Predictive Models for Chem-Bio Human Response, Casualty Estimation and Patient Loads

Chem-Bio Information Systems 2005

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Gene McClellan, Karen Cheng, and Jason Rodriguez

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APPLIED RESEARCH ASSOCIATES, INC.

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Topic Outline

- Human response / human performance – historical foundation
- Casualty estimation
- Patient loads
- Applications
  - NBC Casualty and Resource Estimation Support Tool (NBC CREST)
  - Consequence Assessment Tool Set (CATS)
  - Joint Operational Effects Federation (JOEF)

DTRA Developed the Methodology for NBC Effects on Human Performance

- Intermediate Dose Program, **1981...**
  - Battlefield impact of acute radiation sickness
  - *illness* → *symptoms* → *performance*
  - Performance degradation = task time extension
- Human Response Program, **late '80s**
  - Individual → Crew/Unit Degradation
  - Nuclear combined injury, psychological effects …
  - Combined Human Response Nuclear Effects Model (CHRNEM)
  - Protracted radiation doses

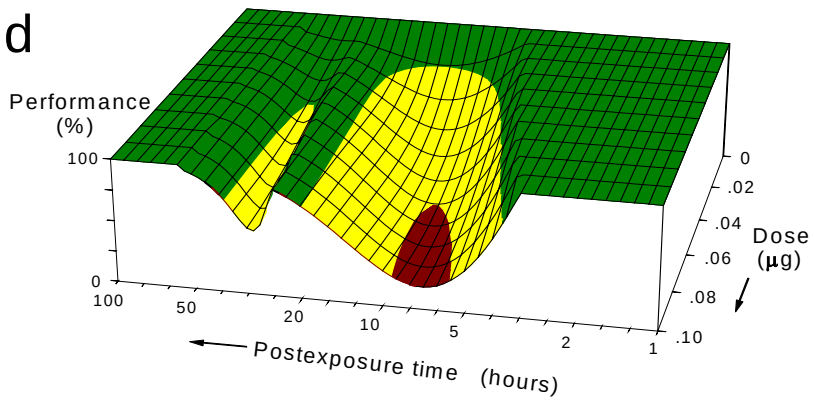
DTRA

DSWA
DEFENSE SPECIAL WEAPONS AGENCY

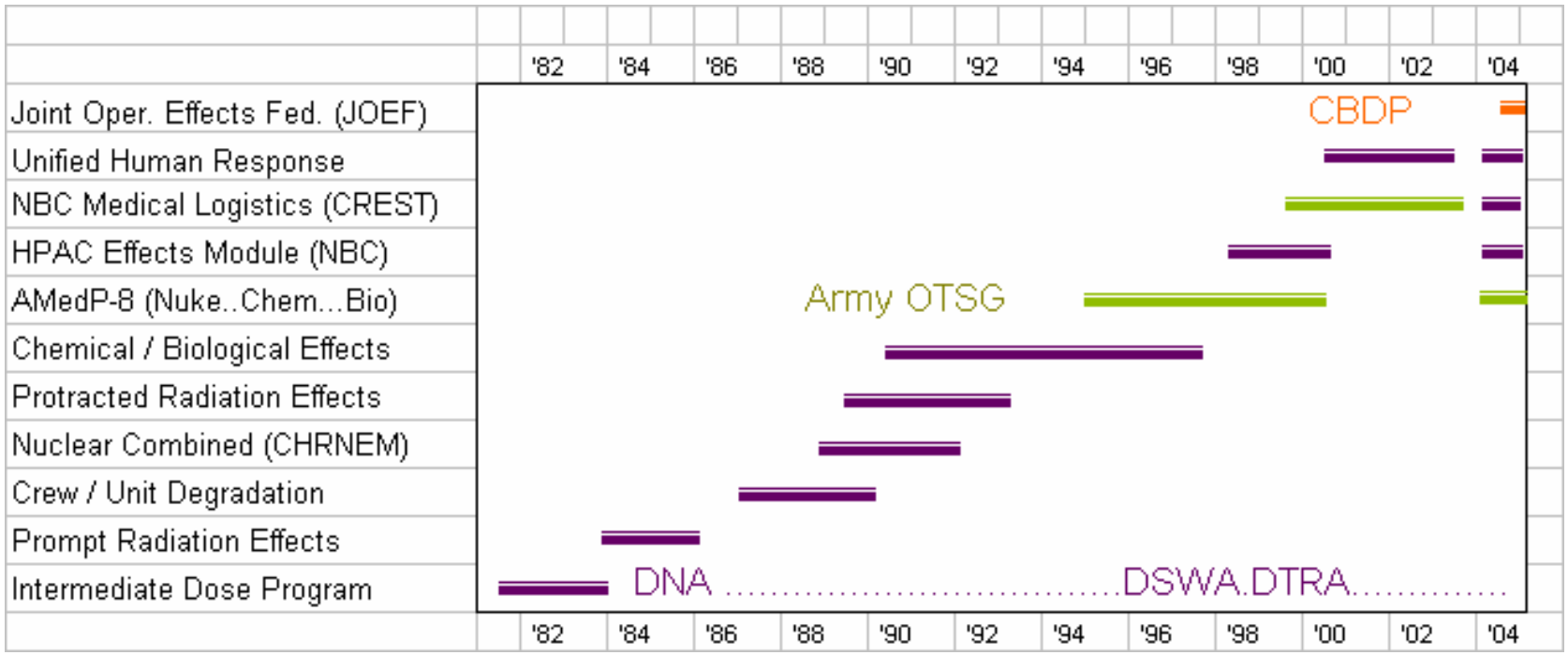
dna
Defense Nuclear Agency

Developments Continued into the '90s

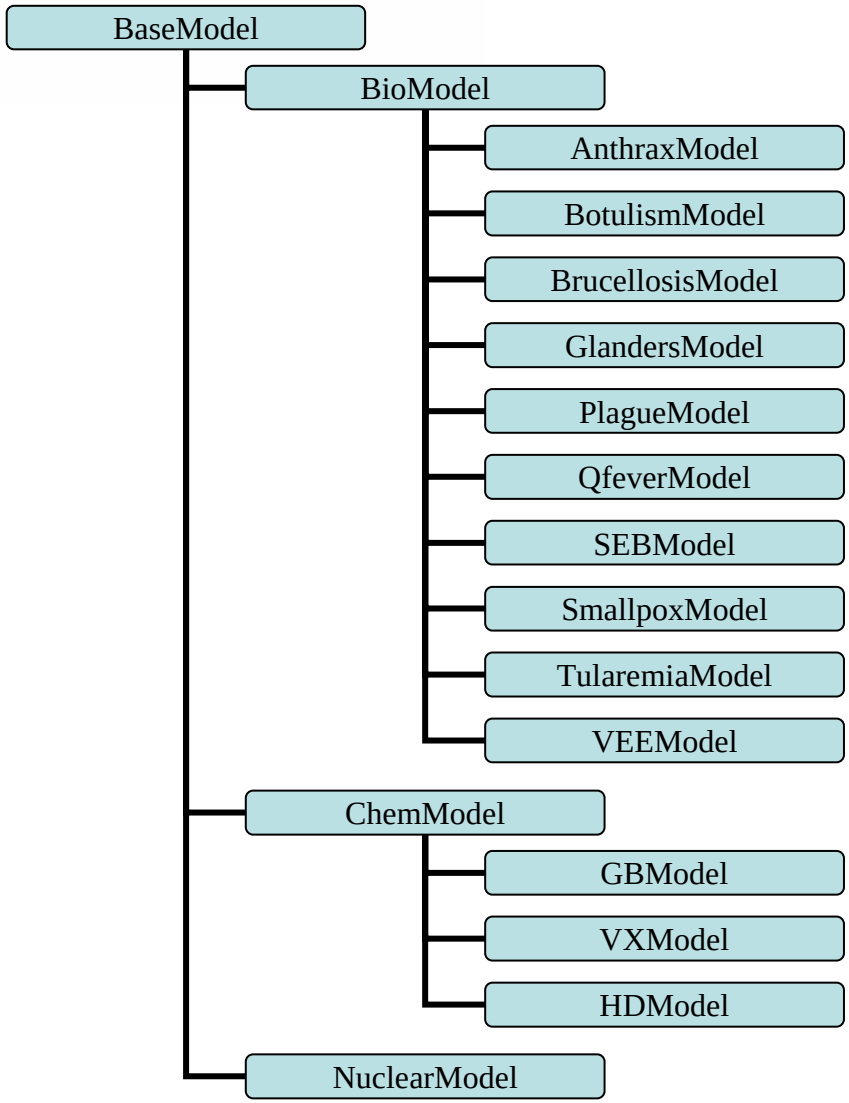
- Radiation Risk/Safety Program
  - Radiation-Induced Performance Decrement (RIPD) software
  - Extend methodology to chemical agents and kinetic injury
  - Performance impact of individual protective gear
- NBC Consequence Assessment Program
  - biological agents
  - CENTCOM interest in port and airfield operations after NBC attack
- Human effects modules including casualty estimation for the Hazard Prediction and Assessment Capability (HPAC)



