MODELING STAFFING DYNAMICS FOR POD OPERATIONS IN AN INFECTIOUS DISEASE EMERGENCY

by

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ABSTRACT

The effects of variables impacting mass prophylaxis point-of-dispensing (POD) staffing in an infectious disease emergency could potentially aid in preparedness efforts by advising recruiting, training, and emergency planning. This project aims to explore three factors that may impact staffing capabilities for POD: pathogen, absenteeism, and response rates. These factors were explored through building an agent-based model in the *NetLogo* modeling platform. An agent-based modeling approach was used to emphasize the impact of indirect interaction between individuals that results as roles are filled by individuals who volunteer first. This model set the environment at different absenteeism and response levels, and different POD staffing requirements based on pathogen (influenza vaccinations or anthrax antibiotics). To measure the effects of these variables, time-to-staff and staff shortages were recorded at the end of each simulation run. For influenza conditions, staffing capabilities became more constrained as absenteeism increased, and response decreased. However, for anthrax conditions, these constraints were very mild, and the differences in these trends between influenza and anthrax were significant. Overall, this model provides an example of staffing constrains that could be

anticipated if such a model were to be developed for use in local health departments. Such a model could allow for planners to find staffing weaknesses before they manifest, and tailor recruiting and training efforts accordingly to create a staff pool that would be overall more able to successfully staff PODs in an emergency. The public health significance of this project is to provide a foundation for future development of this type of agent-based model to aid in public health preparedness planning.

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PREFACE

I would like to thank the Allegheny County Health Department staff members who helped me shape my frame of reference for this project. Many thanks specifically to Jamie Sokol, MPH, and Tom Mangan of ACHD’s Emergency Preparedness and Response Division for providing me with existing staffing data and allowing me to collect additional data through their drill channels. Further thanks to my entire thesis committee for providing their insight and guidance on this project and the editing of this document.

1.0 INTRODUCTION

This study aims to use Allegheny County and the Allegheny County Health Department (ACHD) for a modeling experiment to explore selected factors that may influence staffing for mass prophylaxis points-of-dispensing (PODs): pathogen influence on logistics, willingness to respond, and absenteeism. Actual infectious disease emergencies warranting the opening of PODs are rare, causing relevant agencies to rely on drills and computer modeling to exercise their preparedness and to anticipate their ability to activate and run PODs efficiently.

In the event of an infectious disease emergency, up to 50 PODs may be set up in pre-designated government buildings within Allegheny County in order to provide antibiotics or vaccinations to the entire applicable population within 48 hours. Currently, almost 6,000 staff members are needed to man all 50 PODs, with 29,000 individuals in the pool of potential staff. (However, it is important to note that it is highly unlikely that a full activation would occur.) Potential staffing sources include other county employees, Medical Reserve Corps (MRC) volunteers, and local health students. The MRC is an important staffing supplement, as they have been pre-trained for many different public health emergencies. Each POD has a designated throughput estimate—the number of people that can receive prophylaxis per hour. Throughput is related to staffing in that generally, a larger staff is required for a higher throughput, and vice versa (however, benefits of a larger staff are limited by other factors involved in throughput, such as space in the POD facility, available supplies, etc). (Allegheny County Health Department, 2012) In addition to PODs run by ACHD, closed PODs may be run by local organizations for the purposes of vaccinating their own employees and their families. For the purpose of this study, we will focus only on ACHD-run PODs.

These PODs consist of four general stations: greeting/briefing, screening, prophylaxis distribution, and exit. Generally speaking, the structure of a POD can be applied to any emergency from any pathogen, with allowances for scaling depending on the event. However, there are a few key differences between vaccination PODs and an antibiotic POD. First, vaccination PODs require that medical professionals administer vaccinations, whereas in an antibiotic POD, antibiotics can be administered by any volunteer, regardless of medical expertise. Second, in a vaccination POD, every individual to be vaccinated must be physically present at the POD. However, an antibiotic POD can run on the "head of household" model, which allows one person in each household of up to 15 people to receive antibiotics for themselves and their family members. (Allegheny County Health Department, 2009) These differences are important because they affect staffing numbers either directly (through differences in staffing needs) or indirectly (through differences in POD throughput).

Many factors are involved in POD planning, including but not limited to the rate at which the disease spreads through the population, POD supply lines and availability, staff availability, and characteristics of the population. Each one of these areas comes with its own complex set of variables, which interact dynamically both within and among each of the factors. This study will focus specifically on the three variables involved in staffing a POD: pathogen influences, willingness to respond, and absenteeism. The following research questions will be addressed:

1. Does pathogen influence on logistics (vaccine vs. antibiotic) have a significant impact on fully staffing a POD

2. Does willingness to respond (vaccine vs. antibiotic) have a significant impact on fully staffing a POD

3. Does absenteeism (vaccine vs. antibiotic) have a significant impact on fully staffing a POD

It is important to note that Allegheny County staffing data are being used as the inputs for this model, but Allegheny County is not necessarily the target organization to benefit from such a model. In all but the worst scenarios, Allegheny County has a large enough pool of potential volunteers from many different sources (city and county employees, health students, etc.) that it is unlikely that they would experience any significant shortage. However, a smaller jurisdiction that may have to rely on a pool of fewer than 1,000 individuals, similar to the staffing pool used in this project, may find great value in being able to predict where their staffing shortcomings may occur, and at what levels of response.

2.0 LITERATURE REVIEW

There is much work that has already been done to examine factors influencing staffing requirements, to advise on how to define and drill different personnel sources, and even on applying modeling to advise staffing and general POD operations. The literature presents findings that are mostly meant to be applied to health departments, but their goals in application vary. For example, some reports provide recommendations on how to ensure a health department is better prepared to utilize its staff (via actions such as conducting regular drills), while one existing model aims to advise health departments on how to most efficiently use the staff they have once a disaster strikes. While both of these approaches are very valuable, this project will attempt to merge the two, by using modeling to advise health departments on how to be better prepared to utilize its staff.

2.1 FACTORS INFLUENCING STAFFING REQUIREMENTS

There are three different types of variables that can impact staffing requirements: staff factors, POD demands, and pathogen influence on logistics.

Staff factors include willingness to respond, absenteeism, recruiting, and relevant skills. Willingness to respond has been shown to depend on the responder's decision process via their perception of situational threat versus individual efficacy. (Barnett, et al., 2009) General availability in a person's everyday life, influenced by factors such as work commitments, dependent family members, and similar standing commitments, also plays a large role in a responder's decision to respond, and can be assessed through no-notice call-down drills for potential responders. It is recommended that these drills be practiced with all staff who have been identified as POD staff. However, flagged government staff could number in the tens of thousands, making this an unrealistic task. In this event, a representative sample should be randomly chosen for the drill. (Nelson, et al., 2009)

Furthermore, to strengthen potential POD volunteers' understanding of a POD itself, virtual reality simulations based off of the Second Life online virtual world have been proposed. These simulations would allow users to explore a virtual POD world, and practice different challenges that may present themselves in an actual emergency. While a virtual simulation could never make up for in-person simulations, this approach greatly exceeds in-person simulations in cost-effectiveness and convenience. (Yellowlees et al, 2008)

POD staffing demands—how many tables are present at each station, which stations are present, and how many people must man each station—all go hand-in-hand with POD throughput. This links POD demands very closely to pathogen characteristics such as virulence, transmission rate and route, and general public perception of the agent.

High virulence, fast transmission, and high public concern can all contribute to a need to provide prophylaxis for more people, and to do so with more urgency.

The effect of the pathogen of interest has yet to be explored extensively in a research setting. However, government plans show a clear differentiation between the requirements for administering vaccines and distributing antibiotics or other medication. For example, the ACHD POD Operations Manual includes diagrams for the layout of each of these PODs. These layouts clearly show a difference in number of staff required, as well as a simplified layout for an antibiotic POD. It stands to reason that, logistically speaking, an anthrax outbreak would be simpler to respond to.

