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Throughput of the Strategic National Stockpile Points of Distribution

Maryann Fenwick
University of Arkansas, Fayetteville

Throughput of the Strategic National Stockpile Points of Distribution

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Maryann Fenwick

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Dr Charleen McNeill
Honors Thesis/Project Director

Dr. Kelsey Gilmet
Committee Member

Dr. Nan Smith-Blair
Committee Member

Dr. Peggy Lee
Committee Member

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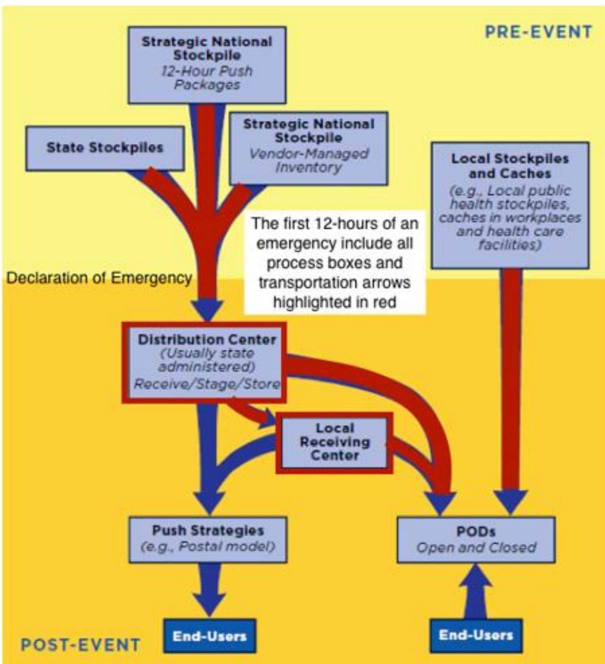
Since 2000, the United States (US) has experienced 400 natural disasters (Guha-Sapir, Below & Hoyois, 2015). These natural disasters have resulted in over 6,500 deaths, impacted over 22 million people, and cost over $59 billion. Also, the US has experienced 81 technological disasters during the same time period (Guha-Sapir, Below & Hoyois, 2015). These technical disasters have resulted in 1377 deaths, impacted 16,560 people, and cost almost $20.5 billion. With predicted changes to climate, the number of disasters is predicted to increase worldwide (Intergovernmental Panel on Climate Change, 2011).

Arkansas is not without risk of disasters having experienced 32 major disaster declarations since January 2000 (Federal Emergency Management Agency [FEMA], 2017). Arkansas Nuclear One, near Russellville, Arkansas, poses many health concerns for Arkansans (US NRC, 2015). The Nuclear Regulatory Commission (NRC) has identified several safety violations and has placed the plant in Column 3 of the NRC Action Matrix; Column 4 indicates a facility is inoperable. The Zika virus and Ebola are threats throughout the US, to include Arkansas (Centers for Disease Control and Prevention [CDC], 2016a) and the flu kills over 23,000 Americans each year (Arkansas Department of Health [ADH], 2011a). When states experience major disasters, the US has the stockpiled resources to provide scalable response measures within the Strategic National Stockpile (SNS; CDC, 2016b).

In the event of a public health emergency, the timely dispensing of medical countermeasures is paramount. Those medical countermeasures begin their route for distribution at the SNS and must be delivered within 48 hours. See figure 1. The logistics associated with mass distribution to impacted populations within target timelines are complex. One method for local distribution is via Points of Dispensing (PODs), which are locations where the public goes to obtain emergency supplies after a disaster. Challenges associated with POD operations include staffing them to meet required throughput and reaching vulnerable populations. The inclusion of home health care and nursing school assets in local dispensing operations have the potential to address these challenges. The purpose of this research is to evaluate the incorporation of these assets in current distribution methods to determine if improvements are available.

Figure 1. Current Dispensing Strategies for Medical Countermeasures



Adapted from Stroud, C. Current dispensing strategies for medical countermeasures for Anthrax. U.S. National Libraries of Medicine.