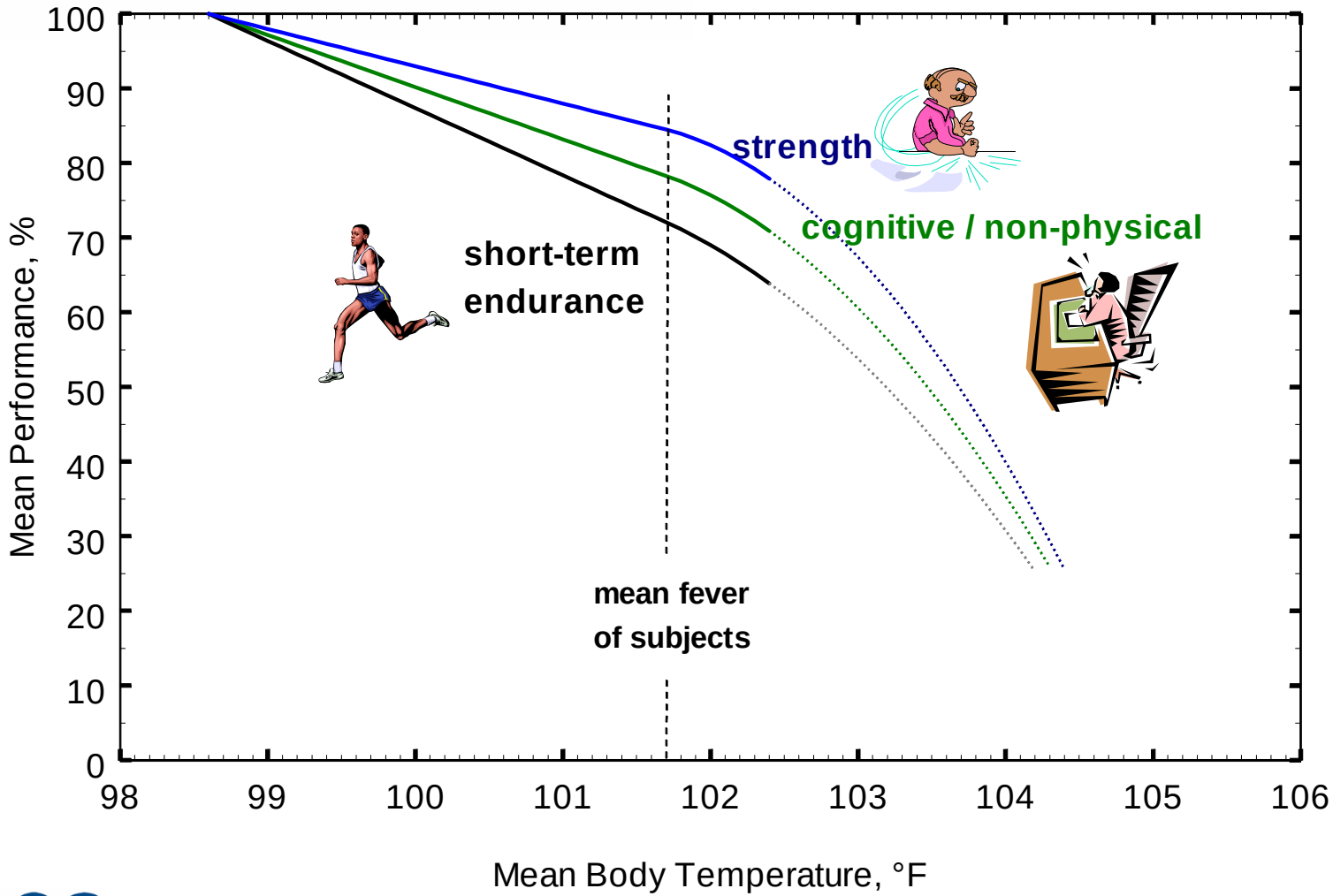
DTRA Foundation for CBRN Health Effects is Widely Applied



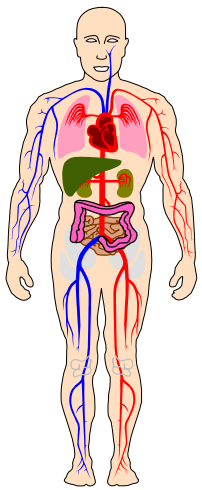
Human Response: Object-Oriented Design for the CBRN Effects Module



