Science of Surge
Medical Response Capability

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PACER Surge Research and Initiatives

- Theoretical Constructs
- Analysis/Critique of knowledge
- Modeling and Simulation
- Applet Development
- Clinical Experimentation to Augment Surge

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Why Study Surge Capacity

- One of 37 associated target capabilities of the Nat Prep Goals
- HSPD 21 major focus
- IOM Major Focus
- DHS JAWG Major Focus

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Medical Surge Areas to Study

Surge Area	Literature
Health System	++++++
Public Health	++
Community	+
First Responder	+
Supply Chain Dynamics	+++++
Morgue	o
Specialty Service (PC)	o
Communications	+++
COOP	+++++

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Surge Capacity Definition

- Webster's: "…rise suddenly to an excessive or abnormal value"
- Health Care system's ability to expand quickly to meet an increased demand for medical care in the event of bioterrorism or other large-scale public health emergency (AHRQ)
- Components necessary to care for sudden…increase in patient volume that exceeds current capacity. (Shultz and Koenig)
- Additional capacity to deal with sudden unexpected upturns in demand (D. Hafling)
- Ability to provide adequate medical [resources] during events that exceed the limits of normal infrastructure of an affected community (Barbera and Macintyre)
- Ability to manage sudden, unexpected increase…severely challenge or exceed current capacity…. (Hick AEM 2004; 253)

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Surge Capacity Definition

- : "…rise suddenly to an excessive or abnormal value
- ability to expand increased demand
- Components necessary increase in patient volume exceeds capacity
- Additional capacity unexpected
- adequate exceed infrastructure affected community)
- manage sudden unexpected severely challenge

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Hospital Preparedness Measures

Dimensions of Preparedness Measured By Surveys

Dimension	NCHS	AHRQ	GAO	APIC	JCAHO	CDC/ NPS	CDC/ SV
Response Plan	√	√	√	√	√		√
Surge Capacity	√	√	√	√	√		
Incident Mgmt	√	√		√	√	√	
Educ & Training	√	√	√	√		√	√
Surveillance		√		√	√	√	
Communications			√	√		√	√
Security			√	√		√	√
Logistics				√		√	
Integration in CEP	√	√	√	√	√	√	

Hospital Preparedness Measures

Characteristics of Existing Surveys

Instrument & Purpose	Developer	Type	Target	Items	Mode
BT & MC Preparedness	NCHS	Generic	Hospital	83	Self
BT Preparedness	AHRQ	Generic	HC facility	213	Self
BT Preparedness	GAO	Generic	Hospital	?	Self
MC Checklist	APIC	Generic	HC facility	252	Self
Hospital Integration	JCAHO	Generic	Hospital	57	Self
NPS Preparedness	CDC	NPS specific	Pub Health	125	Self
Smallpox Vaccination	CDC	Incident specific	Pub Health	36	Self

Measuring Surge Capacity

- The Joint Commission (JCAHO)

  have urged

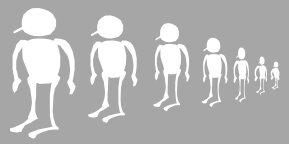
  ". . . an agreed-upon set of units, or measures, of surge capacity at the federal level or, at the very least, at the state level . . ." for facility-based surge capacity

Health care at the crossroads: strategies for creating and sustaining community-wide emergency preparedness systems. Joint Commission on Accreditation of Healthcare Organizations: 20(http://www.jcaho.org/about+us/ public+policy+initiatives/emergency_preparedness.pdf

Conceptual Framework

EMS Patients

Self-Reporting



Bottleneck

Emergency Department

Hospital

Finite Capacity

Discharges to Home

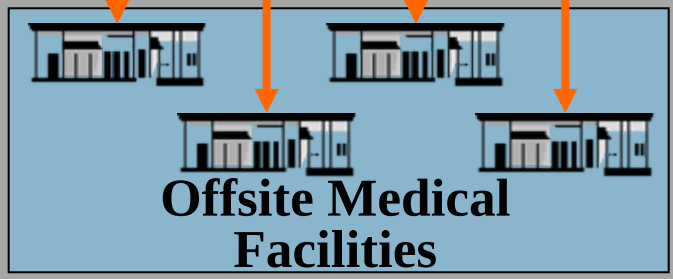
Discharges to Home Care

Transfers to Other Facilities

Cancel Electives

Creative Bed Solutions

Inpatient Surge Capacity



Outpatient Surge Capacity

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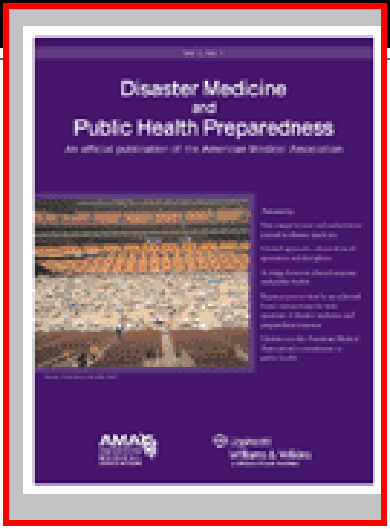
Surge Capacity



What are the Components of Medical Surge Capacity

System	Space	Staff	Supplies
Planning	Facilities	Numbers	Biologics
Community Infrastructure	Medical Care	Capability/Skill Set	Respirators
Government	Storage	Expertise	PPE
Informal Networks	Laboratory	Stamina	Standard Supplies
Public Health	Mortuary	Psyche	Food and Water
Incident Command	Housing of Staff		
All Levels			
HEIC	Quality		
Regional Co-operation	Size		
Multiagency	Capability		
Interhealth System			
Communications & Information Flow			
Supply Chain Distribution			
EMS/First Responders			
Continuity of Operations			
Cyber Security			

