

Using an Intelligent Database for the Early Detection of Outbreaks

Jay A. Brown, MD, MPH; Tacoma, WA, USA; brownjay@haz-map.com

Methods

An intelligent database was envisioned as a map of the knowledge domain of all diseases that could present as outbreaks. The content would include emerging infectious diseases, bioterrorism, chemical weapons, occupational diseases, foodborne illnesses, zoonoses, and other communicable diseases. The system would include these features:

1. All information will be comprehensively collected by a physician;
2. All information will be systematically indexed using categories and a vocabulary that is structured and unambiguous;
3. All information will be stored in a computer-based relational database with a graphical user interface that will enable users to sort and filter hundreds of records instantaneously.



Knowledge Coupling

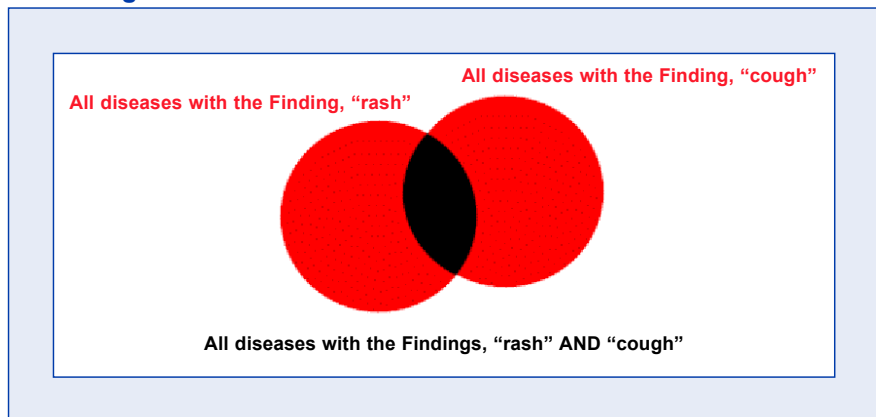
The explosion of medical knowledge
The limits of human memory
The need for specific information



Larry Weed has described the knowledge-coupling problem as the explosion of medical knowledge, the limits of human memory, and the need for easy access to the right information at the right time. Knowledge coupling is a problem in all fields of medicine, but especially in information-intensive fields such as toxicology and infectious diseases.

What Is an Intelligent Database?

Venn Diagram



OutbreakID™ is an example of an "intelligent database." The designer of an intelligent database selects all the relevant information in a particular knowledge domain and maps it using intelligent indexes and categories. It is a very labor-intensive activity to prepare the information for subsequent use by another health professional. The goal is to take advantage of the computer's infinite capacity to store information, and to make it as easy as possible for the health professional to access that information. There are no hidden algorithms operating in an intelligent database. A query results in a list or an intersection of lists. For example, show me all the diseases that have cough as a finding or show me all of the diseases that have cough AND rash as findings. You could do the sorting by hand, but the computer does it instantaneously.

What Is Zoom-Intersection?

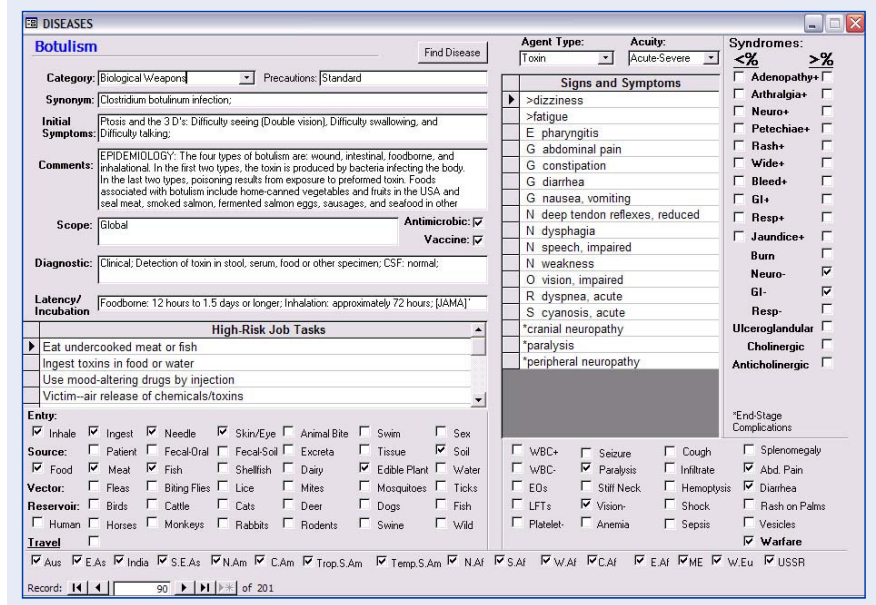
Zoom-intersection is an important concept for users of OutbreakID™. When two circles intersect as shown in the **Venn diagram** above, the area of intersection represents the results of a query for two criteria (an AND search). The idea is similar to finding a location on a map. If one street name is known, the search is narrowed to all addresses on that street. If both intersecting streets are known, the target is further narrowed down to just a few addresses.