Background and Significance

The SNS is designed to supplement state agencies with large quantities of medicine and equipment which can be sent from a number of confidential locations in the US (Prior, 2004). Such supplies are stored in push packages, which are ready for immediate release and are rapidly deployed in public health emergencies and disseminated to PODs in the impacted area. A POD is the public place that medical supplies are dispensed to the community during a crisis; they must be able to respond to both large and small incidents (CDC, n.d). In the event of a national public health emergency, FEMA has a 48-hour timeline between the declaration of the emergency and the treatment of the last person in need in the last active POD of medical countermeasures (CDC, 2016b; Fisk, 2015; The National Academies of Sciences, 2017).

As remarked previously, the SNS is part of a scalable response measure within the US. The SNS system was designed to facilitate the dissemination of needed medical supplies within the 48 hours following the emergency declaration (Prior, 2004). This design was not tested until September 11, 2001 and the anthrax events that followed (Prior, 2004). In 2014, SNS was deployed 6 times in Arkansas alone (CDC, 2016c). The SNS responds to appropriate emergency declarations by sending 12-hour push packages containing medications and medical supplies (Robarge-Silkiner, n.d.). These packages should make it to the initial storage site at the emergency location within 12 hours so that it is ready for dissemination to the PODs and ultimately available to the community within 48 hours of initial deployment (Robarge-Silkiner, n.d.). The mandatory dissemination timeline necessitates testing times of dissemination, or a time series analysis. Such a time series analysis is used to measure the resources available to disseminate medications and supplies to each member of a community and how long it takes for the extant resources to do so. This information is used to help determine how many POD's must be deployed in a jurisdiction and adequacy of throughput to meet the needs of every member of the targeted community.

POD design, staffing and location for each unique emergency require timely decisions based on a complex set of variables that requires specialized software (Lee et al, 2009). While supply resources can be stockpiled to be available in needed quantities, human resources are limited and add to the challenge of finding an optimum use of available resources. When creating the variable list for the software, scarcity of available trained staff for each POD is an important bottleneck in the delivery process. Even with best available deployment of limited trained staff, few cities are able to meet the 48-hour window. POD placement when one or more resources is limited requires even more complex decision software (Ramirez-Nafarrate et al, 2015). The first limiting variable in this software is trained human resources. Since in PODS triage time is insignificant in comparison to dispensing time, the dispensing time is a close estimate of the wait time per POD. In modeling of delivery throughput, available trained staff for dispensing at each POD is acutely important to throughput. This holds true whether arrivals use the shortest line or are evenly distributed. Nurses are the majority of the healthcare providers worldwide and should receive disaster preparedness training as undergraduates (Rafferty-Semon et al, 2017). In the four disaster simulations, nursing students were able to obtain the necessary information to function as trained POD delivery staff from Job Action Sheets and Public Health staff in a short time.

The efficiency of response measures is of particular interest to researchers. In an emergency event, mass vaccination has been found to lead to fewer deaths than trace vaccination (Kaplan, Craft & Wein, 2002). In this study, the tracing of those who would require vaccinations was determined to require a significant increase in time, whereas mass vaccinations would reach all quickly and ultimately decrease the number of deaths. In a later study it was found when volunteers are used to augment trained staff, the pre-event training requirement is increased to ensure vaccination administration is safe (Rebmann et al., 2015). Additionally, there tends to be more training planned than is actually administered, potentially negatively impacting safe administration when lay volunteers are utilized (Rebmann et al., 2015). Nursing students are uniquely prepared to fill the gap in the administration of vaccinations or pills in the interest of reaching more affected populations. While they are not currently obligated to report to work as a nurse in times of emergency, senior nursing students have training that qualifies them to augment the POD staffing in such times, theoretically increasing throughput dramatically (Arkansas State Board of Nursing, 2017). The staff of the health department alone is not enough to get the medications dispensed in the 48-hour requirement (CDC, n.d.).

Methods

The purpose of this research was to analyze and evaluate current SNS distribution methods and resources inclusive of human capital to determine if improvements are available and/or necessary to achieve complete SNS dispensation within the 48-hour target range. Emphasis was placed on dispensing activities that occur within open PODs. Simulation models of POD operations were utilized to replicate the existing distribution methods and resources as well as to create alternative SNS distribution strategies. These strategies specifically consider one major modification to the current method in which supplies are dispensed at the local level: utilizing senior nursing students to augment the staff administering medications at open PODs. A comparison of the effectiveness of a dispensing operation that uses only public health staff at open PODs to one that utilizes both public staff and senior nursing students at PODs was conducted.

