Introduction to Computer Planning Models
Module I

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Outline

• What are computer planning models?
• Types of computer planning models
• Computer planning models during H1N1
Module One Objectives

- Describe how computer planning models can help plan for large public health events.
- List at least three types of computer planning models.
- Describe how computer planning models assisted local public health planners during the 2009-2010 H1N1 influenza outbreak.
History of Our Collaboration

• Funding through APC

• We needed to answer the following questions:
  - How many patients per hour?
  - How large of a facility is needed?
  - How much staff is needed?
  - How do you determine most efficient flow pattern for your POD?

• Needed to effectively measure POD plans
• Developed several computer models to solve different problems
Models
Computer Modeling

• “Formal, quantitative representation of a real world phenomenon that allows users to do one or more of the following:
  • define problems and negotiate boundaries around a system of interest;
  • better understand changes within the system over time;
  • anticipate the likely consequences of particular conditions; and
  • estimate the relative leverage of and trade-offs associated with different action scenarios.”
  – Frumkin, 2007; Rosenfeld et al., 2009
Model Features
(Powell and Baker, 2004)

- Decisions
  - Choices, things that we control.
- Outcomes
  - Consequences, performance.
- Structure
  - Relationships between decisions and outcomes.
- Data
  - Actual observations of the real world;
  - Estimates of key variables.
Modeling and Decision-Making

• Modeling is a tool to improve decision-making.
• Answers questions about possible outcomes:
  – “What if we do this?”
  – “What if this happens?”
• Helps find good solutions:
  – “What is the best alternative?”
Models and the Real World

• A model is an abstraction of the real-world; it simplifies things.
• Because it is simpler, we can test alternatives and consider different scenarios.

Introduce the concept of computer planning models and their role in connecting the real world to decision-making processes. The diagram illustrates the steps involved:

1. **Real world**
   - Formulate model
2. **Model**
   - Analyze model
   - Implement decision or plan
3. **Decision or plan**
   - Interpret results

This structured approach helps in systematically addressing complex real-world scenarios through simplified models.
Model Tradeoffs

More realistic

More complex

More costly

Slower

More abstract

Simpler

Less costly

Faster
Factors affecting use of computer models for preparedness functions

- Validity: Credible and “valid” assumptions that are used to create the model
- Reliability: Confidence that the model is tested
- Authorship: Source of the model
- Accessibility: Ability to download model software
- Scalability: Capable of making adjustments to local setting
- Relevance: Current with mandates from state and federal initiatives
- Capacity: Qualified and trained staff to run models
- Applicability: To specific hazards, response functions, and/or populations
  – Rosenfeld et al., 2009
Challenges in Using Computer Models

- Concerns about validity, reliability, model derivation or source, accessibility, and scalability.
- Insufficient time and funding to train existing staff or hire new staff.
- Difficult to become aware of new models; need better communication and dissemination.
  - Rosenfeld *et al.*, 2009
Recommendations for Modeling Disaster Responses in Public Health and Medicine

- Health sector disaster response models should
  - address real-world problems,
  - be designed for maximum usability by response planners,
  - strike the appropriate balance between simplicity and complexity,
  - include appropriate outcomes that extend beyond those considered in traditional cost-effectiveness analyses,
  - and be designed to evaluate the many uncertainties inherent in disaster response.

- Good model reporting is particularly critical for disaster response models.
  - Brandeau et al. (2009)
Key quality criteria for reporting
(brandeau et al., 2009)

- Authors identified key uncertainties
- Model can be customized or interrogated
- Model available for use by others
- Event pathway clearly identified
- Intervention analyzed in the model clearly identified
- Sensitivity analyses reported
- All key assumptions described
- Limitations clearly discussed
- Time horizon sufficient to capture all relevant future effects
- All the relevant model inputs and their sources were described
- Authors described model validation
- Model was peer reviewed
- Authors described real-world interpretations of their model

Number of Models

- Did not fulfill criterion, or unsure
- Fulfilled criterion
Pandemic Flu

- FluAid 2.0: provides a range of estimates of impact in terms of deaths, hospitalizations, and outpatients visits due to pandemic influenza.
- FluSurge: estimates the number of hospitalizations and deaths of an influenza pandemic (whose length and virulence are determined by the user) and compares the number of persons hospitalized, the number of persons requiring ICU care, and the number of persons requiring ventilator support during a pandemic with existing hospital capacity.
- FluLabSurge: predicts demand for specimen testing.
- FluWorkLoss: estimates the potential number of days lost from work due to an influenza pandemic.
- InfluSim 2.1: predicts the course of an influenza epidemic in a fully susceptible population.
- Vaccine Allocation Model is a Microsoft Excel workbook that can determine how many persons in different target groups can receive treatment if the number of vaccinations available is limited.
FluSurge 2.0