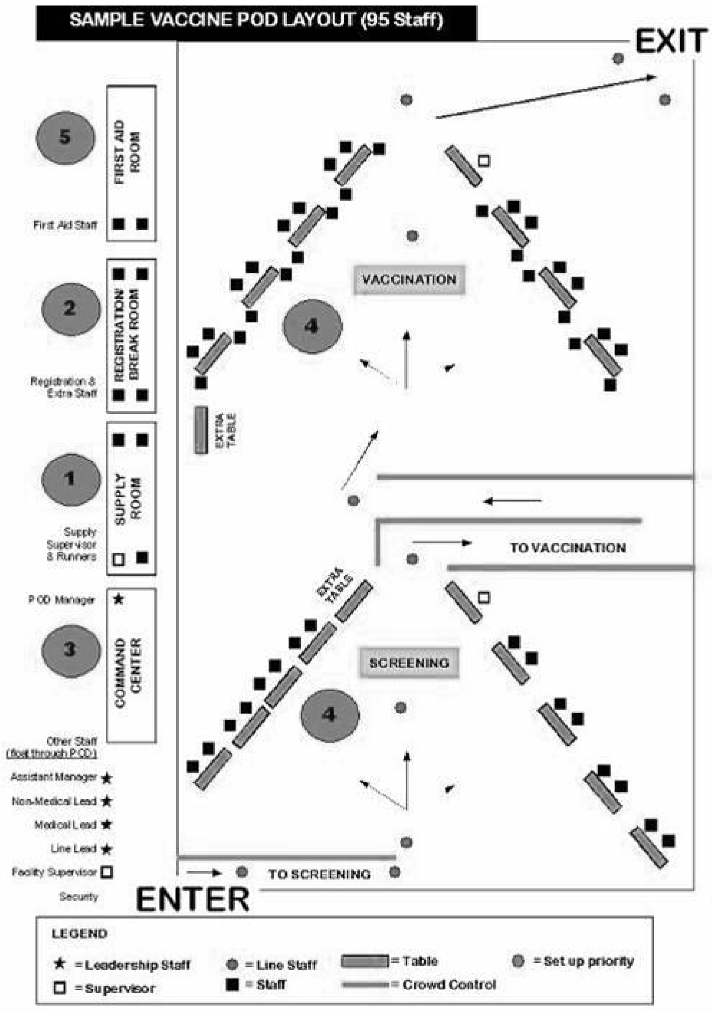

Figure 1 Vaccination POD Layout (Allegheny County Health Department, 2009)

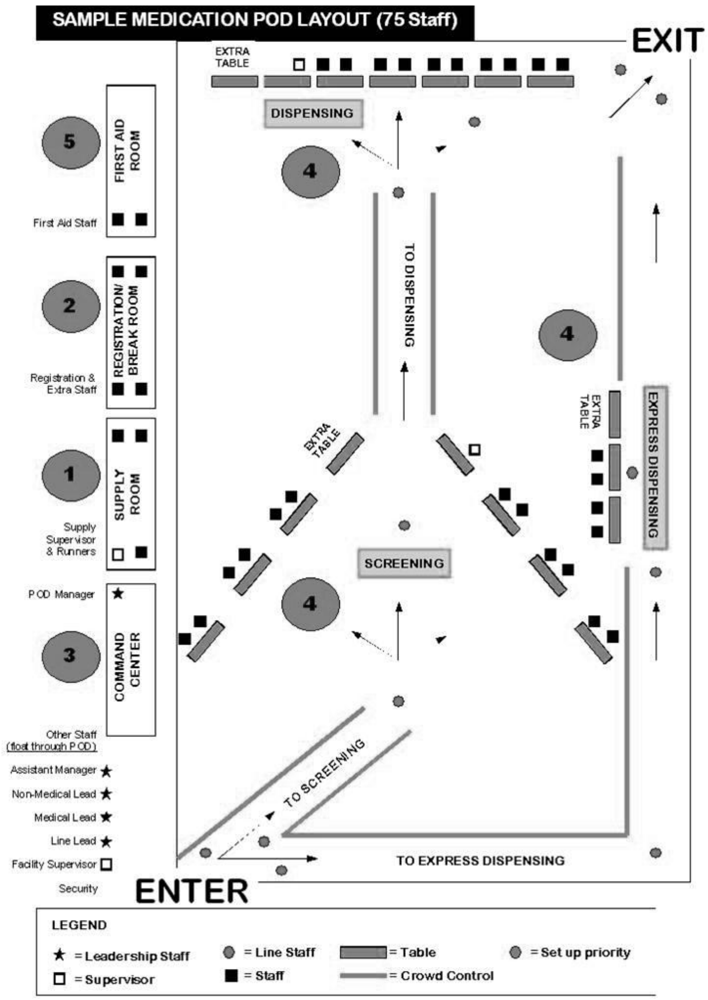

Figure 2 Medication/Antibiotic POD Layout (Allegheny County Health Department, 2009)

However, the success of a mass prophylaxis campaign is affected by more than just pure logistics. An anthrax outbreak, or any event perceived as being a terrorist event, would bring risk communication challenges that, if not properly handled, could result in the public creating challenges for the campaign. For example, *Fischhoff et al (Biosecurity and Bioterrorism 2003)* showed that 46.8% of individuals surveyed in their study believed that anthrax could spread from person to person. Such beliefs about an agent with so strongly connoted with terrorism would likely, at the very least, but strong pressures on local health departments and entirely change the dynamic under which the POD operates. Furthermore, *Shepard et al (Emerging Infectious Diseases 2002)* showed that those who were started on post-exposure prophylaxis for anthrax in the 2001 attacks didn't always complete their course of antibiotics. Rates of completing the course ranged from 82% in the Hart Senate Building in Washington, D.C. to only 58% in New York City. These rates show a potential disconnect in education on the importance of completing a full course of antibiotics, as well as the possibility that these individuals are not actually fully protected.

Examining logistical differences between different pathogens is relatively simple in comparison to differences in perception and knowledge of pathogens by individuals from the general public to government officials. More research is necessary on the latter to better inform this kind of comparison.

2.2 PERSONNEL SOURCES

The first line to provide staff for PODs is health department staff. These staff members are most likely pre-trained or will receive just-in-time training, and will be required to work a POD. Employees from other areas of the government may still be required to respond if needed. These additional employees may lack prior training, but would still benefit from just-in-time training. (Nelson, et al., 2009) However, many limitations can occur. A skeleton of the staff must still be present at the health department to continue to perform normal functions. Absenteeism can become a problem for many reasons: ill personnel, school closure requiring employees to stay home with children, and general concern about becoming ill.

Volunteers through the Medical Reserve Corps are essential to public health preparedness, and have become a large part of POD planning. These volunteers can receive the same training as health department employees, and can provide a large supplement to regular staff. However, since this is a volunteer workforce, it can be difficult to gauge what the response rate will be. (Nelson, et al., 2009)

In the case of Allegheny County, there are many additional sources of staff if there is still a shortage after the prior sources have been utilized. These include local health students, AmeriCorps volunteers, and Community Emergency Response Teams (CERTs). (Allegheny County Health Department, 2012) However, while these groups would be fairly easy to access and would likely be very motivated to volunteer, their members are relatively transient so it may be difficult to anticipate their response rates.

2.3 EXISTING MODELS FOR POD PLANNING

RealOpt is a modeling program developed by Georgia Institute of Technology and is used to aid in logistical planning for many aspects of POD operations. It is possibly the most comprehensive and robust planning model currently available allowing local health departments to test the efficiency of their current plans, and alter them accordingly to maximize the effectiveness of their operations. It allows emergency planners to explore many different areas of a POD, such as “treatment distribution points, staffing levels, impacted populations, and potential impact on a compressed window of time” and to expose where bottlenecks—points where individuals accumulate in a POD because the POD can’t keep up with demand—are most likely to occur. (Georgia Institute of Technology, 2008) RealOpt is largely response-oriented: How can we best use what we already have to meet the need of various emergencies? However, the model developed in this project is more preparedness-oriented: How can we alter or strengthen our current resources to meet the need of various emergencies? While the latter could certainly still be examined using RealOpt, this is not the task that RealOpt is specifically designed to accomplish.