Research Question

This research examines possible increases to throughput of PODs with the following research question: What changes in throughput are noted when senior nursing students dispense medications at points of distribution in an emergency in Northwest Arkansas?

Data Collection

Most of the required data collection and time series analysis for this research was collected at an emergency exercise with the Arkansas Department of Health in October 2016.

This includes some simulation input parameters, POD distribution methodology, and modeling results of a previous simulation study utilizing only public health personnel available. This event allowed for the recording of additional simulation parameters and first-hand observations of distribution techniques. Comparative analysis of alternative distribution methods and resources utilizing statistical analysis to compare simulation results inclusive of only public health personnel to alternative distribution methods inclusive of senior nursing students was performed.

Analysis

Discrete event simulation performed with Arena Simulation Software is used to model dispensing operations within PODS. Discrete event modeling is the process of depicting the behavior of a complex system as a series of well-defined and ordered events. It provides a complete range of statistical distribution options to accurately model process variability. The models are demonstrated for a single county case study. Within each simulation and testing of the model, four stations within the PODS were included: greeting, registration, dispensing, and form collection.

Results

For the ADH simulated service time input for each of the four stations, distribution triangulation was calculated (Table 1). Further, the model was tested at a flu clinic conducted with ADH and the University of Arkansas nursing students. Standard measures of dispersion around the mean for each station were calculated (Table 1). Further inputs of the model included personal and average wait time for each participating entity. Case study results indicate the current POD model can serve 47.2% of the impacted population within the target timeframe of 24 hours. Augmenting staffing resources in PODS with nursing students would further increase coverage to 66%. The population of Washington County is approximately 225,477. Of that population, approximately 8,600 would be served by closed PODS, 5,411 by home health agencies, 22,547 by local hospitals. The remaining target population to be served by the open PODS is approximately 188,919 people. The 12-hour throughput for one POD staffed with only public health personnel is 11,146 for a total of 89,168 across 4 PODS in a 24-hour period. For PODS staffed with nursing students, it is 15,586 for one POD for a total of 124,687 across 4 PODS in a 24-hour period. Distribution of response measures is to be achieved for 100% of the population in a 24-hour period.

Table 1. Data from ADH and University of Arkansas (U of A) Computer Simulations

	Greeting	**Registration**	**Dispensing**	**Form Collection**
ADH simulation service time input				
distribution (sec.)	~TRIA(5,10,15)	~TRIA(60,120,180)	~TRIA(60,120,180)	~TRIA(3,5,10)
mean (sec.)	15	180	180	9
UofA flu clinic data				
min (sec.)	2	51	64	13
max (sec.)	30	415	255	70
mean (sec.)	7	164	126	21
stdev (sec.)	5	82	46	10
Personnel				
medical	0	0	31	0
non-medical	3	31	0	2
total	3	31	31	2
Avg wait time				
ADH	0.25 min.	6.5 min.	1 min.	4 sec.
UofA	3.5 hr.	5 min.	3 hr.	3.5 hr.
24-hour throughput				
ADH personnel only – 89,168 people served				
Augmenting PODS with senior nursing -- 124,687 people served				
Total population needing service -- 188,919				

Discussion

The CDC disaster planning goal requires the impacted population to be treated within a 48-hour timeframe (CDC, 2016b; Fisk, 2015; The National Academies of Sciences, 2017). After allowing for POD location determination, delivery, setup and staffing, 24 hours is the expected timeframe available to deliver the appropriate response measures to the target population. Current simulation parameters indicate prophylaxis delivery would reach far less than 100% of the citizens (47.2%) in the case study county within the 24-hour distribution time. The post disaster survivability of the target population can be severely reduced due to this inability to achieve or to even nearly achieve the goal. Failure to deliver prophylaxis to a sufficient portion of the population can allow the vector to become uncontrolled. Failure to deliver life supporting supplies can result in countless additional casualties. Identifying additional potential staffing resources is required to even approach the goal (Lee et al, 2009).

The simulations and real-life flu-clinic data show the addition of senior nursing students to the current ADH staff can increase population access to needed countermeasures from 47.2% to 66%, making a significant difference towards achieving the 100% within 24 hours goal. Nursing students are attractive resources in emergent scenarios as they are not committed to service elsewhere and are thus a significant force multiplier at a critical time. Their education status and faculty supervision meet requisite qualifications for participation.