• Estimates the number of hospitalizations and deaths of an influenza pandemic;
• Compares the number of persons hospitalized, the number of persons requiring ICU care, and the number of persons requiring ventilator support during a pandemic with existing hospital capacity.
• Users can change some assumptions:
  – the average length of hospital stay for an influenza-related illness
  – the percentage of influenza-related hospital admits that will require a bed in an Intensive Care Unit (ICU)
FluSurge 2.0

Step 1: Determine population of locale by age groups:

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-19 yrs</td>
<td>1,350,707</td>
</tr>
<tr>
<td>20-64 yrs</td>
<td>2,806,171</td>
</tr>
<tr>
<td>+ 65 yrs</td>
<td>353,154</td>
</tr>
</tbody>
</table>

Enter Data in WHITE boxes only!

Step 2: Determine basic hospital resources:

- Total licensed non-ICU beds: 7,300
- % licensed non-ICU beds staffed: 100%
- Total staffed non-ICU beds: 7,300
- Total licensed ICU beds: 759
- % licensed ICU beds staffed: 100%
- Total Staffed ICU beds: 759
- Total number of ventilators: 691
- % ventilators available: 100%
- Total number of ventilators available: 691

Step 3: Determine duration (6, 8, or 12 weeks) and attack rate (15%, 25% or 35%) of the pandemic:

- Duration: [ ]
- Attack rate: [25%]

Step 4: Click to View Results
POD Planning Models

- Bioterrorism and Epidemic Outbreak Response Model (BERM): allows planners to formulate realistic mass antibiotic dispensing and vaccination contingency plans for their target populations.
- Clinic Planning Model Generator: evaluates plans for mass vaccination or dispensing sites (PODs), including estimates of patient waiting time and staff utilization.
- Clinic Surge Planning Model: for short-duration, high-volume clinics that have a surge of patients when the clinic opens.
- Maxi-Vac: calculates staffing requirements and allocates staff for large-scale smallpox vaccination clinics.
- RealOpt: includes simulation and optimization modules to determine staffing that optimizes performance in user-defined scenarios.
- RealOpt Regional: identifies the best locations for multiple PODs.
- Vaccine refrigeration planning model: determines the storage space needed to keep vaccine refrigerated.
Other models

- **Evacuation Planning**
  - Urban to Rural Evacuation Tool: presents statistical data for counties surrounding large cities where evacuations may occur in case of a terrorist attack or other disaster.

- **Casualty Assessment**
  - EMCAPS: estimates casualties arising from biological (Anthrax, Plague, Food Contamination), chemical (blister, nerve and toxic agents) radiological (dirty bomb) or explosive (IED) attacks.

- **Decontamination Operations**
  - Mass Casualty Detailed Decontamination Model: calculates decontamination throughput and decontamination site staffing.

- **RSS Operations**
  - SNS TourSolver: web-based software for use by the Strategic National Stockpile for planning and managing distributions.

- **Radiologic release**
  - plume models

- **Severe heat wave**
  - National Weather Service Heat Index
Using Computer Models to Plan H1N1 Vaccination Clinics
H1N1 Background

- Late March first discovery of H1N1 in Mexico
- WHO declared a flu pandemic in June 2009
- Development of vaccine July-September 2009
- Vaccine distribution began in early October 2009
- LHDs across the country began vaccination clinics to priority groups in October 2009
Number of ER Encounters

[Graph showing number of ER encounters over time with different markers for Montgomery.]
ILI Age Comparison
H1N1 Scenario

• Montgomery County MD was charged with planning a mass vaccination clinic for 5,000 people in November 2009.
  - A four hour limit was imposed (not including setup and demobilization)
  - Located on a Sunday at a local community college
  - Open to all-priority groups
Clinic Layout/Site Selection

Figure 2 - Clinic Setup and Overview

Physical Education Building
Clinic Layout/Site Selection

HINI MASS VACCINATION CLINIC
Montgomery County Public Health Services
Montgomery College - Rockville Campus
60-00-21

KEY:
- 6' x 30" Tables (4) in foyer for staff registration/sign in
- Flow Line
- Screening Rooms
- Vacc. Blue
- Vacc. Green
- Vacc. Yellow
- Flow Control/Handouts
- Pharmacy/First Aid
- Exit Control