The Bioterrorism Epidemic Outbreak Response Model (BERM) was created through the Agency for Healthcare Research and Quality’s (AHRQ) Public Health Emergency Preparedness program. While this program has been discontinued, the model is still available online as a tool that “allows planners to formulate realistic mass antibiotic dispensing and vaccination contingency plans” by providing “the number and type of staff needed to respond to a major disease outbreak or bioterrorism attack.” (Hupert & Cuomo, 2005)

In this model, the user inputs a population size for coverage, a time frame in which coverage must be accomplished, anticipated staff requirements, and characteristics of the POD site (room capacities, throughput per POD) and of the event (communicable or non-communicable disease). This generates generalized staff totals, counts by POD station, and throughput rates for the entire prophylaxis campaign, assuming that there are no limitations on staff. The user than then customize support staff numbers and staffing constraints, and then summaries of model results, results by scenario (communicable versus non-communicable), a sample POD layout, and a form for a customized staff model. (Hupert & Cuomo, 2004)

While this model is also very comprehensive and offers excellent data on specific POD roles, it has its limitations. First, since the project has been discontinued, it will not be updated as the field of preparedness changes. Second, while the model does a good job in generating different numbers, it doesn't account for factors influencing response, nor the randomness that comes with these factors. Because of this, the user will always get the exact same outputs from a given set of inputs. This doesn't allow for the user to account for the possibility that a large number of people capable of serving essential roles may become ill themselves, or similar situations. It is important to acknowledge that these scenarios are possible (though probably unlikely), and using a model that accounts for other relatively random variables would provide more generalizable outputs.

Overall, the existing literature provides a look at several different components of staffing (and the modeling of staffing) for PODs based on certain skills for certain situations. However, these different components have yet to have been brought together as a model to look specifically look at POD staffing based on roles and skills. This project will work to begin to establish such a model.

3.0 METHODS

This study creates an agent-based model using the *NetLogo* (Wilensky, 1999) platform, utilizing ACHD and MRC staffing data to simulate the effects of different levels of absenteeism and willingness to respond. The model provides outputs in the form of time it takes to staff the POD, where staffing shortcomings (if any) occur, and average rank of each staffed role. An agent-based modeling platform was chosen for this project to emphasize the indirect interaction between agents (POD staff) that occurs as a consequence of the individual agent's decisions. For example, Agent A may decide to volunteer, and subsequently be assigned to a role that will then not be available to Agent B (or vice versa).

3.1 STAFFING DATA

To serve as input data for the model, staffing data were collected and adapted into a format that would allow for comparison within the model. While coming from different sources and undergoing different levels of re-formatting, the final data set for input provides counts for available staff categorized by occupational category and what rank each category holds for filling each POD. For full procedures for this process, please see Appendix B.

3.1.1 ACHD Employees

The following different sources of data obtained from ACHD were used to determine characteristics of the staff pool available for response in staffing a POD:

- **ACHD Employee Classifications:** These numbers were obtained from the ACHD Emergency Preparedness and Response Manager, and classify all current ACHD employees (as of November 2012) as medical (54) or non-medical (297) under 7 different categories. These 351 employees are further broken down into the following groups:

Table 1 ACHD staff categorizations as of November 2012

Category	Medical	Non-medical
Administrators and Managers	6	80
Supervisors	5	29
Professionals (non-nursing)	3	74
Professionals (nursing)	32	--
Clerical	0	64
Technical	8	30
Other*	0	23
Total	54	297

** Plumbers, Tradesmen, and Drivers originally existed as separate categories. These occupations were condensed into one, since they all have the same skill sets as applied to a POD.*

- **POD Operations Manual:** This document is used by ACHD personnel to guide POD planning and response operations. It was used to advise design of the model by providing a reference for overall POD staff organization and descriptions of POD roles. This made it possible for the model to better reflect actual guidelines that would be referenced in an actual event.

3.1.2 Medical Reserve Corps

A no-notice call-down drill was conducted with the MRC over a four day period in August, 2012. This drill included all members of the MRC and asked for volunteers to respond for an infectious disease emergency to staff a POD. Volunteers received the scenario by a pre-designated mode of contact—typically email or SMS text. The scenario included instructions on how to reply, followed by answer choices denoting if the volunteer would respond and to which pathogen(s). For the full text of this scenario with answer choices and reminder statements, please see Appendix A.

This drill produced a series of eight spreadsheets—four with demographic information and four with response data, creating one pair for each day of the drill. Once de-identified, I combined these spreadsheets, added variables regarding volunteer disciplines using the same seven categories as for ACHD employees, and recorded the group's overall willingness to respond. Appendix B describes the full methods of this categorization process, including definitions of categoies. Of note, there are no MRC volunteers in the "Supervisors" category. This is for two reasons: 1) volunteers do not hold supervisory positions within the MRC, and 2) in a POD, supervisory roles will be filled by ACHD staff only.

Table 2 MRC staff categorizations as of August 2012

Category	Medical	Non-medical
Administrators and Managers	0	6
Supervisors	--	--
Professionals (non-nursing)	208	34
Professionals (nursing)	179	--
Clerical	1	1
Technical	6	1
Other	0	71
Total	394	113

3.2 POD VARIABLES OF INTEREST

In the context of agent-based modeling, it is generally better to begin with a small number of variables, and work up to build a more complex model. (Railsback & Grimm, 2012) While many different variables can affect staffing distributions, this early-stage model will focus only on the following four variables.

- **Pathogen:** Since vaccine PODs and antibiotic PODs have different staffing requirements and different throughputs, this variable could play a large role in effectiveness of staffing efforts, especially when combined with changes in other variables. This model will look only at pandemic influenza and anthrax. These pathogens were chosen because they represent an example of a pathogen warranting a vaccination POD and an antibiotic POD, respectively. These two pathogens will allow the model to explore the differences between the two types of PODs.

- **Willingness to respond in volunteers:** While there are approximately 30,000 individuals that have been flagged as potential volunteers in Allegheny County, it is highly unlikely that all or even most of these individuals will be willing or able to volunteer in an actual event. Conducting no-notice drills with volunteers can help to estimate the level of response that a health department could expect in an emergency. Furthermore, modeling could generate an estimated range for the minimum level of response that a mass prophylaxis effort could function with. If these two numbers do not agree, the health department could work ahead of time to increase willingness to respond in their volunteers.
- **Volunteering with employees:** ACHD employees are required to staff PODs when needed, but the general practice is to ask for volunteers among the employees first. The model will account for this, by asking for volunteers from the employee pool, instead of assigning them. However, “mandatory” staffing can still be modeled by running the model with 100% volunteer rates.
- **Absenteeism:** Potential POD staff members are still subject to the all the effects of the disease that the general public is feeling. Therefore, employees may be absent due to their own illness, caring for an ill family member, or

supervising children if a school closure has been implemented. The idea of absenteeism in this model accounts for potential staff members who are *unable* to staff a POD. An individual who is unable to respond will be rendered inactive and will not be given the chance to decide to volunteer.

The MRC drill data, which was collected over four days, or a series of "asks," was used to approximate changes in response rates over subsequent "asks" for volunteers in the model. It is assumed that this drill data provides appropriately generalizable information on the change in rate of response over time. The full process of obtaining this information can be found in Appendix C.

3.3 MODEL

The model for this project is based on environmental variables that define the "world", or scenario, in which the model is operating, as well as the agents that are acting within the environment. This section will discuss these parameters, as well as the process and assumptions under which the model operates.

3.3.1 Environmental Variables

ACHD has compiled a spreadsheet of all 50 potential PODs within Allegheny County as well as specific positions within the POD, and how many people will be needed in each position at each location. Anticipated throughput for each of these PODs is set at 1,019.

This spreadsheet is scaled off of the staffing distributions used in Philadelphia, PA. (Allegheny County Health Department, 2008)

This model will only look at four PODs out of these 50 designated PODs: Chartiers Valley School District, McKeesport Area School District, North Allegheny School District, and Pittsburgh School District. These were the PODs that were activated during the 2009 H1N1 pandemic, and provide a realistic portrait of the PODs that would most likely be used in an event of similar severity. The model will run as if all of these PODs were activated, regardless of other factors. This will provide the following variables:

- These four PODs will require 118 medical staff (who may or may not be performing an actual medical task), 40 non-medical staff, 115 line staff, and 4 POD managers for a total of 277 staff members.