Performance Impact of Short-Term Febrile Illness Based on Clinical Data



Casualty Estimation is Based on NATO AMedP-8 Methodology

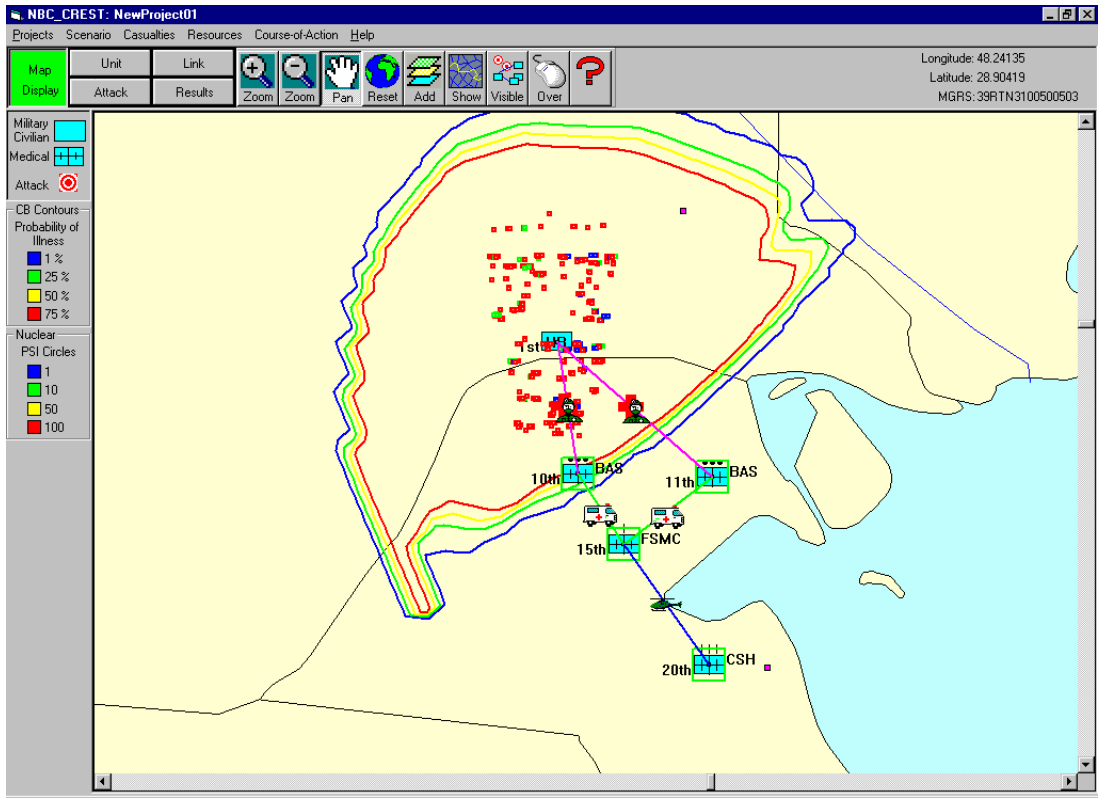


- Sign/symptom (S/S) severity profiles based on time- & dose-dependent descriptions of human response
- S/S severity profiles are used to determine performance degradation
- Performance (P) degradation calculations are used to estimate casualties (i.e. operational casualties, $P \leq 0.25$)
- US (OTSG) is the NATO custodian
- N, B, and C volumes ratified by NATO in Feb 01

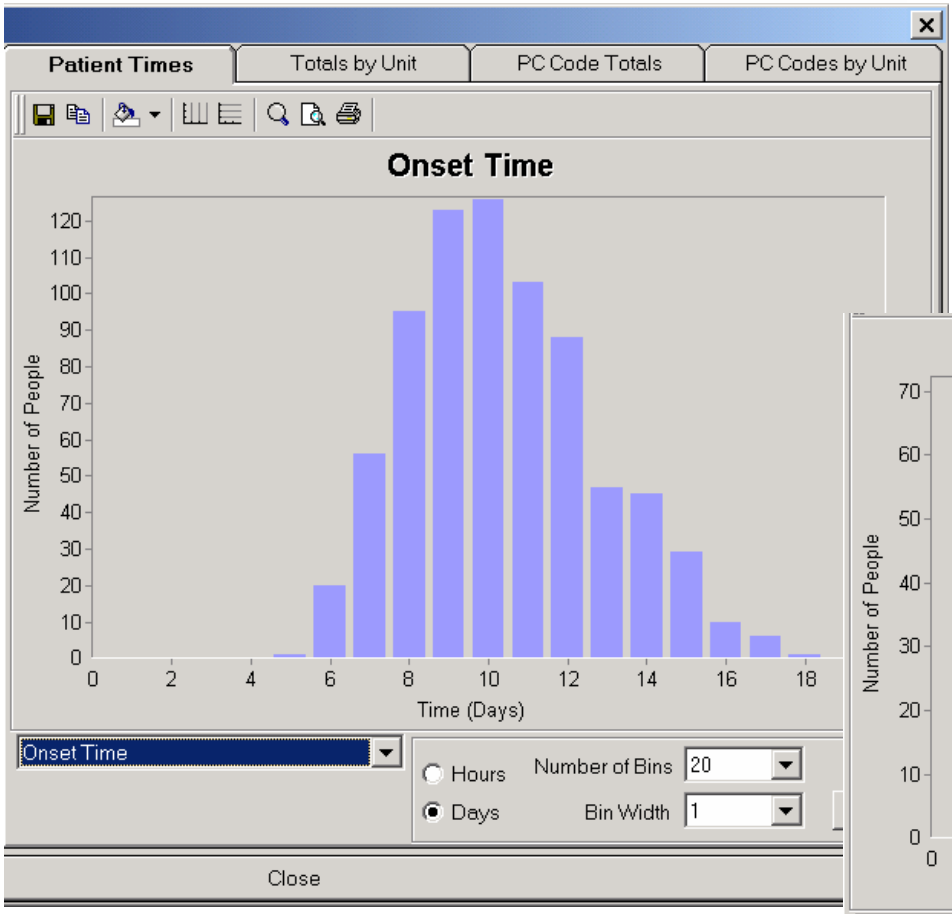
Allied Medical Publication 8 (AMedP-8): *Medical Planning Guide for the Estimation of NBC Battle Casualties, Three Volumes, N, B and C.*

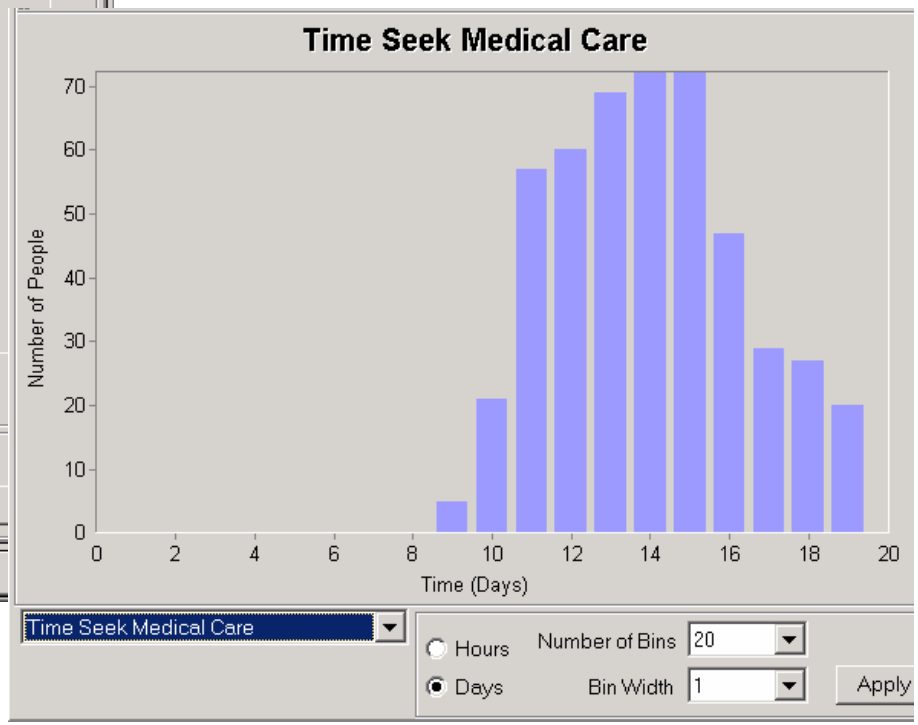
NBC CREST Casualty Estimation Module Uses AMedP-8 Methodology in User-defined Scenarios