Note: See Figures 3+4 for detailed setup + flow in small + big gyms, respectively

Figure 2 - Clinic setup and overview
CPMG Development-Screen One
CPMG Development-Stations
CPMG Development-Support Staff

The image shows a window for the UMCP Clinic Generator software. The window is divided into three sections:

1. Clinic Setup
2. Select Stations
3. Support Staff

The Support Staff section contains a list of positions including:
- Site Director
- Recorder
- Information Officer
- Site Operations Leader
- Line Worker
- Replacement
- Flow Control
- Site Logistics Leader
- Mental Health Assistant

The positions can be moved up or down using the buttons labeled "Move Up" and "Move Down."
### Routing Probabilities

<table>
<thead>
<tr>
<th>From Triage/Pre-Screening</th>
<th>From Medical screening</th>
<th>From Flu Vaccination (All ages)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>98.0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>99.0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

| Sum                       | 100.0%                 |

*Sum should be 100%*
### CPMG Development-Model Parameters

#### Arrival:
- **Arrival batch size**: 1
- **Interarrival time SCY**: 1
- **Average walk speed (ft/s)**: 4.05

#### Station Details:

<table>
<thead>
<tr>
<th>Station</th>
<th>Processing Time (min)</th>
<th>Variance (min$^2$)</th>
<th>Batch Size</th>
<th>Self service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triage/Pre-Screening</td>
<td>2.4</td>
<td>0.0741</td>
<td>1</td>
<td>FALSE</td>
</tr>
<tr>
<td>Medical screening</td>
<td>1.752</td>
<td>1.6104</td>
<td>1</td>
<td>FALSE</td>
</tr>
<tr>
<td>Flu Vaccination (All ages)</td>
<td>2.2306</td>
<td>0.8554</td>
<td>1</td>
<td>FALSE</td>
</tr>
</tbody>
</table>
### Staff Planning

#### Demand
- Size of population treated: 5000
- Time allotted for treatment (days): 1
- Daily hours of operation: 4
- Number of clinic sites: 1
- Required throughput (patients per hour): 1250

#### Staffing (per clinic site)

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Staff per shift</th>
<th>Minimum staff per shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triage/Pre-Screening</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Medical screening</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Flu Vaccination (All ages)</td>
<td>46</td>
<td>4</td>
</tr>
<tr>
<td>Total Service Staff</td>
<td>134</td>
<td>134</td>
</tr>
<tr>
<td>Total Staff</td>
<td>173</td>
<td>[Set all to minimum]</td>
</tr>
</tbody>
</table>

#### General Performance
- Time in clinic (min): 3.2
- Average number of patients in batch: 673
- Batch interarrival mean (min): 0.05
- Clinic capacity (patients per hour): 1275
- Total staff per shift across all c: 145

#### Station-level Results

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Wait time (min)</th>
<th>Queue length</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triage/Pre-Screening</td>
<td>2.08</td>
<td>42</td>
<td>58.8%</td>
</tr>
<tr>
<td>Medical screening</td>
<td>1.82</td>
<td>20</td>
<td>58.7%</td>
</tr>
<tr>
<td>Flu Vaccination (All ages)</td>
<td>10.60</td>
<td>214</td>
<td>30.8%</td>
</tr>
</tbody>
</table>

*Values in red signify below minimum staffing levels.*

*Values in red denote the "worst" station for that characteristic.*

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Surge Planning

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Actual Event

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Actual Event
Actual Event End Report

<table>
<thead>
<tr>
<th>Source</th>
<th>Unit Time Occupied</th>
<th>Unit Time Available</th>
<th>Core Time Available</th>
<th>Core Load</th>
<th>Total Load</th>
<th>Total Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>12</td>
<td>10</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>Output</td>
<td>1</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>12.5</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
</tbody>
</table>

Queue Time per Station

Utilization of Stations
Bibliography


Using Computer Models

• This module covered three key topics:
  – What are computer planning models?
  – Types of computer planning models
  – Computer planning models during H1N1

• Future modules on this topic:
  – Using POD planning models
  – Medication distribution models
  – Visual modeling and end-user models
For more information

• Online community:
  – phpmodels.ning.com

• Public Health Preparedness Modeling Blog:
  – http://blog.umd.edu/phpm

• Project web site:
  – http://www.isr.umd.edu/Labs/CIM/projects/clinic/

• APC web site:
  – http://www.montgomerycountymd.gov/apc