Table 3 Number of Individuals Needed for a Fully-Staffed POD by Role and POD Location

Role	POD: Chartiers Valley	McKeesport	North Allegheny	Pittsburgh	Total
POD Manager*	1	1	1	1	4
Medical Operations Lead**	1	1	1	1	4
Screening Supervisor	1	1	1	1	4
Screening Staff	9	10	14	12	45
First Aid Room Staff	2	2	2	2	8
Medication Dispensing Supervisor	1	1	1	1	4
Medication Dispensing	7	9	12	10	38
Express Medication Dispensing	3	3	5	4	15
Non-Medical (Logistical) Lead**	1	1	1	1	4
Registration/Training/Break Room	4	4	4	4	16
Supply Supervisor	1	1	1	1	4
Runner	3	3	3	3	12
Facility Supervisor	1	1	1	1	4
Line Lead**	1	1	1	1	4
Line Staff	14	17	20	20	71
Extra Medical Staff	2	2	2	2	8
Extra Non-Medical Staff	6	8	9	9	32
Total	58	66	79	74	277

**This role can only be staffed by an ACHD employee, and exists independently of other staff categories.*
***These roles can only be staffed by ACHD employees.*

These PODs can cover a population of 150,240. While this is much smaller than the entire population of Allegheny County of about 1,223,589 that the Local Technical Assistance Report (LTAR) reports coverage for, this is likely sufficient to cover the at-risk population in the area who are not already receiving prophylaxis from a closed POD, private medical provider, or other source. During the 2009 H1N1 pandemic, these four PODs were used to administer vaccines to 8,926 individuals. In this pandemic, demand for the vaccine in a POD was relatively low due to individuals receiving the vaccine through an alternative channel, or simply opting not to get the vaccine.

3.3.2 Agents

The available staff pool for the model will be held constant throughout different runs. This will consist of the availability data that ACHD reports in its LTAR report. For simplicity, this pool will only include ACHD employees and MRC volunteers. The actual available pool of potential POD staff members also includes “6,000 Allegheny County employees (including ACHD), 22,600 public school employees” and health graduate and professional student in the area. However, ACHD employees and MRC volunteers provide the most data and, in all but the worst case scenarios, would provide the bulk of staff for a POD. Overall, this will create an available staff pool of 351 ACHD employees and 507 MRC volunteers for a total of 858 individuals.

Each agent in the model contains the following agent variables:

- **Organization**: ACHD or MRC
- **Medical capability:** medical or non-medical skills
- **Job category:** a number representing one of the 7 previously-discussed job categories
- **Role ranks:** represent order in which job categories fill a role. Procedures for this ranking system can be found in Appendix B.

3.3.3 Design Concepts

- **Adaptation:** Based on the willingness to respond and absentee rates designated by the user, each volunteer or employee agent will decide with that probability whether or not they will volunteer.
- **Interaction:** Agents do not directly interact with each other, but still impact each other in that if an agent occupies a staff slot, no other agent can subsequently occupy that spot.
- **Observation:** Two measures will be recorded to compare different model runs: 1) how many ticks (representations of one occurrence of an ACHD asking for volunteers) it takes the run to complete (whether full staffing is reached or not), and 2) the POD role(s) in which staffing shortcomings, if any, are encountered.

3.3.4 Model Setup

The model interface will include pathogen switches for anthrax and influenza. These switches allow the user to select either influenza or anthrax (Note: one, and only one, of the switches can be switched "on" at a time). This will designate the environment variables according to factors surrounding the particular pathogen that impact staffing requirements.

Sliders for willingness to respond and absenteeism will allow the user to select a rate of response for volunteers and employees respectively. The selected absenteeism rate will automatically drop that proportion of individuals randomly from the pool of available staff at setup. These individuals will not be given the decision to volunteer. The selected willingness to respond rate will determine the proportion of agents who decide to respond.

Staff characteristics will be input into the model via text files. Separate text files contain staff ranks for each of the 17 POD roles. These ranks are based on order in which job categories will fill a POD role, as opposed to the order in which a job category can fill POD roles. More information on ranking procedures can be found in Appendix B.

When the user hits the “Setup” button in the model, the following procedures take place:

1. Based on which pathogen switch is turned on, the appropriate staff file will be read in to the model.
2. Turtles will be created to represent each ACHD employee and each MRC volunteer. These turtles contain variables specifying its organization and rank for each POD role.
3. The absenteeism rate selected on the model interface will randomly drop that percentage of turtles (non-discriminately across employee and volunteers) from the pool of available staff.
4. Numbers of staff members needed for each POD role will be specified. These commands are within the code, and are not input via a text file, or specified by the user.
5. The model will specify that all POD roles are currently empty.

Figure 3 provides a screenshot of the model after the above setup procedure has run. In this example, the influenza switch is turned on, and the anthrax switch is turned off, denoting that the model is running under the influenza scenario. Turtles were then created, representing each ACHD employee and each MRC volunteer. While not shown on the model interface, each of these turtles possesses information on its rank for each role based on its job category. However, these variables can be viewed for each turtle via a turtle monitor, such as the one in *Figure 4*. This particular run of this model has been told to run with baseline employee and volunteer response rates (as shown in these sliders) and an experimental absenteeism rate of 25%. This absenteeism rate caused 25% of the turtles to become inactive (denoted by a gray color). The colored blocks on the right side of the interface denote the current status of each role. If the block is red, the role is not fully staffed. Since all roles are empty at setup, all roles appear red in this example.