Challenge: To determine key elements and means to measure

(Kelen & McCarthy, AEMJ: 13:1089-)

How is Surge Related to Capacity

- Surge: ≈ Volume*Time*Complexity (R. Claypool)
  - Volume Rate, Time, Resource Demand
- Capacity: System, Space, Staff, Stuff
  - (Barbish)
- Response Capability (relates the two)
  - (Kelen & McCarthy)

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Figure 1. Functional Relationship of *Surge Response Capability* to *Surge Capacity* and *Surge*

$$\textbf{Surge Response Capability} = \textbf{Planning} * \frac{\textbf{Maximized Available Resources}}{\textbf{Resource Demand}}$$

$$= \textbf{Planning} * \frac{\textbf{Surge Capacity}}{\textbf{Surge}}$$

$$= \textbf{Planning} * \frac{\textbf{System}_{(\text{Integrity})} * \textbf{Space}_{(\text{size} * \text{quality})} * \textbf{Staff}_{(\text{numbers} * \text{skill})} * \textbf{Supplies}_{(\text{volume} * \text{quality})}}{\textbf{Event}_{(\text{type} * \text{scale} * \text{duration})} * \textbf{Resource}_{(\text{demand} * [\text{consumption} + \text{degradation}])}}$$

Note that *Planning*, which is actually a *System* component, is shown as a major variable to emphasize its importance.

(Kelen & McCarthy, AEMJ: 13:1089-)

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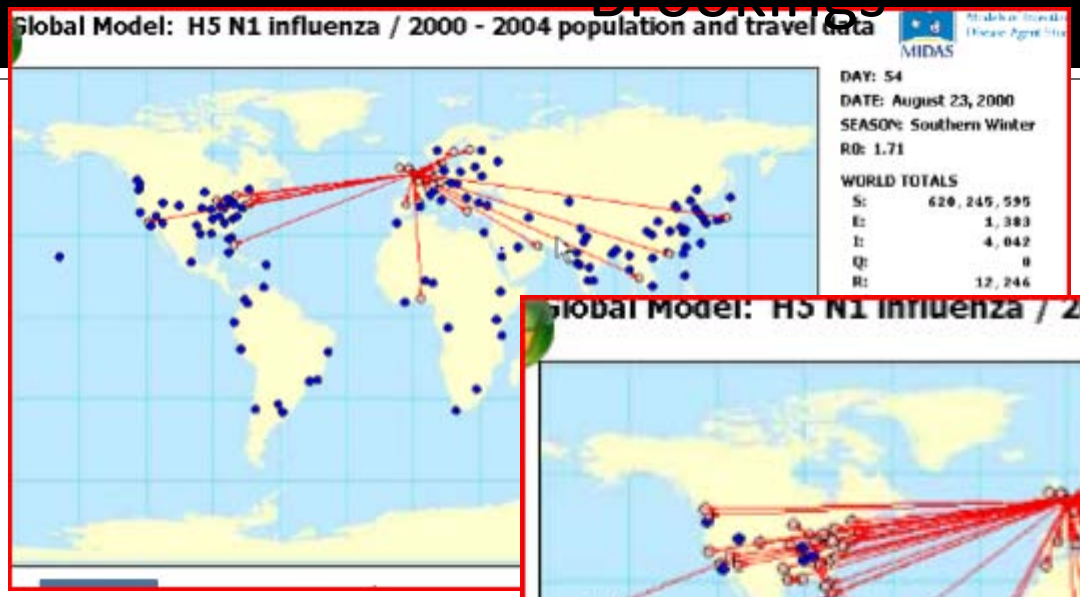
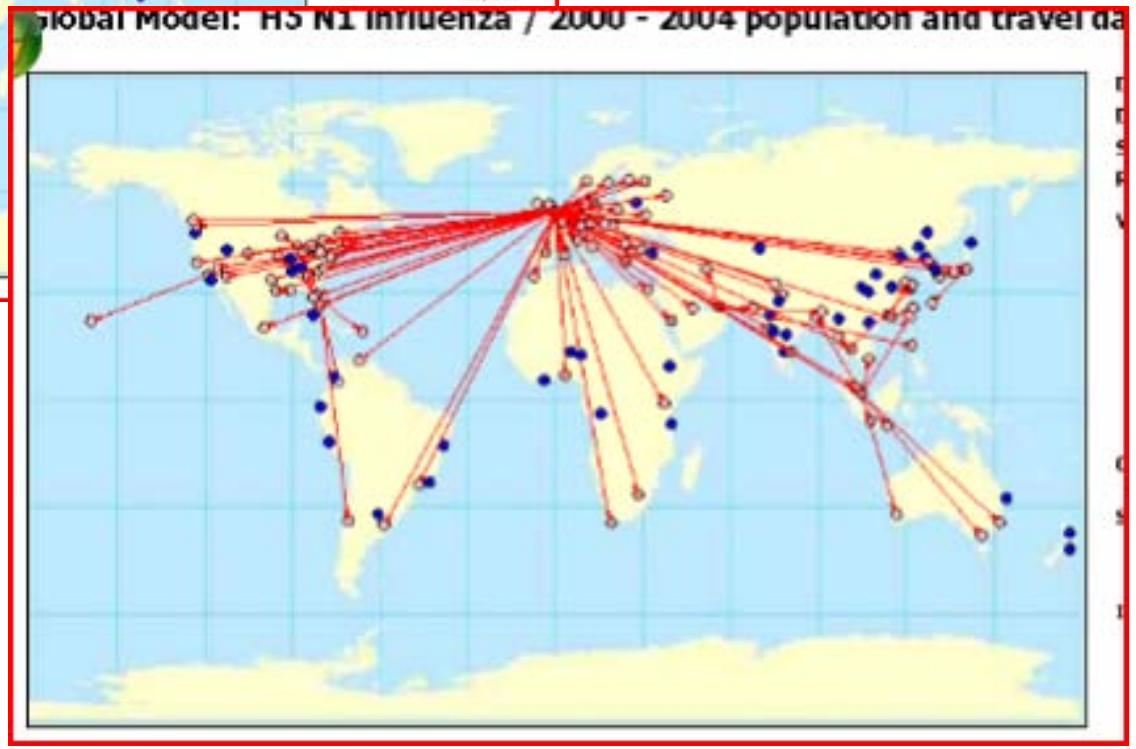
World Surge Model