- Planner defines the NBC casualty/attack scenario in accordance with current threat assessment and operational requirements
- Positions units or population on a map
- Adds network of Medical Treatment Facilities (MTFs)
- Chooses attacks
- Calculates casualties
- Saves patient stream



Patient Loads: Smallpox Model Illustrates Time-phasing of Illness





The Defense Medical Standardization Board (DMSB) Defines *Patient Condition* (PC) Codes

Example: PCs for Nerve Agent Exposure

Code	*Patient Condition*
382	Nerve Agent Vapor Only (Inhalation) Mild
383	Nerve Agent Vapor Moderate
384	Nerve Agent Vapor Severe
385	Nerve Agent Liquid Mild
386	Nerve Agent Liquid Moderate
387	Nerve Agent Liquid Moderately Severe
388	Nerve Agent Liquid Severe

DMSB Treatment Brief for VX Exposure

PC 385 -- Nerve Agent Liquid Mild

ECHELON 1A

Assumptions: 100% ambulatory. Focal areas of sweating and muscle fasciculations in areas exposed to liquid agent, but no skin irritation. No significant systemic symptoms and no miosis, hyperemia, eye pain, or headache are present. Personal decontamination should be performed in exposed areas. Local symptoms are likely to progress and systemic symptoms will develop if skin was not adequately decontaminated promptly (within 2-3 minutes), and progression of symptoms may continue for up to 18 hours.

Treatment: One Mark I kit immediately from patient's supply. Check decontamination of exposed areas if not already done. Evacuate 100% to echelon 1B.

ECHELON 1B

Assumptions: 100% ambulatory. 100% decontaminated prior to medical treatment. Focal areas of sweating and muscle fasciculations in areas exposed to liquid agent, but will not have skin irritation. No significant systemic symptoms and no miosis, hyperemia, eye pain, or headache are present. Signs and symptoms are likely to progress if skin was not adequately decontaminated promptly (within 2-3 minutes), and progression may continue for up to 18 hours.

Treatment: VS, pulmonary examination. One to two Mark I kits from patient's supply as clinically indicated if systemic effects of nerve agent recur. 100% evacuate to echelon 2.

ECHELON 2

Assumptions: 100% ambulatory and decontaminated. Focal areas of sweating and muscle fasciculations in areas exposed to liquid agent, but will not have skin irritation. No significant systemic symptoms and no miosis, hyperemia, eye pain, or headache are present. Mild systemic manifestations (nausea, vomiting, and stomach cramps) have begun because of effects of absorbed agent.

Treatment: VS, pulmonary examination. Start IV(1%). Observation for up to 24 hours with further Mark I (use patient's supply first) or atropine treatment IM (30%) or IV (1%). RTD 100%.

Patient Conditions for VX are Affected by Both Vapor and Liquid Exposure

(Dosage levels in mg-min/m^3, deposition in mg/m^2.)

GB (use vapor dosage levels)

0.25 ≤ dosage < 6 then PC 382
6 ≤ dosage < 30 then PC 383
30 ≤ dosage then PC 384

VX (decide if greater proportion of effective dose is vapor dosage or liquid deposition)