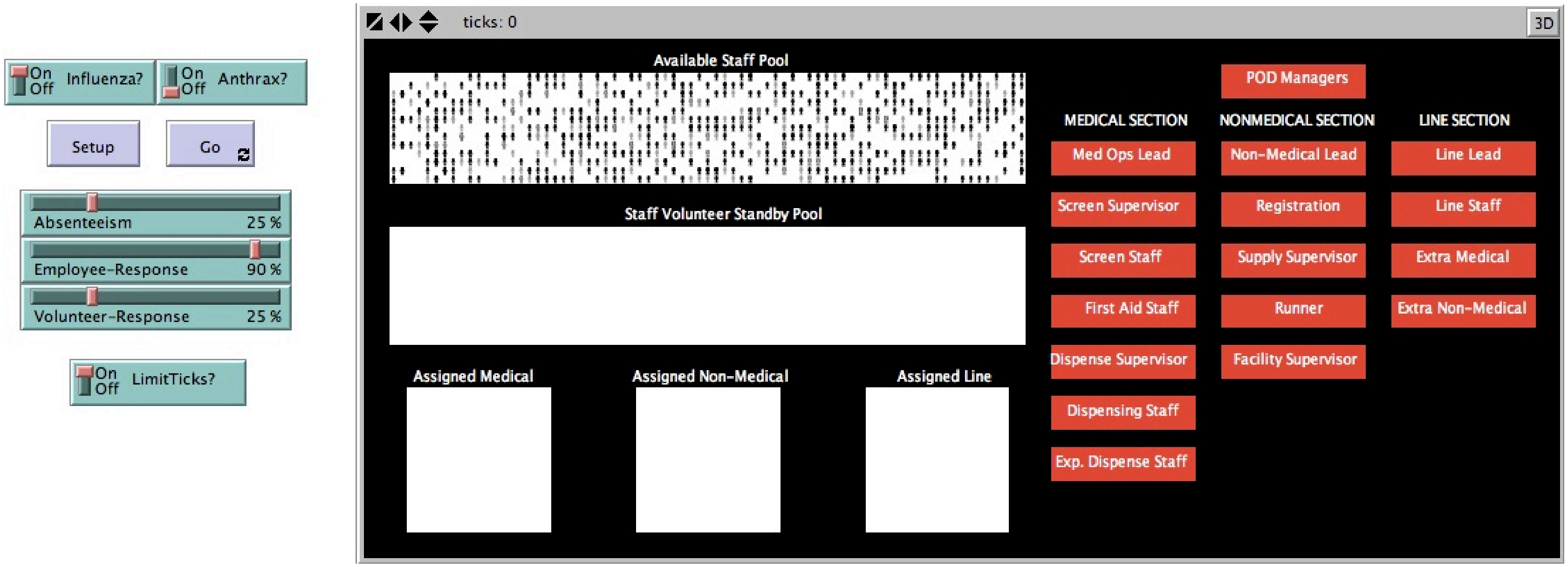

Figure 3 Model Interface After Setup

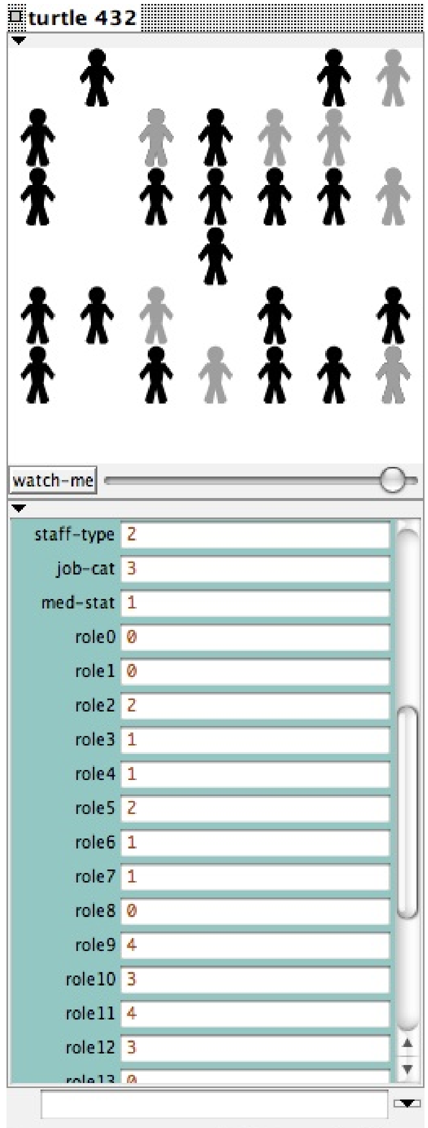

Figure 4 Turtle Monitor Showing Variable Values Not Shown in Interface

Figure 4 shows a turtle monitor for turtle number 432. First, this allows for a better view of available versus absent (coded with a false binary "available" variable in the model) turtles, as the viewing window shows both available (shown in black) and absent (shown in gray) turtles. Second, this allows for closer inspection of variables that are not visible in the main model interface. We can see that turtle number 432 is a MRC volunteer ("staff-type" code: 2), a non-nursing professional ("job-cat" or job category code: 3), and has medical skills ("med-stat" or medical status code: 1). The remaining variables shown ("role0" through "role13") show turtle number 432's rank for each role. This turtle is incapable of serving in Role 0 (POD Manager) or Role 1 (Medical Operations Manager), is the second job category that can fill Role 2 (Screening Supervisor), and so on. The variables shown here are only part of the variables assigned to this turtles. Others include location, size, and shape of the turtle, as well as some additional staff variables.

3.3.5 Assumptions

This model makes the following assumptions:

- Response in employees and volunteers is equally random, though response may occur at different rates
- Response rates are equal for influenza versus anthrax
- Employees are operating on a volunteer basis
- If a model run reaches 20 ticks, denoting that the ACHD official had to ask for volunteers 20 times, this run can be considered an unstaffed POD.

3.3.6 Process Overview and Scheduling

After the model has been initialized, it is ready to run. Once the user hits the "Go" button, the following procedures will run to compose one tick.

1. Employees will decide whether to report to stay home. Volunteers will decide whether to respond. Those who decide to work will then move from available pool to the standby pool.
2. Staff members who have volunteered will begin to be assigned based on their rank. The model will first randomly select turtles and put them in the role they rank the highest for. (Note: if a turtle ever ranks equally for multiple different roles, these roles will be put into a list and the turtle will randomly be assigned to one of the roles in the list)
3. If the role they are selected for is full, they will go through the same process for their next highest ranked role. This process will continue through all ranks that the turtle possesses.
4. If the turtle goes through each step and all possible roles have already been filled by previous turtles, the turtle will become inactive.

Each tick in the model represents one occurrence of an ACHD official asking for volunteers (i.e. if the official asks for volunteers, and the volunteers they get are not sufficient to staff a POD, they will ask for more volunteers). This process will repeat until one of the following stop procedures reports as true:

1. All POD roles are filled.
2. There are no more available staff members to fill the remaining roles.

Figure 5 shows the model interface after the model run that was set up in *Figure 3* has concluded. The employee and volunteer response sliders show that those response rates declined over the series of the first four ticks. The tick counter at the top of the interface shows that this run went to the full tick limit of 20, and then stopped automatically. While there are still available agents in the Available Staff Pool, continuing to “ask” for volunteers will yield too few new volunteers to warrant continuing. Therefore, a run progressing this long is considered not fully staffed. This is denoted by the role boxes on the right side of the interface. All of the boxes appear green, denoting that they are fully staffed. However, the Medical Operations Lead box is still red, meaning there is a shortage in this role.

The Staff Volunteer Standby Pool contains gray “unavailable” turtles. It is important to note that these turtles are not unavailable for the same reasons that the original absent turtles are in the Available Staff Pool. The turtles in the Standby Pool have gone through all of their assignment possibilities, and all roles they were capable of staffing were already fully staffed. In a real-world event, at least some of these individuals would likely be kept to assist in the POD. However, for the purposes of this model (simply showing if the POD can reach staff capacity or not) these turtles are “turned away” from staffing the POD, and are thus rendered inactive.

Figure 5 Model Interface After the Model Run Has Concluded

3.4 RESULTS

Four different sets of experiments were made for each pathogen (for a total of eight runs) using the BehaviorSpace component of NetLogo:

1. A baseline experiment holding absenteeism, employee response, and volunteer response constant at their baseline values. This set of values was run 1,000 times.
2. Absenteeism experiment, varying the absenteeism value at 1%, 10%, 25%, and 50%. Each value was run 1,000 times for a total of 4,000 runs in the experiment. Values below %1 or over 50% were not used because they were infeasible in the scenario that this model was designed to test. For example, it is assumed that ACHD experiences approximately a 1% absenteeism rate (approximately 4 individuals) on a typical workday. Furthermore, an absenteeism rate of over 50% would suggest a very severe event that would warrant far more than this model's scenario of only opening four PODs.
3. Employee response experiment, varying employee response values at 10%, 30%, 50%, 70% and 90%. Each value was run 1,000 times, for a total of 5,000 runs.
4. Volunteer response experiment, varying volunteer response values at 10%, 30%, 50%, 70% and 90%. Each value was run 1,000 times, for a total of 5,000 runs.

Each of these four experiments was run for both influenza and anthrax. This created a total of 28,000 independent simulation runs.

In these runs, various environmental and agent variables were recorded. To examine the staffing environment created by the input variables, the number of "asks" it takes to staff the POD was measured through recording the number of ticks it took for each run to complete. A tick limit was applied, causing runs to stop at 20 ticks. Any staffing shortages were also recorded through indicator variables for each role, with 0 indicating no shortage, and 1 representing a shortage in that role.

Table 4 and *Table 5* show summaries of the average frequencies or percentages of each outcome variable over all of the experimental runs of the model, under influenza and anthrax scenarios respectively. These descriptive statistics show a general pattern of an increase in time-to-staff and staff shortages as absenteeism increases or as response rates decrease. Furthermore, these numbers for influenza seem to be larger than those for the equivalent runs in the anthrax scenarios. This section will aim to test the statistical significance of these patterns.

Table 4 All Experimental Conditions for Influenza

Experiment	Absenteeism	Employee Response	Volunteer Response	Average # of Asks*	Shortages			
					Role 0	Role 1	Role 3	Role 6
Baseline	1%	90%	25%	2.05	0%	4.80%	0%	0%
Absenteeism	5%	90%	25%	2.12	0%	9.80%	0%	0%
	10%	90%	25%	2.31	0%	14.50%	0%	0%
	25%	90%	25%	4.78	0%	38.00%	0%	2.40%
	50%	90%	25%	13.77	0%	93.00%	0%	75.90%
Employee Response	1%	10%	25%	9.95	0%	57.90%	0%	0.10%
	1%	30%	25%	4.25	0%	7.30%	0%	0%
	1%	50%	25%	2.89	0%	4.40%	0%	0%
	1%	70%	25%	2.22	0%	3.20%	0%	0%
Volunteer Response	1%	90%	10%	12.40	0%	26.40%	0%	43.00%
	1%	90%	30%	1.74	0%	3.50%	0%	0%
	1%	90%	50%	1.04	0%	0.60%	0%	0%
	1%	90%	70%	1.01	0%	0.40%	0%	0%
	1%	90%	90%	1.00	0%	0.20%	0%	0%

Only roles with shortages at one or more points in the series of experiments are shown. If a role is not shown in this table, it experienced no shortages in any of the runs.