BROOKINGS





J. Epstein, Brookings Inst.

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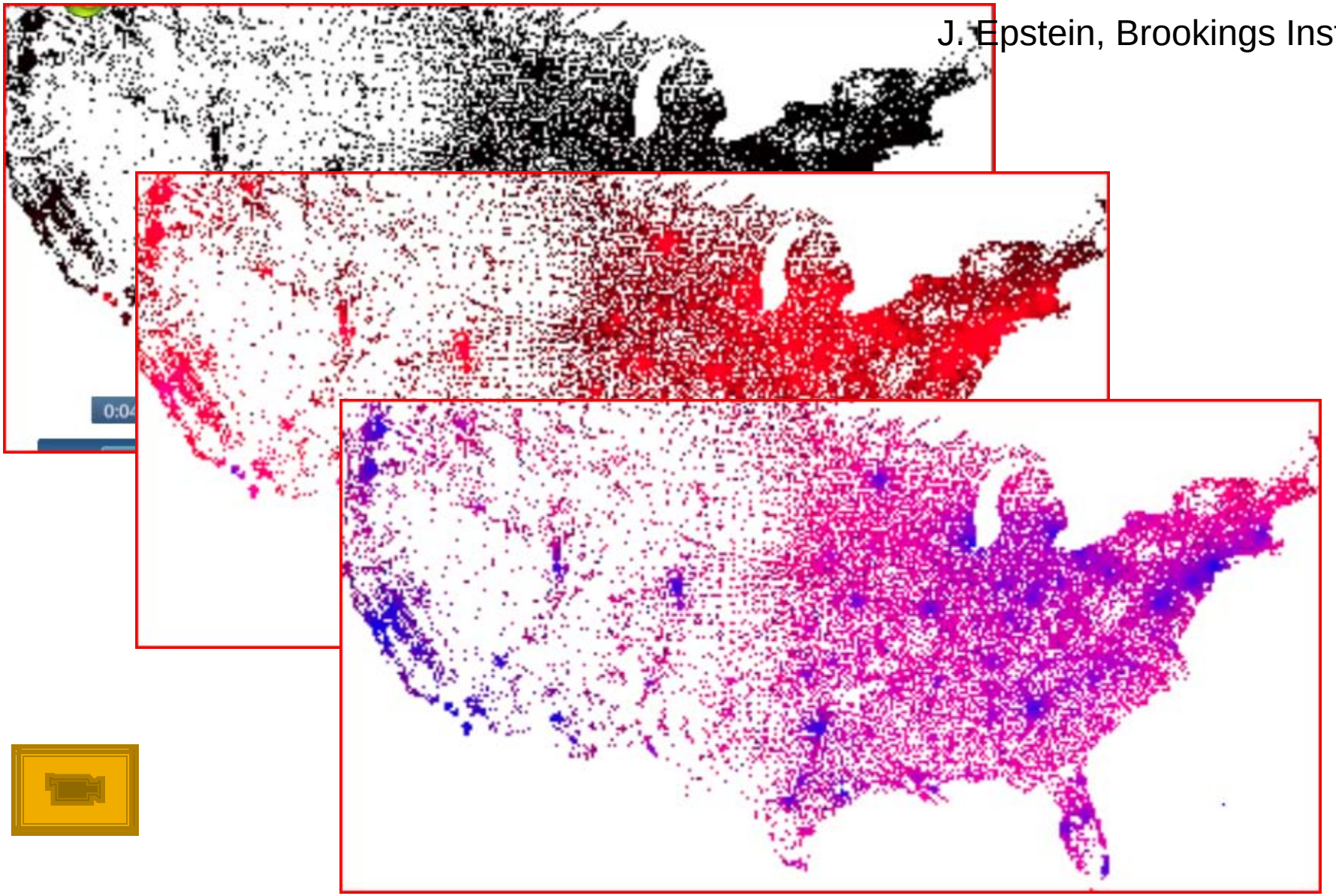
300 Million Agent Based Biothreat Modelling

