

# Critical Assessment of Statewide Hospital Pharmaceutical Surge Capabilities for Chemical, Biological, Radiological, Nuclear, and Explosive Incidents

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## Abbreviations:

CBRNE = chemical, biological, radiological, nuclear, and explosive  
MSHP = Maryland Society for Health-System Pharmacists  
PRP = Pharmaceutical Response Project  
SNS = (US) Strategic National Stockpile

## Abstract

**Introduction:** In recent years, government and hospital disaster planners have recognized the increasing importance of pharmaceutical preparedness for chemical, biological, radiological, nuclear, and explosive (CBRNE) events, as well as other public health emergencies. The development of pharmaceutical surge capacity for immediate use before support from the (US) Strategic National Stockpile (SNS) becomes available is integral to strengthening the preparedness of local healthcare networks.

**Methods:** The Pharmaceutical Response Project served as an independent, multidisciplinary collaboration to assess statewide hospital pharmaceutical response capabilities. Surveys of hospital pharmacy directors were conducted to determine pharmaceutical response preparedness to CBRNE threats.

**Results:** All 45 acute care hospitals in Maryland were surveyed, and responses were collected from 80% (36/45). Ninety-two percent (33/36) of hospitals had assessed pharmaceutical inventory with respect to biological agents, 92% (33/36) for chemical agents, and 67% (24/36) for radiological agents. However, only 64% (23/36) of hospitals reported an additional dedicated reserve supply for biological events, 67% (24/36) for chemical events, and 50% (18/36) for radiological events. More than 60% of the hospitals expected to receive assistance from the SNS within ≤48 hours.

**Conclusions:** From a pharmaceutical perspective, hospitals generally remain under-prepared for CBRNE threats and many expect SNS support before it realistically would be available. Collectively, limited antibiotics and other supplies are available to offer prophylaxis or treatment, suggesting that hospitals may have insufficient pharmaceutical surge supplies for a large-scale event. Although most state hospitals are improving pharmaceutical surge capabilities, further efforts are needed.

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## Introduction

In recent years, government and hospital disaster planners have recognized the increasing importance of pharmaceutical preparedness for chemical, biological, radiological, nuclear, and explosive (CBRNE) events, as well as other public health emergencies. As demonstrated during the aftermath of Hurricane Katrina, critical resource shortages can rapidly overwhelm hospitals and public health systems. The development of pharmaceutical surge capacity is integral to strengthening the preparedness of local healthcare networks.

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In 1999, the US Congress requested that the Department of Health and Human Services and the Centers for Disease Control and Prevention develop a reserve of pharmaceuticals and medical supplies for use during national emergencies. The Strategic National Stockpile (SNS) serves as the nation's repository of pharmaceutical/medical supplies (e.g., antibiotics, antidotes, airway maintenance supplies, and other medical/surgical items). The SNS assets are packaged and pre-positioned for immediate deployment. Rapid-response push packages can be delivered to designated sites within 12 hours, while managed inventory (MI) can be delivered within 24 to 36 hours for specific, identified threats.<sup>1</sup> As of April 2004, all states have plans to coordinate the receipt and distribution of SNS supplies.<sup>2</sup>

Although the SNS serves as an important federal resource, governmental authorities warn that it should not be considered a "first-line" response. While prior deployments have demonstrated the capability to transport SNS supplies to designated receiving sites rapidly, logistical delays arising from delivering, distributing, and dispensing to persons in need must be anticipated.<sup>3</sup> Recent experiences demonstrate that hospitals must be able to maintain self-sufficiency for extended periods of time. Public health officials have recommended that hospitals should prepare for an immediate and sustained response for up to 72 hours and be able to meet their own pharmaceutical needs for patients, staff, and families during public health emergencies.<sup>4</sup>

During an emergency, shortages of pharmaceutical or medical supplies could contribute to increased disease burden and a wide-reaching impact on healthcare systems. Hospital operations may be brought to a standstill when critical supplies are inadequate to meet the increased needs or supply channels have been disrupted.