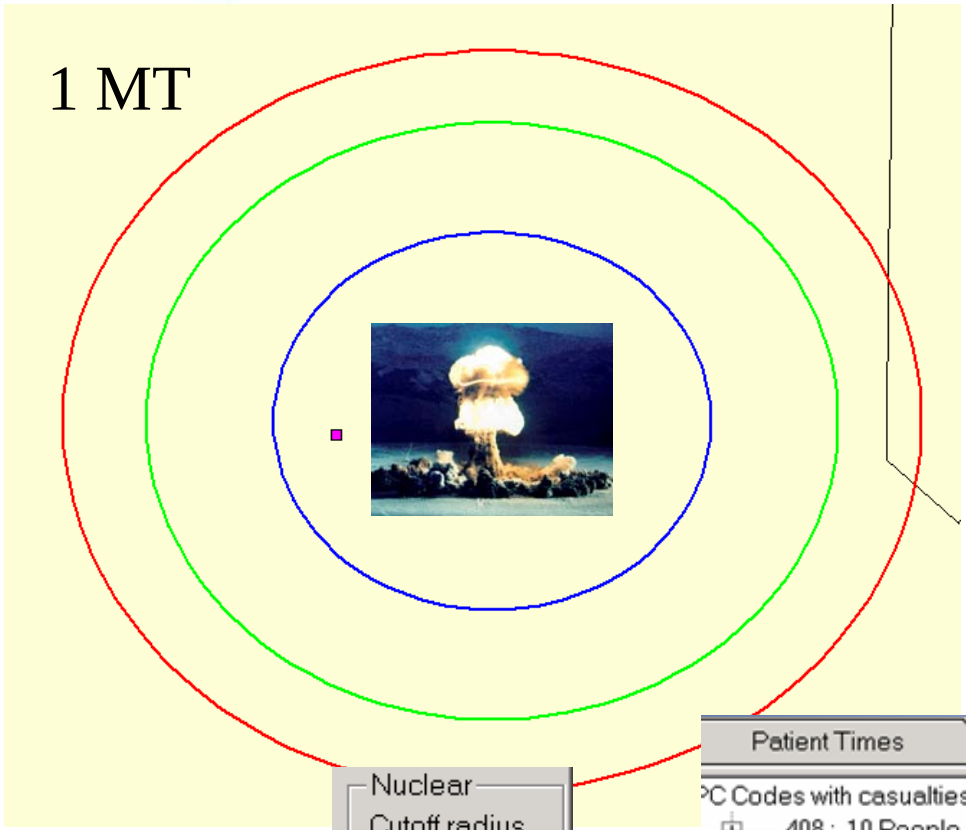
If >50 % vapor:

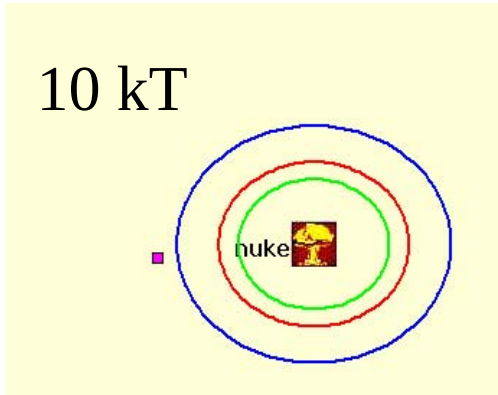
dosage < 0.05 then no PC
0.05 ≤ dosage < 4 then PC 382
4 ≤ dosage < 19 then PC 383
19 ≤ dosage then PC 384

If > 50% liquid

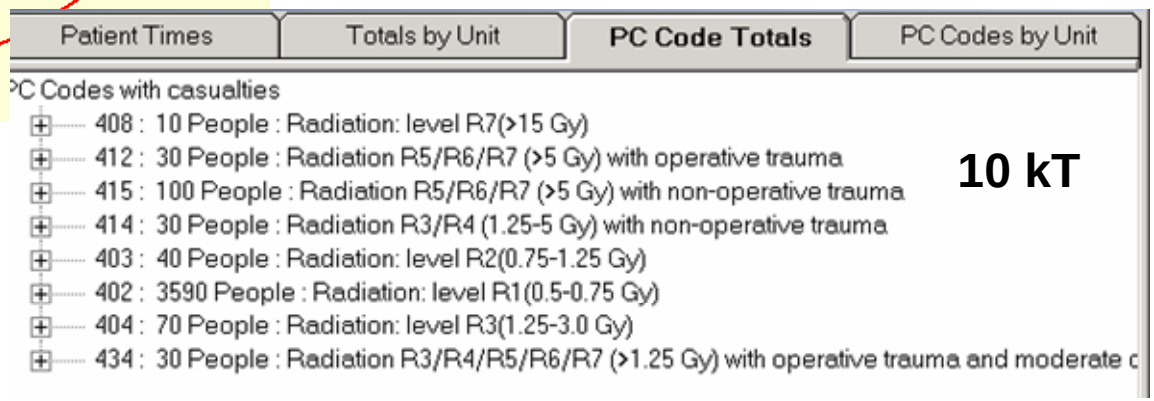
0.01 ≤ dose < 0.8 then PC 385
0.8 ≤ dose < 2.0 then PC 386
2 ≤ dose < 4.0 then PC 387
4.0 ≤ dose then PC 388

Consistent Approach Used for Patient Definition Across CBRN Health Effects





Note spectrum of patients (PCs)



Foregoing Methods Are Implemented in the Medical NBC Casualty and Resource Estimation Support Tool (NBC CREST)

- Originating Agency:
  - U.S. Army
  - Office of The Surgeon General
  - Health Care Operations
  - NBC Defense Staff Officer
- Transition Partner:
  - DTRA
  - Technology Development Directorate

