic systems, 76% of reminder systems, 62% of disease management systems and 66% of drug-dosing or prescribing systems. There was also a significant relationship between CDSSs that automatically prompt the user versus those that require the user to activate the system ($P = .02$).[6]

A second systematic review in 2005 studied the ability of CDSSs to improve clinical practice. Of the 77 studies included, 68% of trials found that the CDSS significantly improved clinical practice. There were four features identified that were significantly more likely to improve clinical practice:

1. Automatic provision of decision support as part of clinical workflow ($P < .00001$)

2. Provision of recommendations rather than just assessments ($P$ = .0187)
3. Provision of decision support at the time and location of decision making ($P$ = .0263)
4. Computer-based decision support ($P$ = .0294)

Of systems that possessed all four features, 94% significantly improved clinical practice.[7]

## Conclusion

CDSSs such as VisualDx have enormous potential to improve the quality of care via improved diagnostic accuracy, the rapid retrieval of relevant information at the point of care and evidence-based medicine standards. Despite their benefits, behavioral adaptations will be required of clinicians and healthcare institutions to incorporate such technologies into clinical care. To get in front of this learning curve, physicians must lead by example and incorporate information technology into their teaching as well as their patient interactions. Formal feedback systems should be developed to refine and create ideal and useful information systems. In addition, further controlled trials, with appropriate sample sizes and power, must be conducted to determine the return on investment in CDSS systems.

*Jennifer A. Byrnes, MLS, MPH, is a medical informaticist in the Department of Dermatology at the University of Rochester School of Medicine and Dentistry, and is the Manager of Content and Clinical Research for Logical Images.*

*Art Papier, MD, is an Associate Professor of Dermatology and Medical Informatics at the University of Rochester School of Medicine and Dentistry, and a co-founder of Logical Images.*

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