For these reasons, robust local pharmaceutical response capabilities to respond to a CBRNE event are essential to preparedness. Thus far, only limited attempts at assessing detailed statewide, hospital pharmaceutical response capabilities have been made. In this report, the work of a collaborative, multidisciplinary team that characterizes the level of hospital pharmaceutical preparedness in response to CBRNE events, will be described.

## Methods

### *Pharmaceutical Response Project*

As a multidisciplinary partnership between the Johns Hopkins Office of Critical Event Preparedness and Response, the Maryland Department of Health and Mental Hygiene, the Maryland Board of Pharmacy, the Maryland Society for Health-System Pharmacists (MSHP), the Baltimore City Health Department, the Maryland Institute for Emergency Medical Services Systems, and the Maryland Emergency Management Agency, the Pharmaceutical Response Project (PRP) was supported through the Health Resources and Services Administration Bioterrorism Hospital Preparedness Program. The principal objectives of the PRP were to assess statewide hospital pharmaceutical response capabilities for CBRNE incidents and develop recommendations on pharmaceutical contingency planning

for acute care hospitals throughout Maryland. Consisting of appointed representatives from each of these agencies, the PRP convened a series of meetings to address issues related to pharmaceutical surge capabilities during CBRNE events and other public health emergencies. A focus on hospital-level pharmaceutical response to biological events was assigned the highest priority by the PRP panel.

### *Regional Characteristics*

With an estimated population of 5,600,388, Maryland is divided into five Health and Medical Planning Regions.<sup>5</sup> There are 45 acute care hospitals in the state.<sup>6</sup> Region I, the westernmost area with two counties and three hospitals, is the most rural. Region II, with two counties and two hospitals, has predominantly rural areas. Region III includes Baltimore, encompasses six counties, and holds approximately half of the state's hospitals. Region IV is the easternmost, with seven hospitals serving eight rural and suburban counties. Region V, bordering Washington, DC, is part of the national capital region, with 13 hospitals in five counties.

### *Survey Design*

A standardized survey instrument developed by the PRP was used to assess current, statewide, hospital pharmaceutical response preparedness and capabilities.<sup>7</sup> Key questions characterized the state of preparedness regarding the pharmaceutical response to biological, chemical, or radiological threats and provided a detailed assessment of acute care hospital pharmaceutical supplies.

The survey elicited information on: (1) state hospital pharmaceutical response preparedness, including the prior establishment of specific protocols and written agreements, access to emergency supply systems, delineated plans for coordination with SNS assets, and exercises conducted; (2) hospital pharmaceutical response capacity for particular biological, chemical, and radiological scenarios; and (3) quantity and type of pharmaceutical supplies.

Other open sources were used to obtain additional relevant information, such as hospital characteristics including setting, staffing, and bed capacity.<sup>8</sup> Initial drafts of the survey were developed in collaboration with hospital pharmacists, the Board of Pharmacy, and the MSHP, and were reviewed by each of the partner agencies. Hospital pharmacy directors were selected as the survey respondents under the premise that they have the greatest knowledge of existing, dedicated reserve hospital pharmaceutical supplies. The survey, designed to take 25–30 minutes to complete, was conducted successfully in Region III.<sup>7</sup> Subsequently, the survey was administered to all directors of acute care hospital pharmacies in Maryland.

## Results

Pharmaceutical response surveys were sent to all acute care hospitals in Maryland. Complete responses were received from 36 of 45 hospitals in the state, representing an 80% response rate (Tables 1 and 2). No significant differences were identified between responding and non-responding hospitals.