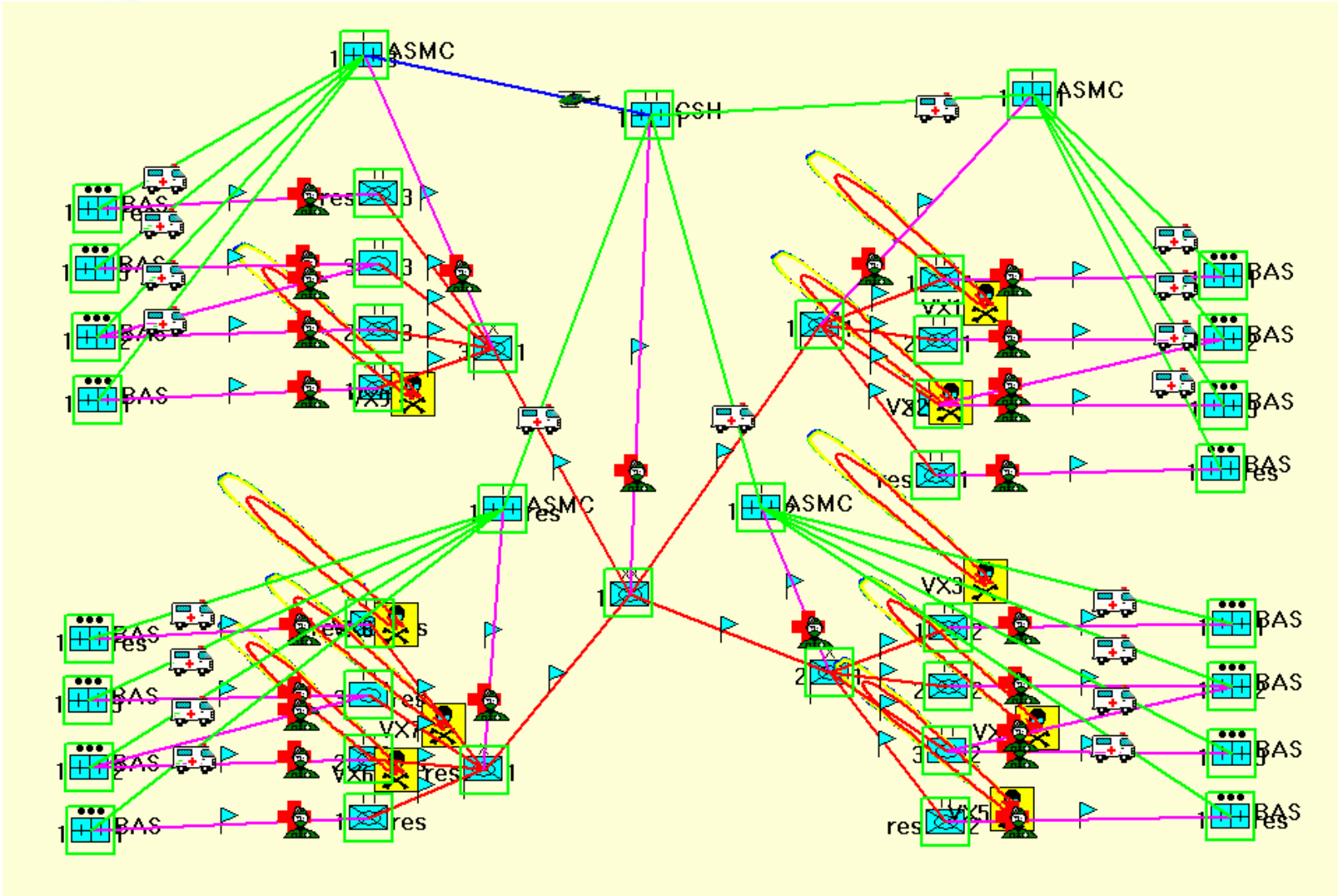
Medical NBC CREST

- **Purpose**
  - Enable advanced planning for medical operations in an NBC environment
- **Objective**
  - Provide Medical Planners with a Tool Set to:
    - Estimate NBC casualties
    - Estimate medical requirements
    - Analyze alternate medical Courses of Action (COAs) (i.e., Gap Analysis)

NBC CREST Capabilities

- Map-based ***scenario*** definition
  - Both troop deployments and civilian population
  - Both command structure and evacuation networks
- Estimation of ***casualties*** with AMedP-8 methodology
  - Provides original AMedP-8 scenarios (VLSTRACK)
  - Will import new plumes from HPAC
  - Nuclear weapons, biological agents, chemical agents
- Provides ***patient stream*** by time of occurrence and by DMSB patient condition
- Joint medical treatment facilities (MTFs) at Levels 1, 2, 3, 4 and 5
- Medical resource requirements by day and level of care
- MTF shortfalls by day and level of care
- Models vaccination, prophylaxis, secondary infection