**Time-to-Staff was only measured within those PODs that were fully staffed. Therefore, the denominator may differ from that of other columns.*

Table 5 All Experimental Conditions for Anthrax

					Shortages			
Experiment	Absenteeism	Employee Response	Volunteer Response	Average # of Asks	Role 0	Role 1	Role 3	Role 6
Baseline	1%	90%	25%	1.00	0%	0%	0%	0%
Absenteeism	5%	90%	25%	1.01	0%	0%	0%	0%
	10%	90%	25%	1.01	0%	0%	0%	0%
	25%	90%	25%	1.54	0%	0%	0%	0%
	50%	90%	25%	6.15	0%	0%	2.50%	4.70%
Employee Response	1%	10%	25%	3.73	0.10%	0%	0%	0%
	1%	30%	25%	2.00	0%	0%	0%	0%
	1%	50%	25%	1.67	0%	0%	0%	0%
	1%	70%	25%	1.08	0%	0%	0%	0%
Volunteer Response	1%	90%	10%	1.79	0%	0%	0%	0%
	1%	90%	30%	1.00	0%	0%	0%	0%
	1%	90%	50%	1.00	0%	0%	0%	0%
	1%	90%	70%	1.00	0%	0%	0%	0%
	1%	90%	90%	1.00	0%	0%	0%	0%

3.4.1 Time-to-Staff

To test whether there were significant differences in the mean time-to-staff (as demonstrated by number of asks) for complete runs across conditions within each pathogen group, a one-way ANOVA was performed for each condition. An ANOVA was chosen because it allowed us to see if there are any differences in means across the category as a whole. If any conditions do not show a significant difference, they will not go on for further analysis of specific differences. This test showed that all experimental conditions under both pathogens had significant differences in their series of means.

Table 6 One-Way ANOVA of Time-to-Staff Across Conditions

Pathogen	Experiment	N	Mean Time-to-Staff	F	p-value
Influenza	Absenteeism	2,737	2.93	312.79	<0.0001*
	Employee Response	3,271	3.99	601.65	<0.0001*
	Volunteer Response	4,356	2.23	4715.26	<0.0001*
Anthrax	Absenteeism	3,887	2.32	1114.11	<0.0001*
	Employee Response	3,999	2.12	1063.33	<0.0001*
	Volunteer Response	5,000	1.16	3628.66	<0.0001*

**Denotes a significant difference($\alpha = 0.05$) in mean number of asks*

Since all conditions showed a significant difference in means, a series of Tukey's Studentized Range pairwise tests were performed for each condition to determine exactly where the differences occurred within the series of values. For example, the one-way

ANOVA showed a significant difference in the set of means for the mean time-to-staff under the absenteeism runs. The pairwise tests will allow us to see if these differences occurred between 10% and 30%, 30% and 50%, and so on. This showed significant differences between most pairs.

Table 7 Tukey's Pairwise Comparisons of Time-to-Staff

Pathogen	Absenteeism Pair	Employee Response Pair	Volunteer Response Pair
Influenza	5% to 10%	10% to 30%*	10% to 30%*
	5% to 25%*	10% to 50%*	10% to 50%*
	5% to 50%*	10% to 70%*	10% to 70%*
	10% to 25%*	30% to 50%*	10% to 90%*
	10% to 50%*	30% to 70%*	30% to 50%*
	25% to 50%*	50% to 70%*	30% to 70%*
			30% to 90%*
			50% to 70%
			50% to 90%
			70% to 90%
Anthrax	5% to 10%	10% to 30%*	10% to 30%*
	5% to 25%*	10% to 50%*	10% to 50%*
	5% to 50%*	10% to 70%*	10% to 70%*
	10% to 25%*	30% to 50%*	10% to 90%*
	10% to 50%*	30% to 70%*	30% to 50%
	25% to 50%*	50% to 70%*	30% to 70%
			30% to 90%
			50% to 70%
			50% to 90%
			70% to 90%

**Denotes significant difference ($\alpha = 0.05$) between test values*

A two-samples T-test was used to determine relationships between the same variables, but across pathogen groups. This showed significant differences between time-to-staff between influenza and anthrax for all scenarios, except for when employee response and volunteer response were both 90%.

Table 8 T-tests for Influenza and Anthrax Time-to-Staff

Experiment	Absenteeism	Employee Response	Volunteer Response	Influenza Mean (N)	Anthrax Mean (N)	t value
Baseline	1%	90%	25%	2.05 (952)	1.00 (1000)	32.06
Absenteeism	5%	90%	25%	2.12 (902)	1.01 (1000)	41.39
	10%	90%	25%	2.31 (855)	1.02 (1000)	38.13
	25%	90%	25%	4.78 (603)	1.54 (1000)	25.52
	50%	90%	25%	13.77 (13)	6.15 (887)	5.82
Employee Response	1%	10%	25%	9.95 (420)	3.73 (999)	30.43
	1%	30%	25%	4.25 (927)	2.00 (1000)	18.53
	1%	50%	25%	2.89 (956)	1.67 (1000)	14.28
	1%	70%	25%	2.22 (968)	1.08 (1000)	30.83
Volunteer Response	1%	90%	10%	12.40 (403)	1.79 (1000)	65.45
	1%	90%	30%	1.74 (965)	1.00 (1000)	47.93
	1%	90%	50%	1.04 (994)	1.00 (1000)	6.56
	1%	90%	70%	1.01 (996)	1.00 (1000)	2.84
	1%	90%	90%	1.00 (998)	1.00 (1000)	1.42*

*Denotes a difference between pathogens that is *not* significant

3.4.2 Role One: Medical Operations Manager

Role One, the Medical Operations Manager, which can only be held by an ACHD official with some level of medical expertise, was the most common source of incomplete staffing. However, this shortage only occurred in the influenza runs, due to the requirements for medical personnel in the setting of administering vaccinations.

To examine if there were significant differences in frequencies of shortcomings in this role, a Cochran-Armitage Test of Trend was run on each condition under influenza. This test was chosen because it allows for analysis of trends in frequency outcome data (Role One shortage) across an ordinal independent variable (absenteeism and response). Anthrax conditions were omitted from this test, since there were no role one shortages under those conditions.

Table 9 Frequencies of Role One Shortages in Influenza Conditions

Pathogen	Experiment	Z-statistic	p-value
Influenza	Absenteeism	42.63	<0.0001*
	Employee Response	-30.60	<0.0001*
	Volunteer Response	-22.98	<0.0001*

**Denotes a significant difference (α = 0.05) in frequency of shortages in Role One*

3.4.3 Additional Roles

Role Six, Medication Dispensing Staff, was the next largest source of staffing shortcomings, mainly only occurring during extreme strain: at 25% or 50% absenteeism for influenza conditions and 50% absenteeism for anthrax conditions, and 10% volunteer response for influenza.

Role three (Screening Staff) also occasionally caused shortages the extreme case of 50% absenteeism in anthrax conditions. There was one sole case on a role zero (POD Manager) shortage. While this is clearly a very essential role to have staffed, no further investigation will be done, since the shortage only occurred once in 30,000 runs.

4.0 DISCUSSION

This model shows potential for using an agent-based modeling approach to emergency planning. The baseline levels of variables supported by real-world situations created relatively non-constrained staffs, similar to what was accomplished by ACHD in the H1N1 pandemic. Furthermore, manipulating response levels and absenteeism levels showed significant changes in time-to-staff and in staffing shortages in various roles. These trends also differed significantly by pathogen.