The majority of hospitals in Maryland have incorporated pharmaceutical preparedness as a part of disaster contingency

	n (%)
Pharmacy participation in a hospital disaster drill	24 (67)
Written agreement or memorandum of understanding for obtaining pharmaceutical or medical supplies	26 (72)
Protocol for requesting assistance from the SNS	18 (50)
Protocol for how emergency pharmaceuticals could be received and transported	25 (69)
Expect to receive assistance from the SNS in 12 h	6 (17)
Expect to receive assistance from the SNS in 24 h	6 (17)
Expect to receive assistance from the SNS in 48 h	8 (22)
Expect to receive assistance from the SNS in 72 h	16 (44)
Expect the facility to be able to function independently for up to 72 h	28 (78)
Expect the hospital to be able to operate at normal capacity with an additional 100 patients for 48 h	8 (22)
Expect the hospital to be able to operate at normal capacity with an additional 100 patients for 72 h	20 (56)

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**Table 1**—Assessment of Maryland hospital pharmaceutical response capabilities (SNS = Strategic National Stockpile) (n = 36)

planning. Within the past year, 67% (24/36) of hospitals had implemented an exercise with pharmacy participation, including five full-scale exercises, eight functional exercises, nine tabletop exercises, and two other types of exercises.

Among the hospitals surveyed, 92% (33/36) had assessed their pharmaceutical inventory to determine whether it could support the treatment and prophylaxis for patients exposed to biological agents, 92% (33/36) had assessed their pharmaceutical inventory for treatment of chemical agents, and 67% (24/36) had assessed their pharmaceutical inventory for treatment and prophylaxis of radiological agents.

With respect to emergency pharmaceutical supply systems, 72% (26/36) had written agreements/memoranda of understanding (MOU) for obtaining or pooling pharmaceutical and medical supplies. Fifty percent (18/36) of responding hospitals had protocols for requesting assistance from the SNS through the local health department, and 69% (25/36) had protocols for how emergency pharmaceuticals could be received and transported securely within the hospital.

Assuming an interruption of the pharmaceutical supply chain, 78% (28/36) of responding hospitals believed that their facility would be able to maintain patient care standards independently for 72 hours. When questioned whether the hospital, while operating at normal capacity, could respond to an aerosolized anthrax incident involving an additional 100 patients requiring inpatient treatment,

56% (20/36) responded that they could operate without outside assistance for  $\geq 72$  hours, and 22% (8/36) responded that they could operate without assistance for 48 hours. Among the hospitals surveyed, 17% (6/36) expected to receive assistance from the SNS within 12 hours, 17% (6/36) within 24 hours, 22% (8/36) within 48 hours, and 44% (16/36) within 72 hours. Overall, >60% of the hospitals expect to receive assistance from the SNS in  $\leq 48$  hours.

Sixty-four percent (23/36) of responding hospitals reported an additional dedicated reserve supply for biological events, 67% (24/36) for chemical events, and 50% (18/36) for radiological events. The existing dedicated reserve supplies at each hospital according to strength/concentration, dosage form, and dosage units were quantified. A dosage unit was defined as the count of a given specific strength and dosage form. Based on the number of inpatient beds, total staff, and staff families, the total required antibiotic dosage units for prophylaxis during the first 72 hours were calculated for each hospital. Reported first-line antibiotics at each hospital were expressed as a percentage of the calculated requirements (Figure 1). The range was 0–122%, with a median of 3.5% (interquartile range: 1% to 18%). Statewide, combined hospital doses of ciprofloxacin and doxycycline totaled 318,729 oral doses for prophylaxis, and 4,261 parenteral doses for treatment.

## Discussion

Development of pharmaceutical surge capacity and response planning for CBRNE incidents and other public health emergencies are essential to meeting US national preparedness goals. Efforts to build pharmaceutical surge capacity should be guided by the results of objective evaluation. However, given the sensitivity of the topic, disclosing information in the interest of furthering pharmaceutical preparedness must be performed with care.

It is important to note that dedicated pharmaceutical reserve supplies represent only one aspect of response planning. Hospitals with fewer pharmaceutical reserves are not necessarily less prepared, but may have chosen to allocate limited resources in other ways to enhance preparedness (e.g., specialized training or equipment). With this caveat, hospitals throughout Maryland appear to be best prepared from a pharmaceutical standpoint for biological incidents, followed by chemical incidents, and then radiological incidents.

