

Improving Medical Diagnosis During Today's COVID-19 Pandemic and Beyond

by Art Papier, MD, CEO & Founder, VisualDx

In responding to the threat of bioterrorism triggered by anthrax spread via the US mail nearly 20 years ago, health systems and government agencies realized the clinicians' need for accurate and timely information to assist diagnosis and infectious disease surveillance. Today's COVID-19 pandemic has likewise greatly and urgently amplified the need for accurate clinical diagnosis and disease management. The present COVID-19 landscape is typified by widespread patient anxiety, fear, and doubt, which is further exacerbated by inadequate testing, high-stress clinical environments, and clinicians' unintended cognitive biases. All these factors are combining to increase the risk of patient harm.

Based on our experience working in public health informatics and on bioterrorism readiness and response from 2002 to 2007, we see clear "best practice" lessons to apply to the current pandemic.

- **First**, diagnostic decision support information and tools can greatly assist the accuracy and timeliness of infectious disease diagnosis and diagnosis broadly.
- **Second**, at the point of care, health systems should augment clinical knowledge with localized infectious disease alerting and reporting delivered within clinicians' existing workflows.
- **Finally**, our response to the current pandemic should be designed to be "future proof" by preparing for future emerging and re-emerging infectious diseases and improving diagnosis broadly.

We share our perspective related to these three key learnings and how they apply to today's pandemic response and beyond through the lens of our work in bio-preparedness for local and national government.

Assist Accurate, Timely Diagnosis at the Point of Care

Anthrax sent via the mail after the 9/11 catastrophe triggered an immediate US government effort to prepare for the possibility of bioterrorism broadly. During those stressful times, public health officials wanted to rapidly educate medical professionals, in particular emergency physicians and generalists, to recognize any bioterrorism victim early. Some patients presenting with the symptoms of respiratory anthrax were evaluated and given the wrong diagnosis and sent home. Our government needed strategies to make sure clinicians could diagnose people accurately and early for rare bioterrorism-related diagnoses that they were almost universally unfamiliar with.

In discussions with leaders in the fields of cognitive theory research and medical diagnostic errors, it is clear there are known factors affecting diagnostic challenges. For example, if a clinician is faced with an unknown disease presentation, the chance of that doctor making the correct diagnosis depends on having the correct diagnosis somewhere in the working differential diagnosis within the first 5 minutes. A contextual clinical decision support-generated differential diagnosis at the point of care can augment clinical decision-making by alerting the clinician early in the diagnostic process to consider unfamiliar diagnoses matching the patient's presentation.

Health officials realized in the early 2000s the need for clinicians to be capable of diagnosing conditions they had never seen. One approach to clinician education was to provide continuing medical education (CME)-based lectures on bioterrorism. However, knowledge that is not used recedes quickly over time. Emergency physicians, like all people, most effectively learn and retain information they repeatedly use in practice. Diagnosing anthrax or ricin poisoning does not fall into this category.

At the request of the Department of Health and Human Services (HHS) and the CDC, VisualDx developed training materials for smallpox vaccination adverse events. This came about because of Dr. Donald A. Henderson's awareness of the VisualDx technology dating back to 2000. Dr. Henderson was the Director of the HHS Office of Public Health Emergency Preparedness and, later, a Principal Science Advisor in the Office of the Secretary of the Department of Health and Human Services. However, to have a diagnostic system for smallpox vaccination reactions, anthrax, or now for COVID-19, alone is not a short- or long-term solution.

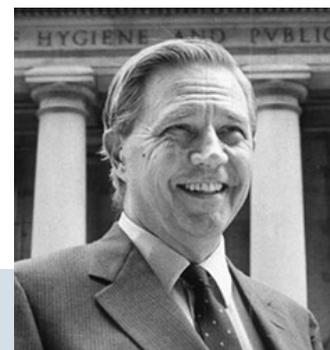
At the time of the anthrax events, our group proposed to public health commissioners an alternative approach. We argued that providing a universal tool for presenting symptoms and a systematic approach to improve diagnosis broadly was a more sensible and sustainable strategy. Clinicians, like all computer-users, prefer training on as few applications as possible. Training on multiple systems for different use cases is simply too much work. A single problem-oriented system covering all the diagnostic possibilities meets daily needs. State, city, and county public health commissioners embraced the idea of an integrated point-of-care system to address both emerging and re-emerging infectious diseases, as well as general diagnostic improvement technology, as a solution.