Developing such a model for actual use in local health departments could provide an excellent way for planners to anticipate staffing constraints ahead of time. They could then use this information to tailor recruiting efforts or enhance training in certain areas.

4.1 EFFECTS OF VARIABLES

Overall, influenza conditions were far more prone to staffing shortages than the same conditions with the staffing requirements of an anthrax POD. The model showed shortcomings of some extent role one (Medical Operations Lead) for every single condition under influenza. While in a real-world situation (in Allegheny County, at least), the adaptability of such a large potential staff pool would likely be able to work around that problem. However, in a smaller jurisdiction this would be useful information to have in order to plan accordingly.

This model did not account for the differences in throughput that come with an antibiotic POD. However, since overall staffing shortcomings were so small, and since throughput requirements are smaller, not larger, in an antibiotic POD, this is a minor point, though worthy of future study.

Increasing absenteeism rates very quickly increased staffing shortages for influenza conditions, leading to near-complete shortcomings with role one by 50% absenteeism and requiring a several inquiries before the POD was staffed. This is an interesting dynamic, since higher absenteeism implies a more serious situation, which would demand more PODs that are fully staffed. However, for anthrax conditions, absenteeism didn't have a very strong effect on either ticks of staffing shortcomings.

As expected, higher response was accompanied by less time-to-staff and fewer staffing shortcomings. Interestingly, once volunteer response moved past 50%, mean number of ticks stopped changing significantly

4.2 LIMITATIONS AND FUTURE RESEARCH

4.2.1 Drill Databases

The primary limitation of this model stems from a lack of robust response information for the staffing sources that were included in this model. Ideally, a central database could be compiled over time that measured responses over all scenarios that are used in these regular drills, and with the same drills being given to both ACHD and the MRC. Currently, these drills are conducted at different times, through different systems, and are stored in different places and in different formats. Creating a central database for all of this information could aid in the creation of a model that would be more intuitive on how individuals respond, and how their response varies in different emergencies.

This would be particularly helpful in understanding exactly which MRC members would be most likely to volunteer in different types of emergencies. For example, currently-working physicians, nurses, EMT's, and other medical professionals would likely be unable to volunteer in a public health emergency due to having to work in their everyday jobs. While it is still well worth including these professionals in the MRC due to their expertise, it is important during planning to account for the potential for their inability to respond in an actual emergency.

In the future, merging drill practices could provide this kind of insight. However, this would require an extensive re-vamping of current practices. Perhaps a more feasible approach—at least preliminarily—would be to survey employees and volunteers with a drill-type scenario using a survey system, as opposed to an actual drill system. Since actual names and demographics are not vitally important at this level, simply asking for organization, occupation, and response could provide a cheaper and more practical preliminary look at the potential usefulness of a standardized test system.

4.2.2 Throughput

In the event that a POD was understaffed, especially if only slightly so, it is far more likely that the POD will simply operate at a lower capacity, than totally shut down the POD. Therefore, creating a new element to this model that assesses throughput based on the staff that is produced could add depth and further applicability to the knowledge gained from this model. This is a complex problem, since some roles slow throughput more than others. For example, if a POD is short on runners, there may be delays in getting supplies to vaccinators, causing minor throughput slowing throughout the day. However, if a POD is short on just one or two vaccinators or screeners, this could cause a bottleneck in the entire POD, slowing throughput down significantly.

As discussed previously, existing models such as RealOpt and BERM already generate an anticipated throughput based on various factors, like staffing numbers. Ideally, these two areas could be merged to form a model that generates a staff based on test criteria, and then generates a POD based on that staff and tests the requirements of that POD. This would allow planners to anticipate just how much operations could suffer if their staffing capabilities are impacted in an emergency. Furthermore, this could allow investigators to see if there is some staffing threshold that may cause a significant drop in throughput.

4.2.3 Absenteeism

Absenteeism is potentially the most complex of all the variables manipulated in this model, since it encompasses so many possible contributing factors: baseline absenteeism, disease spread, and school closure. The effects of these factors—both on their own and as related to each other—would require a study all their own. Ideally, such a study would examine questions such as (but not limited to) the following:

- Does disease spread differently in health professionals, causing them to be more or less likely to get sick in an outbreak?
- If schools were closed, how many health professionals would have to stay home? And how would this impact staffing?
- Are there any relationships between any of these factors? Will school closure cause people to have to stay home with their children, but also prevent others from getting sick and being able to work?

4.2.4 Interactions and Additional Variables

Before a model of this nature can be deployed for actual use, a number of additional factors should be explored. These include:

- **Interactions between variables discussed in this project:** If absenteeism is high, will this influence the perceived level of situational severity in potential volunteers, thus causing response rates to decrease? Different pathogens would certainly affect absenteeism, but would the perceptions of different pathogens affect response as well? These questions were not addressed in detail in this pilot model, but are the next logical step in development.

- **Population characteristics:** What does the population needing coverage look like? A city with a high population of citizens over 65 may need to provide mass prophylaxis for more people than a city with a high population of young professionals. Is there a high incidence of other diseases in the population that may compromise immunity (i.e. HIV) or increase mortality if medical resources are strained (i.e. heart disease). By increasing or decreasing throughput needs, these kinds of factors may indirectly affect staffing needs.
- **Health department needs:** This project was conducted under a scenario involving a weekend POD. This eliminated the need to account for which personnel were going to be continuing the everyday operations of the health department. However, what about scenarios when a weekend POD is not possible? Including a continuity-of-operations component by accounting for normal health department functions as additional "roles" could add to the usefulness of this model. This is particularly true since some MRC members may of better use performing health department tasks instead of manning a POD.

5.0 CONCLUSIONS

This project has provided support for the potential use of an agent-based model as a planning tool in local health departments. If these were actual results, after more validated response information has been obtained, the health department getting these results could conclude that they need to train more health department employees to staff the Medical Operations Lead role, or designate especially knowledgeable MRC volunteers who could fill the role in need be.

While existing models look more closely at how to best deploy and utilize existing personnel resources, this model, if further refined and developed, could help advise decision-makers on how they can tailor their recruiting, training, and similar efforts to produce a well-rounded responding workforce.

APPENDIX A

MEDICAL RESERVE CORPS DRILL SCENARIO AND ANSWER CHOICES

The following drill text was sent to MRC volunteers via the SERVPA volunteer registry as part of a no-notice call-down drill which was conducted with the MRC over a four day period in August, 2012.

MRC drill text:

"THIS IS A DRILL

An infectious disease emergency has developed in Allegheny County and requires mass distribution of medication to the community. Points-of-dispensing (PODs) are being opened at locations throughout the county.

Please log in to the SERVPA System and indicate your willingness to volunteer at a POD location by choosing one of the response options listed below before 10 a.m. on [Day 4]. This will indicate that you have completed your task for this drill.

THIS IS A DRILL

Response Options:

Option #1: I am willing to respond for an influenza outbreak.

Option #2: I am willing to respond for an anthrax outbreak.

Option #3: I am willing to respond for both an influenza outbreak or an anthrax outbreak.

Option #4: I am not willing to respond for either outbreak.

THIS IS A DRILL"

Subsequent drill messages were identical, but were preceded by the following reminder statements:

- Day 2: *"You have not yet participated in this drill. Please indicate your response below."*
- Days 3 and 4: *"You have not yet completed the Point-of-Dispensing volunteer availability drill for the Allegheny County Medical Reserve Corps. Please select the appropriate response below to complete the drill.*

APPENDIX B

STAFF CATEGORIZATION AND SKILL RANKING PROCEDURES

STAFF CATEGORIZATION PROCEDURES

Staffing data from ACHD were provided in the form of medical and non-medical counts for broad occupational groups: administrators and managers, supervisors, professionals (non-nursing), professionals (nursing), clerical, technical, drivers, plumbers. Drivers and plumbers were then more broadly categorized as “other.” MRC data were obtained with specific discipline categorizations, and were then divided into the same categories as the ACHD staff.

By the end of the categorization process, each individual will have two designations: category, and medical status denoting whether that person is medical or non-medical. Of note, medical and non-medical in this capacity differ from medical and non-medical POD role in that a POD role designated as medical under the medical section may not necessarily require medical skills. For example, the screener role is designated under the medical POD section, but does not necessarily require that the person staffing that role to have medical training.