J. Epstein, Brookings Inst.



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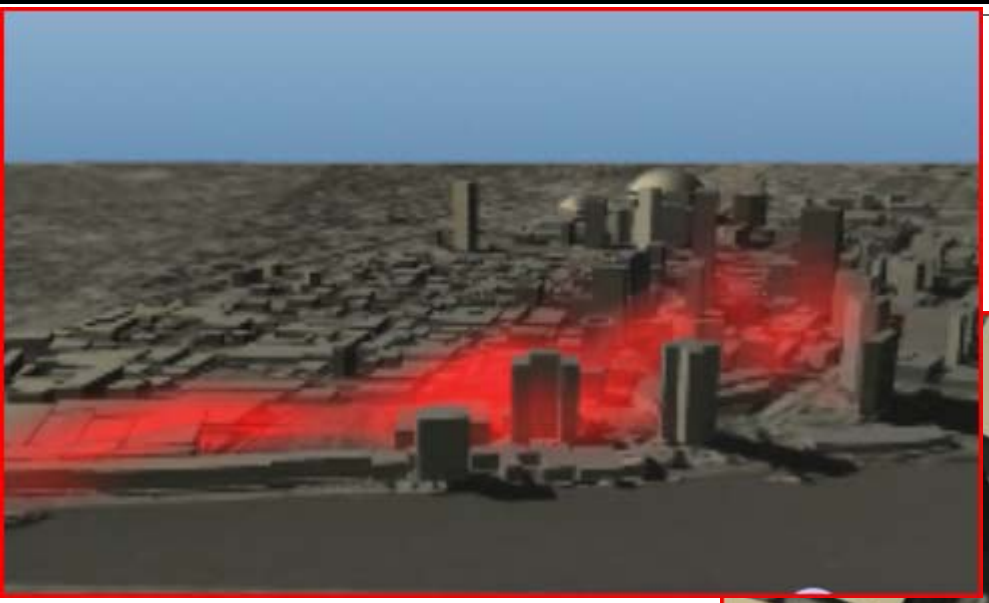
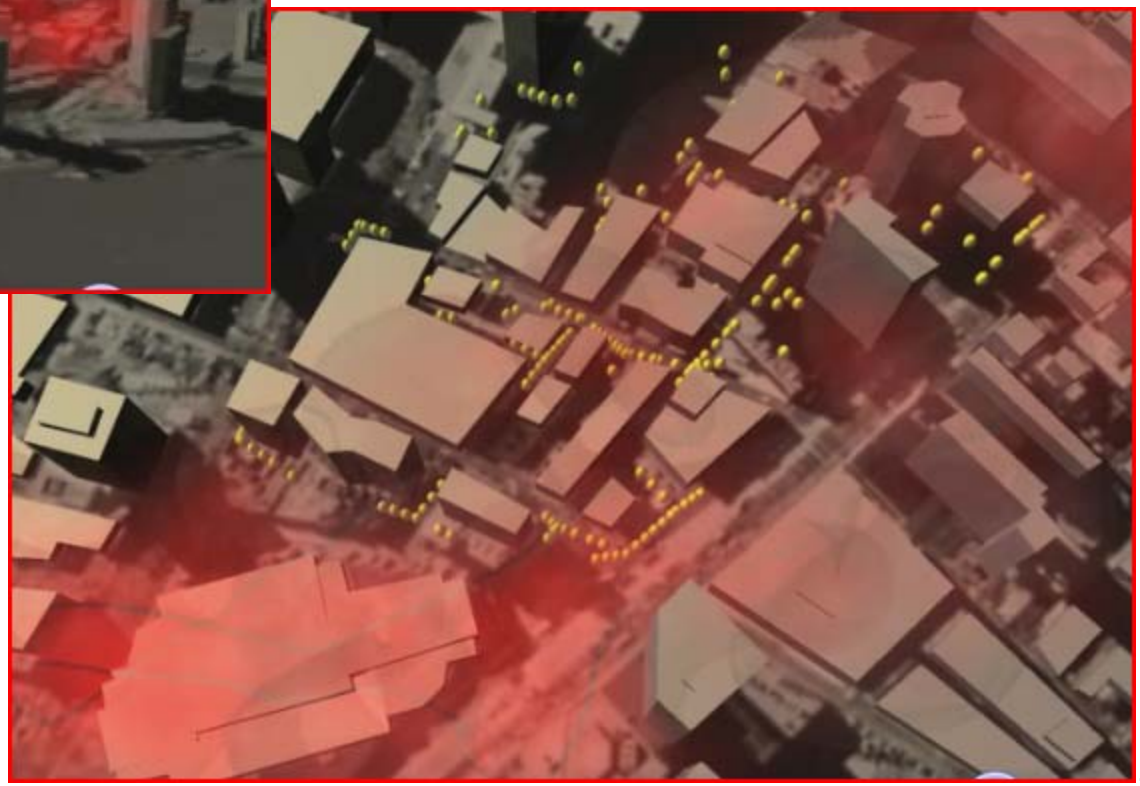
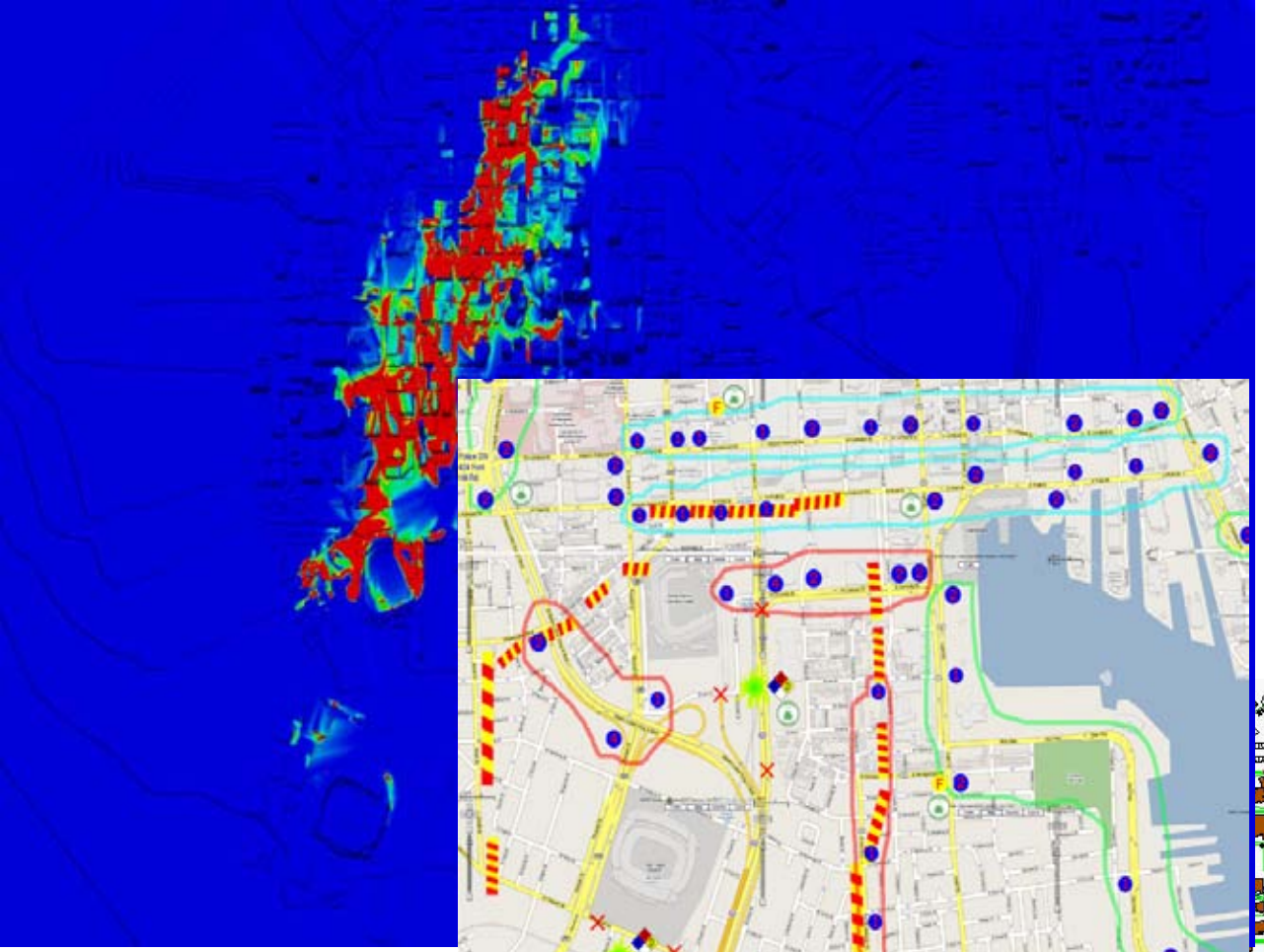
Plume Model Surge

