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

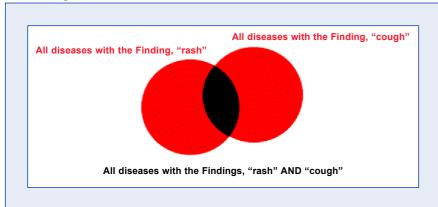
The explosion of medical knowledge The limits of human memory The need for specific information



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	JOBS	SYNDROMES	WARFARE
Abdominal pain	Inhale	Archeologists	GI+	Victimrelease
Blood in stool	Ingest	Butchers	GI-	of any warfare
Bradycardia	Needle	Child Caretakers	Neuro+	agent
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

Botulism	n Find Disease			Agent Type: Acuity:						Syndromes:								
Category:	Biological	Weapon	4	· F	recau	itions: Standa	rd				П		Signs	and Symp			Adenopathy	
Synonym:	ym: Clostridium botulinum infection;				•	>dizzi	ness			_	Arthralgia+							
	Ptosis and the 3 D's: Difficulty seeing (Double vision), Difficulty swallowing, and st; Difficulty talking;						Н	>fatigu	ryngiti				☐ Neuro+ ☐ Petechiae+ ☐ Bash+					
Comments:	EPIDEMIOLOGY: The four types of botulism are: wound, intestinal, foodborne, and s: inhalational. In the first two types, the town is produced by bacteria infecting the body. In the last two types, poscioning results from exposure to preformed tooin. Foods associated with botulism include home-canned vegetables and fruits in the USA and sea lineal. smoked salmon (fermented salmon each; seusages, and seadood in other							G abdominal pain G constipation G diarrhea G nausea, vomiting					☐ Wide+ ☐ ☐ Bleed+ ☐ ☐ GI+ ☐ ☐ Resp+ ☐ ☐ Jaundice+ ☐					
Scope:	, , , , , , , , , , , , , , , , , , , ,						N deep tendon reflexes, reduced N dysphagia N speech, impaired											
Diagnostic:	Diagnostic: Clinical; Detection of toxin in stool, serum, food or other specimen; CSF: normal;						N weakness O vision, impaired				=1	Burn □ Neuro- □						
Latency/ Incubation	Foodborn	e: 12 hou	rs to 1.5	days or long	er; In	halation: appr	oxim	ately 72 hours	; [J/	MA]	Е	R dys		acute acute			GI- Resp-	L
High-Risk Job Tasks					*cranial neuropathy						Ulceroglandula	. [
Eat underc										1100		*paraly					Cholinergic	Г
Ingest toxi												*periph	eral ne	europathy			Anticholinergic	Г
Use mood-																		
Victimair Entry: ☑ Inhale ☑					. r	Animal Bite	г	Swim	г	Sex							*End-Stage Complications	
	Patient		al-Oral	☐ Fecal-S ☐ Shellfish	a F	Excreta Dairy	ㅁ	Tissue Edible Plant	▽	Soil Water	Г	WBC+	L I	1 arayon	□ In	Cough nfiltrate	☐ Splenomeg ☑ Abd. Pain	aly
Source:	111001			Lice		Mites		Mosquitoes Doas		Ticks Fish		EOs LETs	_	Stiff Neck Vision-	L H	Hemoptysis		
	Fleas	☐ Bitin		□ Lice □ Cats	_	Deer											Rash on Pa	

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 guery the database.

PDA User Interface



PDA Interface

application gives you the option to search by "Disease Name" or

OUTBREAKID 🕙 🕑 🖏 🎉 🔳 Botulism - Clostridium botuli... Category: Biological Weapons Agent type: Toxin Acuity: Acute-Severe 12 hours to 1.5 days or longe Inhalation: approximately 72 hours; [JAMA] Wound: 4-17 days; Initial Symptoms: Ptosis and the 3 D's: Difficulty seeing (Double vision), Difficulty swallowing, and Difficult∨ talkina:

> Botulism in the PDA Interface

The opening screen in the PDA Scroll down the screen to see all the fields of information. The field names are in bold text. Each disease uses the same fields.



Query with a Job and a Syndrome

A query for all diseases associated with "Veterinarian" and the syndrome "Neurological with fever (Neuro+)".

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.