At the time of bioterrorism preparedness, we delivered to emergency departments technology centered around patient symptoms and problems that could be applied comprehensively to all diagnostic possibilities. There is a constant demand in medicine to address diagnostic decision-making broadly and not solely focus on the diagnosis of the moment. Today, clinicians need a tool that assists not only with COVID-19 specifically but all the diseases that are in the differential diagnoses of fever, cough, abdominal pain, headache, loss of sense of taste or smell, rash of toes, and more.

Six US state departments of health licensed the VisualDx clinical decision support system using Centers for Disease Control and Prevention (CDC) and federal preparedness funding to bring the diagnostic decision support tool to their community emergency department physicians during the period of bioterrorism concern from 2002 to 2007. In addition, the health departments recognized a second advantage: the ability to insert their local public health alerting and reporting information into the VisualDx system 24/7.

Alerting and Reporting Functionality for All Communicable Diseases

With VisualDx integrated public health linking, county and city health departments can place 24x7x365 health alerts within the point-of-care VisualDx. These alerts are tied to clickable URLs, allowing users to access the local public health alert message immediately. The Los Angeles County Department of Health placed VisualDx into emergency departments for bioterrorism; years



“And to you and your group, a special thank you. If even 10% of those we are involved with at the moment fulfilled 50% of what they had promised, it would be a different world! But you are doing it all and for that we are very grateful. Trying to keep a team and group as large as ours at virtually full throttle for a few months, let alone a year, is exhausting. It is nice to have a group that doesn't need our special push but, instead, are pushing us!”

— D.A. HENDERSON, MD, ON VISUALDX WORK FOR CDC/HHS 2002
1928-2016

Director of HHS Office of Public Health Preparedness
2001-2003
Director WHO Global Eradication of Smallpox Program
White House Associate Director for Life Sciences in the
Office of Science and Technology Policy
Dean Emeritus of Johns Hopkins Bloomberg School of
Public Health

later, their physicians were being alerted to public health issues such as a measles outbreak in California and a patient becoming ill from contaminated cocaine.

In addition to alerting, links can be set to report any communicable disease of public health significance. Each state has a different set of mandatory reportable infectious diseases; the dynamic public health customization allows each health department to push reporting links into each reportable disease in the system. If a state has electronic reporting, the electronic system can be “launched” from the clickable, customized URL. This feature allows time-strapped physicians the ability to quickly access their local county and state public health department pages.

Clinicians embraced the use of the system for general diagnosis. The South Carolina Department of Health and Environmental Conservation (DHEC) licensed VisualDx for every emergency department in the state.

Prepare for Everything

Our goal is to drive accuracy in diagnosis and management of all current and future emerging and re-emerging infectious disease problems in addition to COVID-19. As the COVID-19 pandemic places additional pressure on professionals, tools to speed general medical care, support virtual visits, improve diagnostic accuracy, and provide patient education are critical. As we move to more accurate and consistent COVID-19 diagnosis and wind down from the acute phase of this pandemic, we should consider the structure and functionality of a modern public health digital infrastructure.

Since no one knows which public health threats will emerge in the future as our next crisis, the only sensible strategy is to prepare for all infectious diseases and diseases of public health significance. By providing busy clinicians with VisualDx, an information system covering all diagnoses that can be used for common and uncommon diseases, clinicians will become familiar with the tool and how it works. VisualDx is the only system designed for both public health preparedness and rapid point-of-care visual diagnosis of day-to-day medical disorders. Emerging and re-emerging infectious diseases such as COVID-19, SARS, and pandemic influenza are fully covered along with all viral, fungal, and bacterial chest infections.

VisualDx is also interoperable inside of the electronic health record (EHR). When a new disease emerges, or an infectious disease re-emerges as a population-wide threat, the busy clinician will simply find the knowledge within the system they currently use.