J. Epstein; Brookings
B. Soni: UAB







J Coolahan (JHU-APL)
Bharat Soni (UAB)
Group @ FAMU and FAU

Hazard ID

Chemical Sensor

Incident Command Post

Police Department

Fire Department

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Reverse Triage to Increase Medical Capacity

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Conceptual Work: Consensus Discharge Criteria

Risk of consequential medical event	Basis	Mean upper limit of tolerance for consequential medical events (IQR)
1 (minimim)	Minimum to no anticipated medical events during next 72 h	3·8% (2–5)
2 (low)	Calculated risk of non-fatal medical event. Transfer to low acuity facility appropriate. Consider early discharge when effects of disaster exceed risks of remaining in hospital—eg, risk of biothreat transmission, effects of resource constraints	11·7% (8–15)
3 (moderate)	Consequential medical event quite likely without critical intervention Discharge to home not advisable Transfer to facility of moderate capabilities appropriate	33·1% (25–50)
4 (high)	Patient care cannot be interrupted without virtually assured morbidity or mortality. Highly skilled care required Transfer to major acute-care facility only	61% (45–80)
5 (very high)	Patient cannot be moved or readily transferred Generally unstable for transport Consider ICU-capable transport only	92·3% (95–100)

ICU=intensive-care unit.

Table 1: Consensus disposition classification and tolerance for rate of consequential medical e

Kelen: Lancet 2006;368:1984-90

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Discharge Criteria for Hospital Surge

- 3 Hospital System
- 1680 beds
- Random Selection of 50 units
- Followed for 3d for CI

	Number who voted	Withdraw* (1–10)
CPR or defibrillation	27	10 (10–10)
Intubation or airway management	27	10 (10–10)
Major surgical procedure or operation	26	9 (8–9)
Caesarean section	27	9 (9–10)
Intravenous drugs; pressors; fluids	27	8 (8–9)
Oxygen dependent	27	8 (7–9)
Burn care	27	8 (7–9)
Cerebral bolt	27	8 (7–10)
Dialysis	27	7 (6–9)
Thoracostomy	27	7 (6–8)
Non-invasive PPV	27	7 (7–9)
Thrombolytic therapy	27	7 (6–8)
Transfusion	27	6 (5–7)
Other invasive procedure	27	6 (5–8)
Psychiatric monitoring	27	6 (4–8)
Cardiac catheterisation	27	6 (4–7)
Thoracentesis	27	5 (4–7)
Wound care	27	5 (4–5)
Central line	27	5 (3–5)
Incision and drainage	27	5 (4–7)
Parenteral nutrition	27	5 (3–5)
Paracentesis	27	5 (3–6)
Vaginal delivery	27	5 (3–8)
Arterial line	27	4 (2–3)
Lumbar puncture	27	4 (2–5)
Cardiac monitoring	27	3 (2–4)
Parenteral pain medication	27	3 (3–4)
Support for ADLs	27	3 (2–4)