A significant gap exists in the perceptions of how quickly the SNS would be available following a CBRNE event. While it is a widely held belief among public health officials that hospitals must plan to remain self-sufficient and should not expect to receive assistance from the SNS for up to 72 hours (allowing for distribution, delivery, local setup, and dispensing), >60% of the hospitals expected to receive assistance from the SNS within 48 hours. No correlation between the expected timeframe for assistance from the SNS and the extent of hospital pharmaceutical preparedness was identified. Differing expectations point to the need for clear communication between hospitals and response agencies.

Current hospital pharmaceutical reserves are distributed unevenly. While most hospitals in the state have relatively

	Biological n (%)	Chemical n (%)	Radiological n (%)
Assessment of pharmaceutical inventory	33 (92)	33 (92)	24 (67)
Written plan for prophylaxis	28 (78)	NA	18 (50)
Written plan for treatment	28 (78)	23 (64)	19 (53)
Identified emergency pharmaceutical supply system via local pharmacies	14 (39)	8 (22)	5 (14)
Identified emergency pharmaceutical supply system via pharmaceutical vendors	16 (44)	13 (36)	10 (28)
Dedicated reserve supply of pharmaceuticals	23 (88)	24 (67)	18 (50)

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**Table 2**—Pharmaceutical preparedness for events involving biological, chemical, or radiological agents (n = 36)

limited supplies, a few hospitals have developed large stocks of selected pharmaceuticals, most notably ciprofloxacin and doxycycline. For prophylaxis and treatment against certain high priority biological agents, ciprofloxacin and doxycycline are logical choices for stockpiling given their coverage and cost.<sup>9–15</sup>

Based on the assumption that during a biological threat, each institution should be able to administer initial prophylaxis to all inpatients, staff, and family of the staff, the adequacy of dedicated reserve supplies of first-line antibiotics at each hospital was assessed. In this approach, the variations in hospital size are considered. Only one of the hospitals among the 36 surveyed was stocked adequately to remain self-sufficient for the first 72 hours following an event, and only two had dedicated reserves exceeding 50% of calculated requirements for prophylaxis. A comparison of reserve doses of parenteral ciprofloxacin and doxycycline at each hospital with the calculated required doses to hypothetically treat an additional 100 biological attack victims requiring inpatient treatment for 72 hours demonstrated that <3% (1/36) of responding hospitals would have sufficient reserves to meet these needs.

No association was found between hospitals with greater antibiotic coverage and other measures of pharmaceutical preparedness, such as the development of written protocols or conduct of prior exercises with pharmacy participation. Many institutions, including those reporting the least antibiotic coverage, had written protocols and had conducted exercises with pharmacy participation within the preceding year. Among the top quartile reporting the best antibiotic coverage, only one of the nine institutions did not have a written protocol for a biological event, and all but two had conducted an exercise within the past year.

Statewide, the combined doses of ciprofloxacin and doxycycline totaled 318,729 oral doses for prophylaxis and 4,261 parenteral doses for treatment (Figure 2). This only serves as an estimate, as additional, smaller quantities of non-standard dosages and other antibiotics have been identified. Limited quantities of other medications, such as amoxicillin, rifampin, clindamycin, and gentamicin, have been stockpiled by hospitals. In a large-scale, mass-prophy-

laxis setting, these antimicrobials potentially are less cost-effective and offer less flexible or efficacious coverage.<sup>16–20</sup>

Collectively, limited antibiotics are available to provide prophylaxis or treatment for all hospital staff, their families, and patients, suggesting that hospitals may have insufficient pharmaceutical surge supplies for a large-scale biological attack. The total reserve doses identified fall significantly short of the calculated 1,385,748 oral doses for prophylaxis of target groups identified by the PRP panel consensus (hospital staff, staff families, and inpatients) and the 23,400 parenteral doses for treatment required for a 72-hour period.