OutbreakID™ was designed for zoom-intersection™. Two or three criteria are all you need for a query that will reduce the results list for more accurate differential diagnoses. **Table 1** shows some examples of important criteria to use in searches. An effective query will combine one or more criteria in one column with one or more criteria in a second column. Add an ENDEMIC criteria if you want to limit the search to a specific region of the world. If you are considering terrorism as a possibility, use "Victim-release of any warfare agent" and add one of the SYNDROMES or FINDINGS.

Table 1.

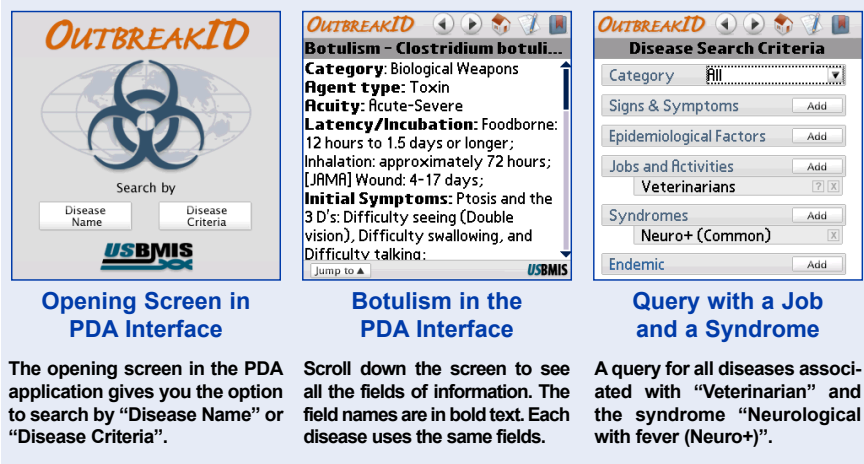
FINDINGS	EPIDEMIOLOGY	JOB	SYNDROMES	WARFARE
Abdominal pain	Inhale	Archaeologists	GI+	Victim-release of any warfare agent
Blood in stool	Ingest	Butchers	GI-	
Bradycardia	Needle	Child Caretakers	Neuro+	
Brain abscess	Animal bite	EMTs	Neuro-	
Conjunctivitis	Food	Farmers	Resp+	
Encephalitis	Water	Fire Fighters	Resp-	
Dyspnea, acute	Patient	Fishers	Rash+	
Eosinophilia	Fecal-oral	Family Doctors	Adenopathy+	
Hemoglobinuria	Biting flies	Foresters	Arthralgias+	
Jaundice	Fleas	Graders/Sorters	Bleeding+	
KFTs, abnormal	Mites	Hunters	Jaundice+	
LFTs, abnormal	Mosquitoes	Janitors	Petechiae+	
Pleural effusion	Ticks	Landscapers	Burn	
Pneumonia	Birds	Loggers	Ulceroglandular	
Proteinuria	Cattle	Microbiologists	Cholinergic	
Pus in stool	Dogs	RNs	Anticholinergic	
Rash on palms	Fish	Soldiers in field		
Seizure	Horses	Soldiers, billeted		
Sepsis	Human	Tree Trimmers		
Skin infection	Rodents	Veterinarians		
Stiff neck	Wildlife	Zoologists		

Access User Interface



The prototype application was developed in Microsoft Access. All information is bi-directional, i.e., the user can see all the symptoms associated with a disease or see all diseases associated with a symptom. The same structured vocabulary is used both to display information about a disease and to query the database.

PDA User Interface



Each disease profile shows initial symptoms, incubation period, signs and symptoms, and associated high-risk activities. For infectious diseases, the application shows where the disease occurs in the world; how it is diagnosed in the laboratory; its source from patients, water, soil, or animals; the route of entry; and the insect vectors and animal reservoirs. Of the 201 diseases, 156 are infectious diseases. Queries by one or more criteria are available for 135 findings, 17 syndromes, 102 jobs, 101 activities, 39 epidemiological factors, and 16 regions of the world.

Conclusion

An intelligent database is an effective tool for developing and updating a decision-support system. Such a system could help medical and public health professionals participate in the surveillance cycle for the early detection of outbreaks.