Potentially modifiable factors to increase senior nursing student's willingness to respond were also noted in the literature to include increasing knowledge of disaster response measures (Adams & Berry, 2012; Chilton, McNeill, Alfred, 2016; Milburn & McNeill, 2016; Qureshi et al., 2005). For this reason, including training in POD staffing duties in the last few weeks of the Junior year may decrease the time required for initial just in time training making nursing students immediately available to provide services upon arrival and more willing to provide such response measures. Also, previous experience with expected duties could reduce stress of an unknown situation and increase the likelihood of participation in a disaster (Adams & Berry, 2012; Chilton, McNeill, Alfred, 2016; Milburn & McNeill, 2016; Qureshi et al., 2005).

The current expected coverage of 46% of the target population within the 24-hour delivery timeframe is woefully inadequate. Even with the addition of current senior nursing students at the simulated and tested increased delivery rate, only 66% of the target population is projected to be reached. The inclusion of training for nursing students and participation in simulated drills can increase the immediate usefulness and expected response rate of qualified personnel further increasing throughput.

Limitations

This study used a limited number of volunteer nursing students from one nursing program that only spent a short time during the simulation working in a POD due to the limited duration of the test scenario and had received no prior training. With the greater number of repetitions at their individual tasks in a real emergency, the Senior nursing students' speed at their designated task would increase. Also, this lack of prior training resulted in longer times required before the nursing students were able to begin supplementing the POD staff.

When senior nursing students spend longer times at their POD station performing their designated duties and arrive on location already aware of those duties, the expected additional achieved throughput would be much greater. Even with this limitation to test simulation, the predicted change in output was achieved in a real life. With the longer time spent working in the POD in an actual disaster and with disaster training as part of the curriculum for senior nursing students the additional members of the target population that could be reached raises the possibility of reaching or nearly reaching the 100% 24-hour goal.

Additionally, the student's instructor also was involved in the coordination of the simulated disaster. The instructor's involvement may have caused a selection bias towards the most active students. Finally, because the students knew the study was to determine the effectiveness of senior nursing student in the PODs, performance bias may have positively affected the students' performance.

Conclusion

As the world in which we live becomes more chaotic, preparedness for disasters and emergencies becomes ever more important. The PODs represent the final mile of the response delivery system and require staffing beyond what is available in the current model to achieve desired outcomes. This research and simulation have demonstrated there is an additional pool of valuable human resources in the senior nursing student body that are not otherwise obligated to provide services in a health care facility in the wake of a disaster. Such students could serve as a "force multiplier" during emergent times.

At the local level and even with the noted limitations, the increase in throughput achieved by using this resource was important. With time spent at their assigned tasks resulting in greater speed and efficiency, participation in emergency preparedness simulations, and POD experience prior to their arrival at the PODs, Senior nursing students could increase POD throughput dramatically, resulting in significantly decreased event casualties. This projected increase in percentage of target population served can and should be applied to the larger regional, state, and national populations.

At the state level, the Arkansas Department of Emergency Management (ADEM) is required by the federal government to have a plan of emergency preparation for the dispensing of medications within the 48-hour guidelines. ADEM published the most recent SNS Plan for the state of Arkansas on August 31, 2016 (ADEM, 2016). This is reviewed and updated regularly based on deficiencies revealed during SNS Program Assessments along with state and local training exercises (ADEM, 2016). These reviews have revealed inadequacies in the achievability of Arkansas' plan of distribution for the SNS supplies. Currently, the ability of all the 156 pre-identified PODs in Arkansas effectively distributing the required amount of medicine for the entire population within the mandatory 48-hour time period is doubtful—especially when one considers that the 48-hour timeline includes packing, shipping, and distributing to the local PODS, decreasing actual distribution time to 24 hours (ADH, 2011b). The inability to reach every citizen in the state of Arkansas with potentially life-saving medications in a time of emergency could result in a dramatic loss of life. Adequate numbers of qualified personnel that are willing and able to report in a time of emergency are a limiting factor in the delivery of required treatment to the target population within the required timeline. Augmenting such public health personnel can assure timely access to response measures.

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