Kelen: Lancet 2006;368:1984-90

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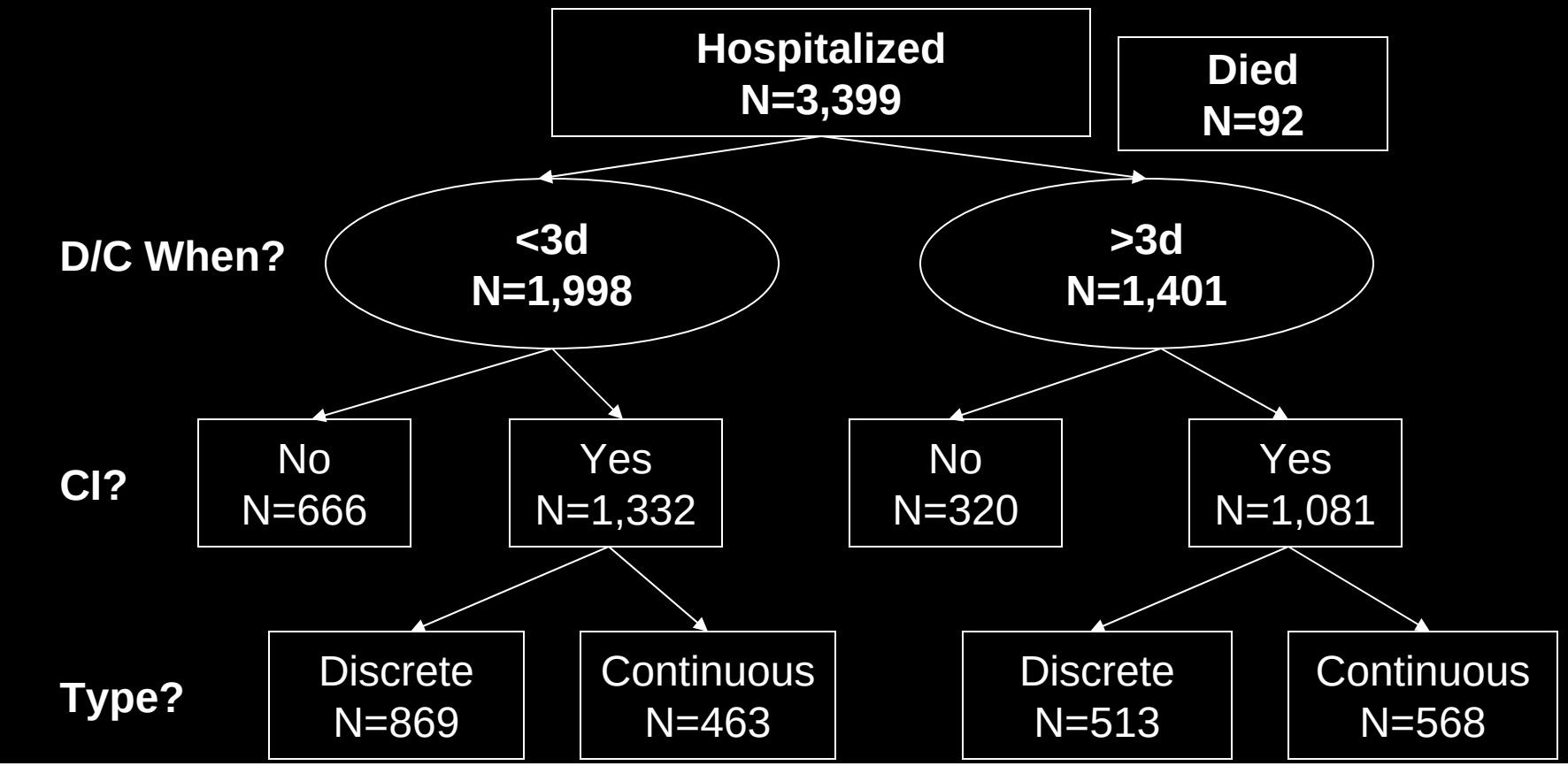
Figure 1. Critical Intervention & Discharge Status of Subjects



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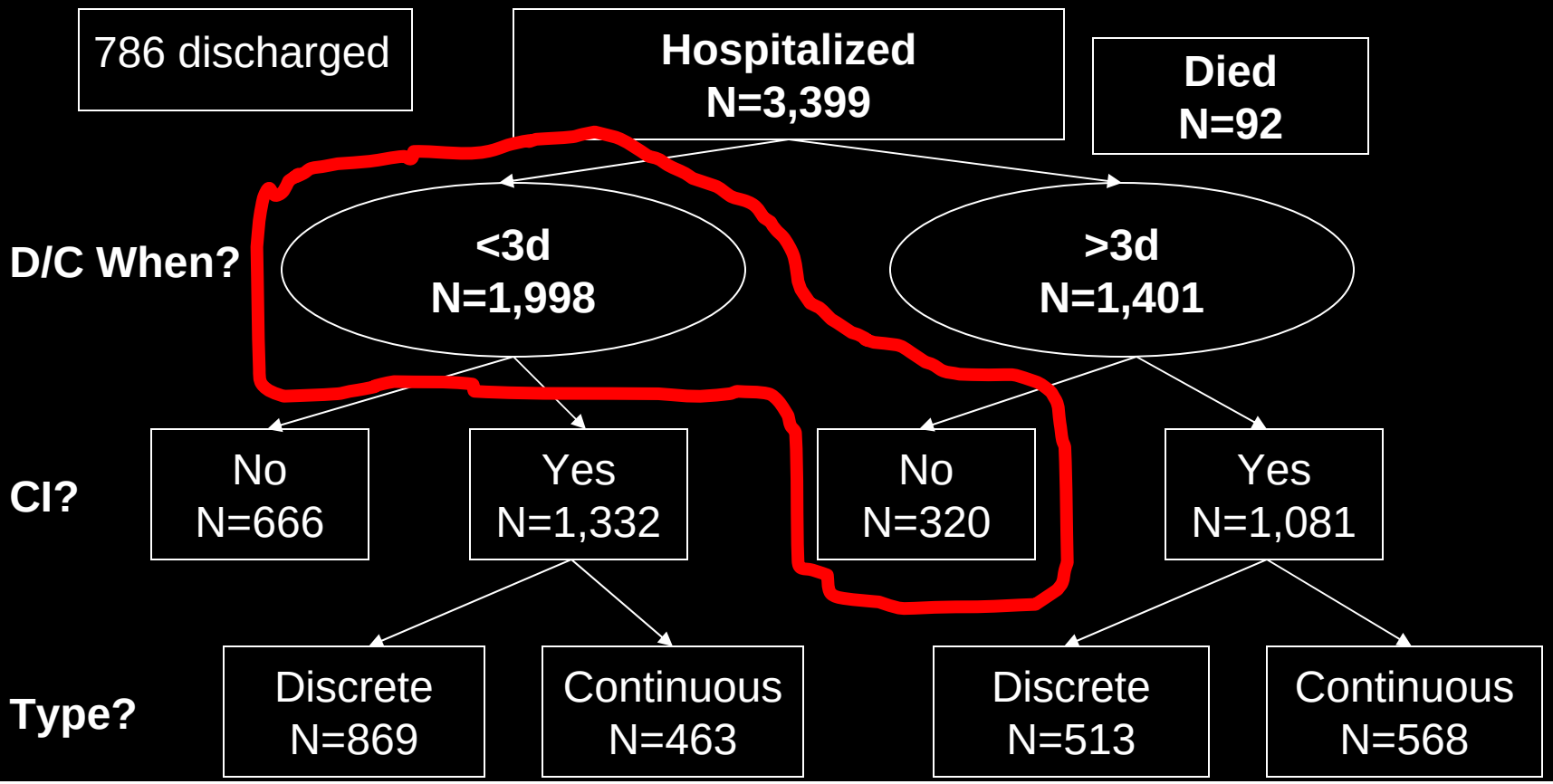