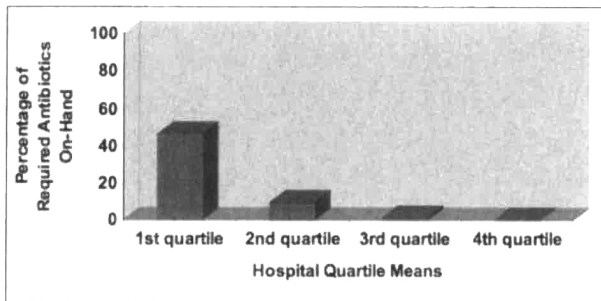
The overwhelming majority of responding hospitals stated that emergency access to a local or regional reserve pharmaceutical stockpile would aid in preparedness planning, suggesting that regional stockpile development or augmentation of par levels with rotating stock should be explored.

The identified gaps may reflect a lack of clear guidance on how to build pharmaceutical preparedness. Specific guidelines on maintaining an optimal hospital pharmaceutical cache was supported by 89% (32/36) of surveyed hospitals. In the future, statewide pharmaceutical preparedness may be strengthened through more detailed recommendations. Alternate explanations for the shortages may be that hospitals did not consider prophylaxis of certain groups, could not afford the expense of the medications, or were hesitant to increase par levels in light of unresolved rotation or storage issues.

The implementation of pharmaceutical preparedness has occurred in stages. For example, a new component of the SNS, the CHEMPACK Program, is aimed at enhancing state and local capabilities to respond to potential threats arising from use of chemical agents. Providing nerve-agent antidotes, emergency medical services containers are intended for field use, while hospital containers are for use by hospital medical staff to treat patients in the emergency department. Though details regarding coordination remain to be completed, this pre-positioning has bolstered statewide pharmaceutical preparedness for chemical threats.

#### Limitations

The survey quantified only dedicated hospital pharmaceutical caches, rather than all pharmaceutical supplies in each



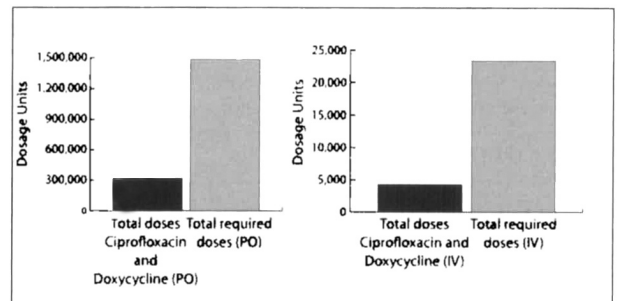
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**Figure 1**—Reported first-line hospital antibiotic supplies as a percentage of calculated prophylaxis requirements

hospital. This may lead to an underestimation of the hospitals' collective resources. However, hospital pharmaceutical supplies vary on a daily basis with just-in-time inventory, and likely are accounted for during an emergency. Thus, an existing, dedicated, hospital pharmaceutical cache may represent a more stable measure of hospital preparedness. This project did not address other caches that may be readily available to the hospital or non-hospital populations from public health resources, community health centers, local pharmacies, or other government facilities (e.g., local Veterans Administration hospitals). Although respondents were directed to use all sources of information available in completing the survey, despite best efforts, responses still may not reflect all of the existing or changing dedicated hospital pharmaceutical reserves. Finally, several hospitals did not participate in the survey. However, these were not found to differ significantly in size or location from participating hospitals.

### Conclusions

Most hospitals throughout the state have taken key steps toward enhancing CBRNE pharmaceutical response capabilities, but much remains to be done. Pharmaceutical



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**Figure 2**—Comparison of available with required dosage units of ciprofloxacin and doxycycline for prophylaxis and treatment for a 72-hour period

response planning at the hospital level should be designed to support local public health plans in the context of regional and national mass-prophylaxis strategies. The continued focused attention of hospitals, public health departments, and the disaster response community on developing CBRNE hospital pharmaceutical surge capabilities is essential for enhancing future preparedness.

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