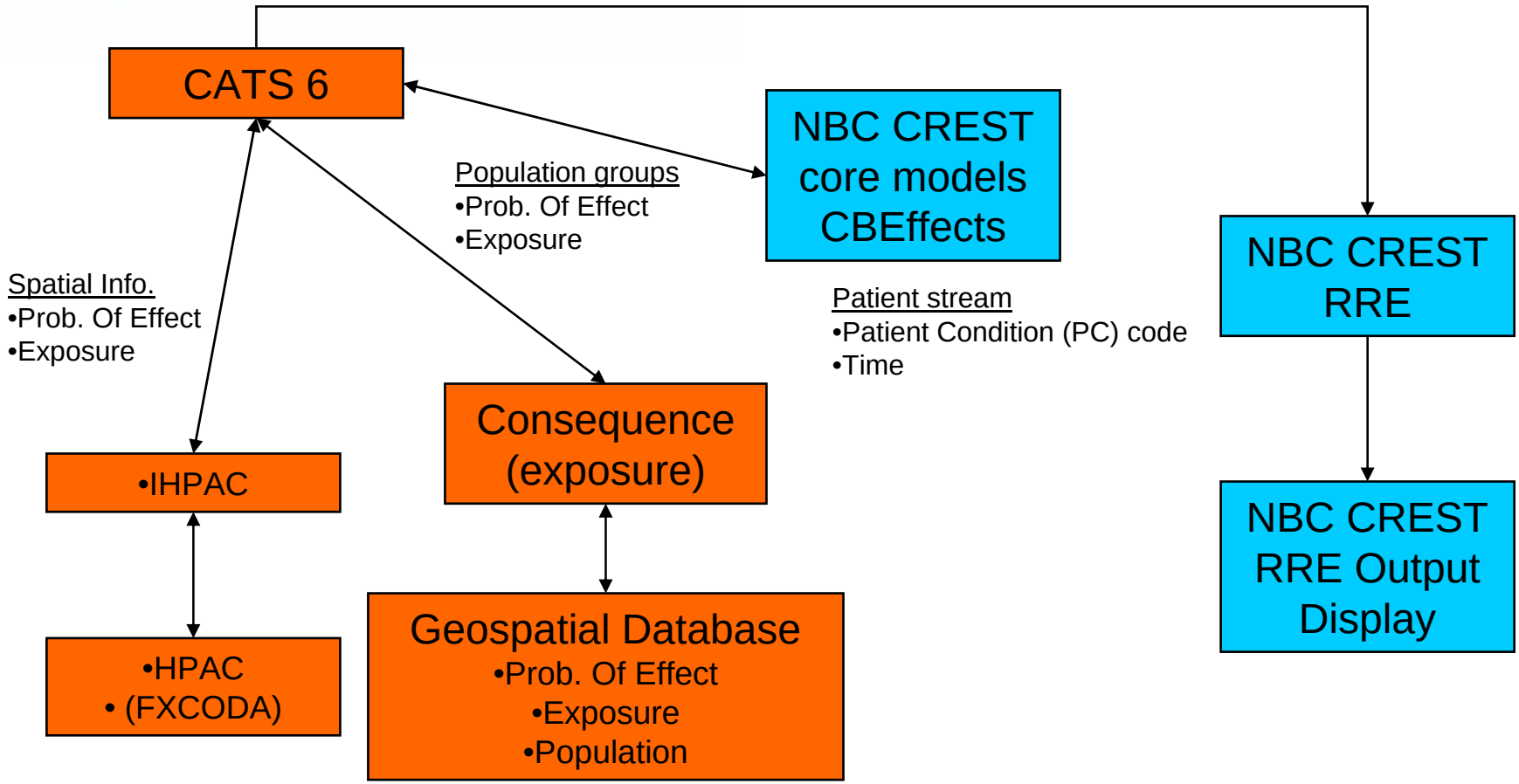
The NBC CREST GUI Supports Large Deployments



NBC CREST in Transition

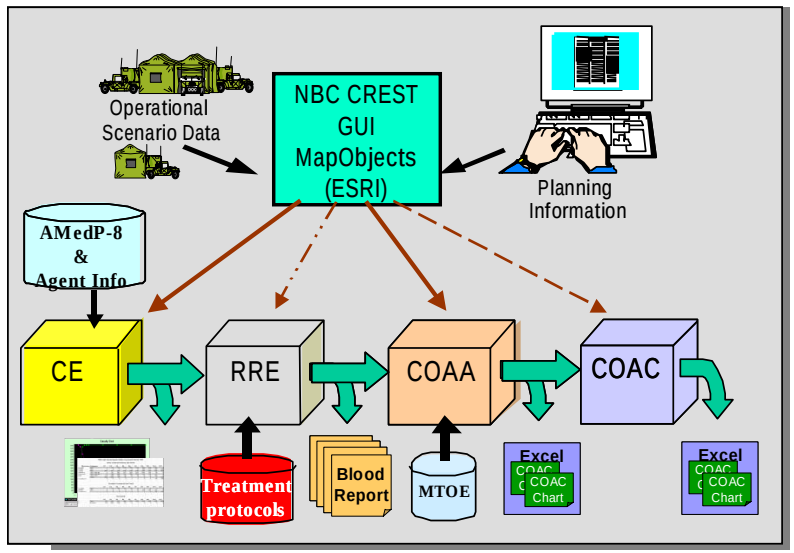
- OTSG maintains purview over the underlying medical planning technology
- Care and feeding of the software application and components transitioned to DTRA
- Deliberate planning capabilities provided by NBC CREST will be integrated with DTRA's Consequence Assessment tools such as CATS
- Simulation capabilities provided by NBC CREST are being integrated with the Joint Operational Effects Federation (JOEF)
  - Medical effects on individual performance capability
  - Delivery of medical care

Initial NBC CREST Integration With DTRA's Consequence Assessment Tool Set (CATS)



Integration of NBC CREST with JOEF

- Accept hazard / exposure data and troop locations from Federation
- Return performance capability / casualties
- Return medical resource requirements
- Match requirements against medical infrastructure
- Adapt modules from NBC CREST to JOEF



Conclusion: High-level Goals

- Maintain compatibility of health effects predictive models across DoD programs, e.g.
  - JEM
  - JOEF
  - HPAC
  - CATS
  - Integrated WMD Toolset (IWMDT)
  - Medical Analysis Tool (MAT)
  - Tactical Medical Logistics (TML+) planning tool
- Maintain currency with applicable COTS technology
- Support efforts to place CBRN casualty estimation in context with conventional casualty estimation