Estimate: 70% beds <72 hrs

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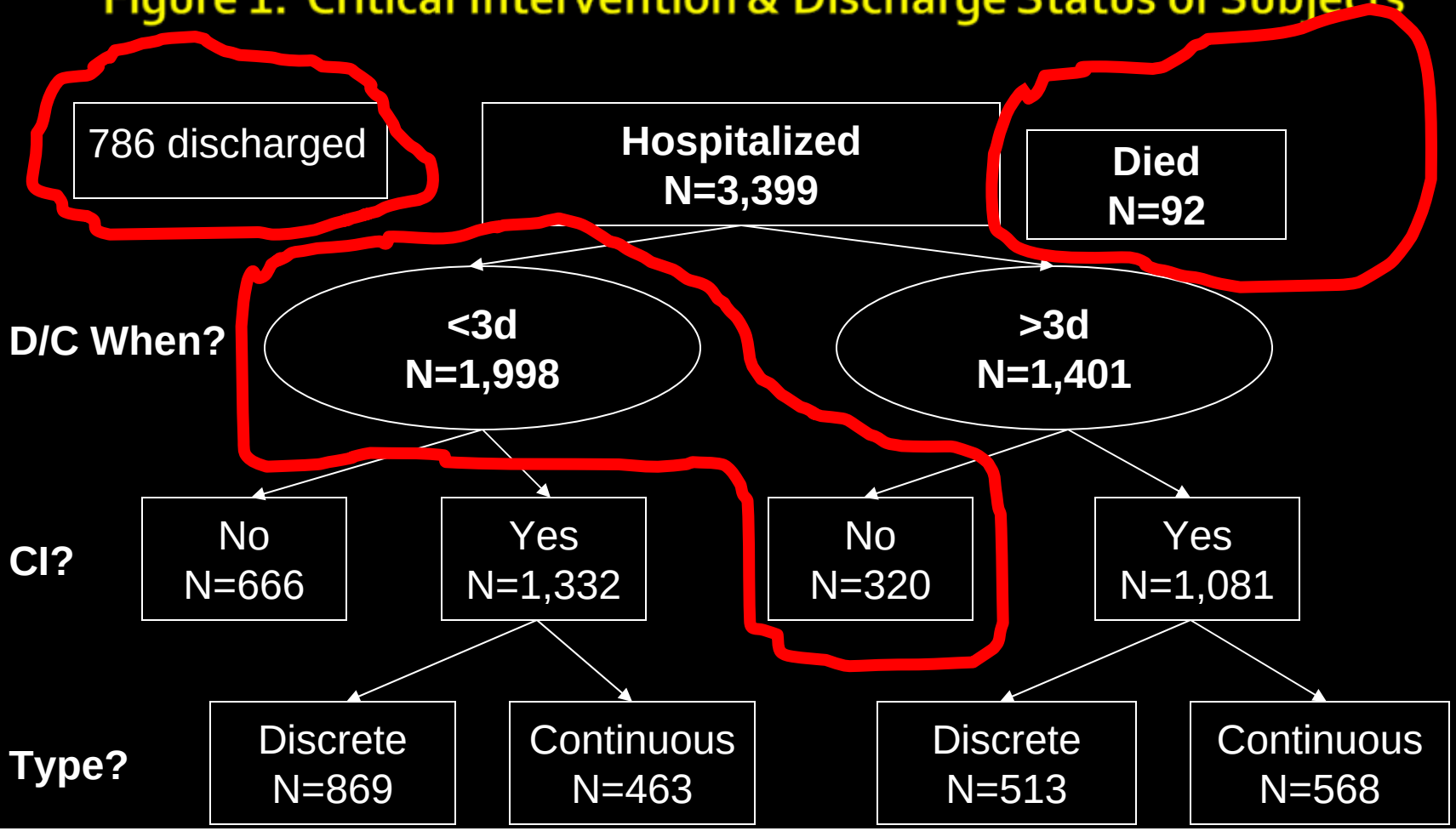