Surveillance Capability

As a cloud-based service, VisualDx use is continually monitored, and search patterns can be surveilled by geolocation. Baseline searches by professionals can be measured and compared with changes from baseline. This means we can incorporate what clinicians are seeing on the front lines to the public health data stream insight and use search patterns as clues to the emergence of a disease. Rather than relying on diagnostic searches alone, trends in symptoms and other clinician-entered search findings can be used to look for patterns of emerging disease.

Used and Trusted Around the World

Following our initial work for the CDC on the smallpox training program, VisualDx expanded licensing of the VisualDx system to many state, city, and county health departments. Los Angeles County, Metro San Antonio, New York City, Delaware, South Carolina, Georgia, Oklahoma, South Dakota, and Wyoming used CDC and federal hospital funds to deploy VisualDx to all emergency departments in their respective localities. These deployments were true “success stories” of the federal preparedness funding that reached the states and hospitals.

The system has since grown during the interval to include more than 3,100 diseases, over 42,000 professional images, and tens of thousands of searchable patient findings. This clinical diagnostic decision support system is the result of more than 20 years



William Finn, MD, an emergency physician in Greenville, used the system when a nurse practitioner on the team reported a child as having streptococcal pharyngitis and unusual small skin lesions. With VisualDx to assist him, Dr. Finn concluded that the diagnosis was bacterial sepsis and meningococemia, not strep throat. The child was started immediately on intravenous antibiotics and transferred to a tertiary care center, and miraculously walked out of the hospital one week later despite having had positive blood cultures for meningococcus bacteria. This all-hazards approach resonated with busy clinicians and health commissioners.

of effort of hundreds of physicians, computer scientists, graphic designers, and usability experts. It provides information for diagnoses within the system.

- VisualDx is in use now by tens of thousands of providers and in more than 2,300 hospitals and large clinics globally.
- The Veterans Health Administration, as of October 1, 2010, has contracted with the company for a nationwide VisualDx site license.
- The system has been incorporated into the curricula of over 90 medical schools (Stanford, Yale, Harvard, the University of Washington, the University of Rochester, and many other leading institutions).
- It is integrated into telemedicine as a method to standardize and ease remote consultation.
- Use of the system has grown steadily, with over 88 million images viewed by users in 2019 alone.

Bringing public health preparedness as an “all-hazards approach” to the point of care uniquely provides busy clinicians with a comprehensive resource for day-to-day use. While clinicians can use VisualDx for everyday problems such as medication reactions and common rashes, the system also has broad applicability to the public health mission, covering not only pandemic flu and bacterial and viral infections, including West Nile virus and other diseases of public health significance, but also sexually transmitted diseases, child abuse, methicillin-resistant *Staphylococcus aureus* (MRSA) infection, and infections in travelers and the immunocompromised patient.

VisualDx is the only system in which a user can search by symptoms, signs, geography, medical history, and more to see a structured differential diagnosis with images of typical and variant disease presentations. The application has evolved to include a machine learning/AI capability for skin rash and lesion analysis as well. There is special emphasis on presenting the variant presentations of disease as well as displaying how diseases present in people with dark skin. VisualDx dovetails directly with the trend toward point-of-care evidence and diagnostic accuracy as a patient safety issue.

We would be pleased to share references and more details on how VisualDx can augment medical decisions and bring reliability to a highly stressed medical environment.

A Call to Action

The United States needs a modern public health informatics infrastructure. Based on our experience supporting the CDC and state, city, and county health departments at the time of anthrax, we recommend the following immediately:

- 1. Bring public health into the clinical exam room to assist diagnosis and patient care.**
- 2. Prepare for everything: Emerging and re-emerging diseases as well as diseases of public health significance.**
- 3. Integrate public health alerting, reporting, and physician search surveillance for all infectious diseases.**

About VisualDx

VisualDx is an Internet-based secure system licensed only for professional use. The system operates in Internet Explorer, Firefox, Safari, and Google Chrome browsers with no need for any additional “plug-ins” or special software. It is fully functional on the iPad, iPhone, and the Android operating systems. The system integrates images from leading academic departments including University of California, Los Angeles, New York University, University of Rochester, and more. VisualDx is peer reviewed.

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