Table 10 Staff Category Definitions and Examples

Staff Category	Medical* Example(s)	Non-Medical** Example(s)
Administrators and Managers: Operate in an administrative or managerial capacity over a program.	Clinic administrators	Social and community service manager, public health administrators
Supervisors: Operate in a supervisory capacity over personnel.	Medical program supervisors	Non-medical program supervisors
Professionals (Non-Nursing): Operate in a professional role. May be medical, but differentiated from nursing.	Physicians, EMT's, pharmacists	Behavioral health professionals, epidemiologists
Professionals (Nursing): Operate in any sort of nursing capacity—either licensed/registered, or aides.	RN's, LPN's, nursing aides	----
Clerical: Operate with clerical tasks such as answering phones, filing paperwork, managing logistics.	Medical assistants	Administrative assistants, fee clerks
Technical: Technical trades, often requiring certification.	Medical/clinical lab techs, pharmacy techs	Microbiologists, information technology
Other: Any discipline that doesn't fit in one of the above categories	----	Law enforcement, dispatchers

* *Medical positions are those that require medical credentials, particularly those which require contact with patients*
** *Non-Medical positions are all positions that do not directly require medical credentials*

RANKING PROCEDURES

Each staff category will be ranked by its capacity to operate in each individual role in a POD. These ranks apply to the category group (i.e. Professional (Non-Nursing)) as a whole, and do not account for variation within that category (i.e. a nurse comfortable with operating in a supervisory role, as opposed to a nurse without this capacity). Since a seasoned nurse with extensive experience may be better fitted for a given role than a new physician, future work would ideally account for this variation.

Overall, ranks are based on order in which job categories will fill a POD role, as opposed to the order in which a job category can fill POD roles. Because of this, a certain job category may lack ranks within its category.

Ranks were determined based on the following criteria:

- If a category possesses a desired skill, they will be given a higher rank (i.e. medical professionals receive a higher rank in medical roles)
- If a category possesses a skill is highly desired elsewhere, they will be given a lower rank in roles that desire no advanced skills. (i.e. medical professionals receive a low rank for line staff, since line staff roles require no advanced skills, but medical skills are of high priority elsewhere)
- If multiple categories possess similar skills that are equally necessary in a role, they will receive equal ranks
- For backup staff roles, ranks will be at a lower value than the lowest rank in any other role. (i.e. if the lowest rank out of all other groups is a 6, backup roles start ranking at a 7) This will ensure that primary roles are filled first.

Table 11 Personnel Ranking by POD Role for a Vaccination POD (Influenza)

POD Category	Role	Admin/Managers		Supervisors		Professional (Non-Nursing)		Professional (Nursing)		Clerical		Technical		Other	
		Med	Non	Med	Non	Med	Non	Med	Non	Med	Non	Med	Non	Med	Non
Medical	Medical Operations Lead[*]	2	--	1	--	2	--	3	--	4	--	4	--	4	--
Medical	Screening Supervisor	2	--	1	--	2	--	3	--	4	--	4	--	4	--
Medical	First Aid Room Staff	2	--	2	--	1	--	1	--	3	--	3	--	3	--
Medical	Medication Dispensing Supervisor	2	--	1	--	2	--	1	--	3	--	3	--	3	--
Medical	Medication Dispensing	1	--	1	--	1	--	1	--		--	--	--	--	--
Medical	Express Medication Dispensing	1	--	1	--	1	--	1	--		--	--	--	--	--
Non-Medical	Non-Medical Lead[*]	4	1	4	1	5	2	5	--	5	2	6	3	6	3
Non-Medical	Registration/Training/Break Room Staff	3	2	4	4	4	2	4	--	1	1	1	1	3	3
Non-Medical	Supply Supervisor	2	2	1	1	3	3	3	--	2	2	3	3	3	3
Non-Medical	Runner	3	2	4	4	4	2	4	--	1	1	1	1	1	1
Non-Medical	Lead Facility Supervisor	2	2	1	1	3	3	3	--	2	2	3	3	3	3
Line	Line Lead[*]	4	1	4	1	5	2	5	--	5	2	6	3	6	3
Line	Line Staff	4	1	5	5	5	1	5	--	3	2	3	2	3	2
Line	Extra Medical for Staff Breaks	7	--	7	--	7	--	7	--	7	--	7	--	7	--
Line	Extra Non-Medical for Staff Breaks	7	7	7	7	7	7	7	--	7	7	7	7	7	7

Table 12 Personnel Ranking by POD Role for an Antibiotic POD (Anthrax)

POD Category	Role	Admin/Managers		Supervisors		Professional (Non-Nursing)		Professional (Nursing)		Clerical		Technical		Other	
		Med	Non	Med	Non	Med	Non	Med	Non	Med	Non	Med	Non	Med	Non
Medical	Medical Operations Lead*	2	5	1	5	2	5	3	--	4	5	4	5	4	5
Medical	Screening Supervisor	2	5	1	5	2	5	3	--	4	5	4	5	4	5
Medical	First Aid Room Staff	2	4	2	4	1	4	1	--	3	4	3	4	3	4
Medical	Medication Dispensing Supervisor	2	4	1	4	2	4	1	--	3	4	3	4	3	4
Medical	Medication Dispensing	1	2	1	2	1	2	1	--	2	2	2	2	2	2
Medical	Express Medication Dispensing	1	2	1	2	1	2	1	--	2	2	2	2	2	2
Non-Medical	Non-Medical Lead*	4	1	4	1	5	2	5	--	5	2	6	3	6	3
Non-Medical	Registration/Training/Break Room Staff	3	2	4	4	4	2	4	--	1	1	1	1	3	3
Non-Medical	Supply Supervisor	2	2	1	1	3	3	3	--	2	2	3	3	3	3
Non-Medical	Runner	3	2	4	4	4	2	4	--	1	1	1	1	1	1
Non-Medical	Lead Facility Supervisor	2	2	1	1	3	3	3	--	2	2	3	3	3	3
Line	Line Lead*	4	1	4	1	5	2	5	--	5	2	6	3	6	3
Line	Line Staff	4	1	5	5	5	1	5	--	3	2	3	2	3	2
Line	Extra Medical for Staff Breaks	7	--	7	--	7	--	7	--	7	--	7	--	7	--
Line	Extra Non-Medical for Staff Breaks	7	7	7	7	7	7	7	--	7	7	7	7	7	7

APPENDIX C

DETERMINING CHANGING RESPONSE RATES

Over a given series of "asks," it is assumed that the highest response rate will be on the first ask. It is further assumed that individuals on subsequent asks will respond when they see a continued need, but this response rate will drop as the number of asks goes on. The drill responses from the MRC drill were used to provide a basis for demonstrating this dynamic.

The drill was distributed to 507 individuals and a total of 120 responded saying they would volunteer to work in a POD of some sort. On the first ask, the drill text was distributed to 507 people, with 77 people actively responding, all of whom had a positive reply. On the second ask, the drill text was distributed to the 430 remaining people, with 33 people responding (24 positive, 9 negative). On the third ask, the drill text was distributed to the 397 remaining people, with 19 responding (14 positive, 5 negative). Finally, on the fourth ask, the drill text was distributed to the 378 remaining people, with 6 responses (5 positive, 1 negative).

In determining response rates, only positive responses were used. This is because in the model, non-respondents are treated the same as negative respondents. The amounts of negative responses were relatively low in this drill, so it is assumed that if there were an actual emergency, asking these individuals again may illicit a different response. However, this is a limited assumption, since in this drill negative respondents were not surveyed again, while non-respondents were.

Table 13 MRC Response Rates by Ask Number

Ask Number	Positive Responses	# Asked	Response Rate	Proportion Change
1	77	507	15.2%	--
2	24	430	5.6%	2.7
3	14	406	3.4%	1.6
4	5	392	1.3%	2.7

The resulting proportions will be applied to the model for the first through fourth asks, to adjust for this change in response. However, no adjustment will be applied for subsequent asks. This is for two reasons: 1) the data used to obtain these scales ended after the 4th ask, and 2) response counts at this small of a percentage are so low that any changes will likely be negligible.

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