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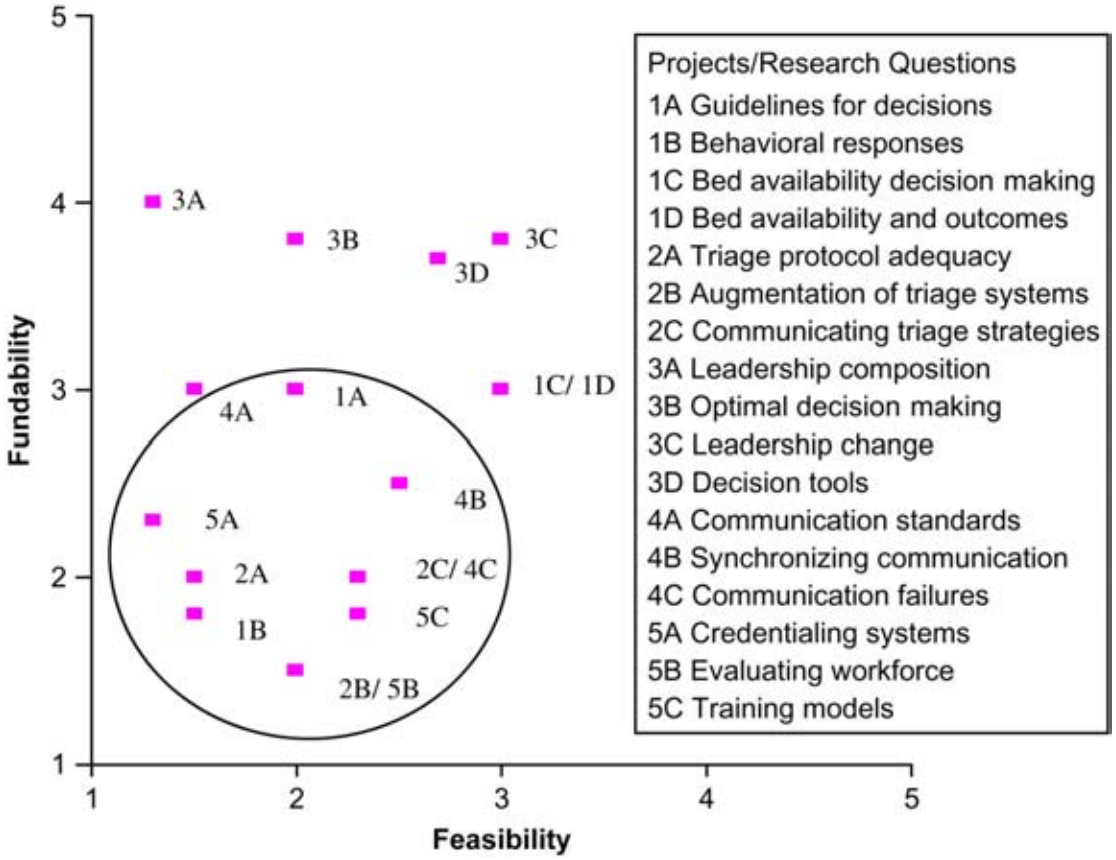
What needs to be studied



SAEM Consensus Conference, May 2006

Rothman, AEMJ 13:1160-68

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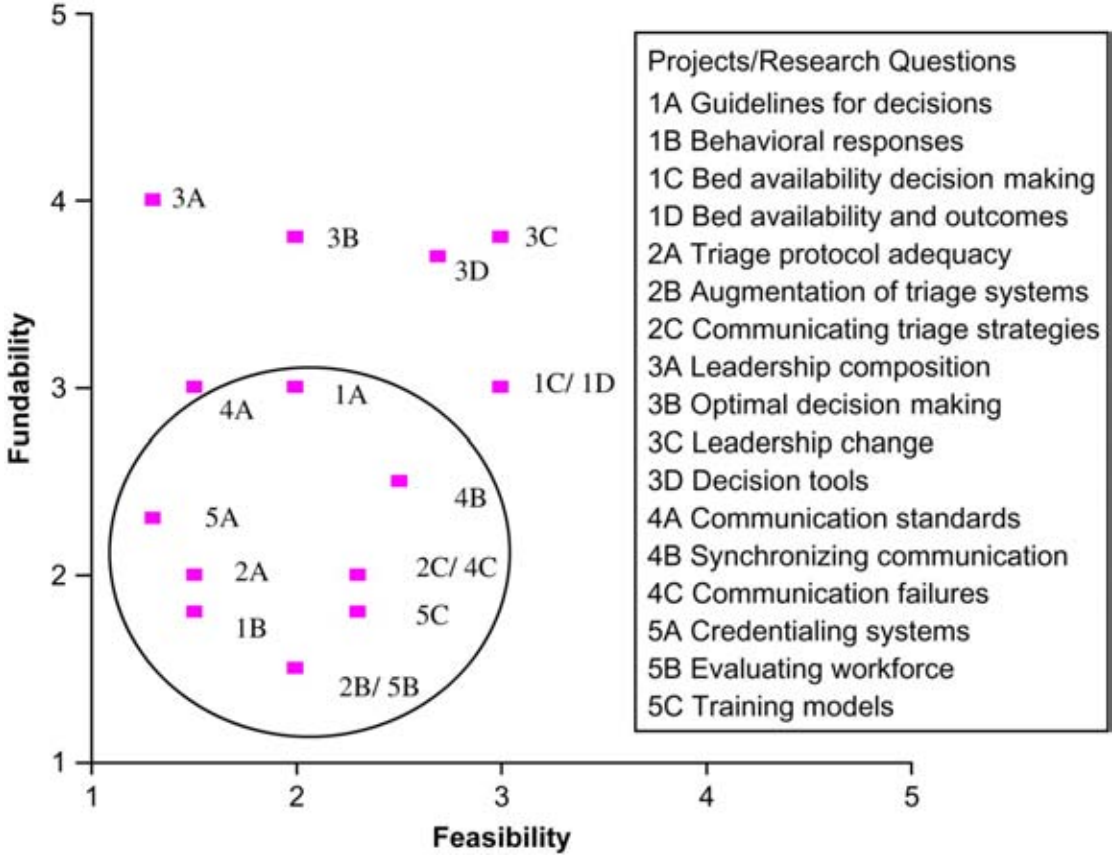
What needs to be studied



- My Opinion
  - Metrics
  - Situation Awareness
  - Supply Chain
  - Altered Stds of Care
  - COOP
  - Evacuation

Rothman, AEMJ 13:1160-68

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