

Financial Implications of Hospital Response to Bioterrorism Based on Diagnosis-Related Group Analysis

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Abbreviations:

CMI = Case Mix Index
DRG = diagnosis-related group
HCDS = Health Care Delivery Systems
PUH = academic, tertiary care, Level-1 trauma center
RCC = ratio of costs-to-charges
StM = community hospital
TB = tuberculosis

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Abstract

Introduction: During an infectious disease outbreak, the ability of a hospital to continue routine operations depends upon its ability to absorb expected losses in revenue when the routine charge base is replaced by infectious disease-related charges.

Objective: The purpose of this study was to determine the probable financial impact of a bioterrorism event or an infectious disease outbreak on an academic and a community hospital.

Methods: During the fiscal year 01 July 2002–30 June 2003, the average number of inpatient charges identified by the diagnosis-related-groups (DRGs) of an academic, tertiary care, Level-1 trauma center (PUH) and a community hospital (StM) were obtained retrospectively. *Per diem* charges were determined for patients with: (1) gastroenteritis; (2) sepsis; (3) meningitis; (4) tuberculosis (TB); and (5) pneumonia. These charges were used to simulate the financial coding of patients exposed to biological agents.

Results: The total average PUH *per diem* charges per patient for all 31,530 discharges was (US)\$10,516. Specifically, the average charges were \$20,499 for patients with transplants, \$14,406 for receiving critical care services, \$12,650 for the provision of cardiac care, \$11,576 for trauma/orthopedic care, and \$8,259 for services for patients who suffered a stroke. For patients with infectious diseases, the average *per diem* charges per patient were: (1) \$6,184 for patients with gastroenteritis; (2) \$7,842 for patients with sepsis; (3) \$10,831 for patients with meningitis; (4) \$6,118 for patients with TB; and (5) \$4,586 for patients with pneumonia. Per patient per day, PUH would generate a potential net on average loss of: (1) \$4,332 for gastroenteritis; (2) \$2,674 for sepsis; (3) \$4,398 for TB; and (4) \$5,930 for pneumonia replaced an admission. Patients with meningitis on average generated a net gain (\$315) compared to the average, but would not compensate for the denial of transplant, cardiac, trauma/orthopedic, and some critical care services during the event. Total average StM *per diem* charges per patient for all 10,470 discharges equaled \$3,008. Specifically, \$4,965 for critical care, \$3,022 for cardiac care, \$4,397 for trauma/orthopedic care, and \$3,037 for stroke services. For infectious diseases, the average *per diem* charge per patient was: (1) \$2,273 (+\$735) for gastroenteritis; (2) \$3,047 (+\$39) for sepsis; (3) \$2,504 (-\$504) for meningitis; (4) \$2,887 (\$120) for TB; and (5) \$2,652 (-\$356) for pneumonia (net loss/gain in parenthesis).

Conclusions: Through DRG analysis, the probable financial impact of a bioterrorist attack on a Health Care Delivery System is largely detrimental. Preparedness for a biological event must include an assessment of hospital capability and capacity to handle these types of patients, but also must consider the financial ability to absorb expected losses in charges or ways in which to recover the losses.

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Introduction

From an analysis of mock disaster exercises regarding the intentional release of biological agents such as TOPOFF I-III¹ and Dark Winter (Washington, DC, 2001),² it is apparent that local and regional Health Care Delivery Systems (HCDSs) will be overwhelmed with individuals seeking medical care related to a bioterrorist attack.³ The HCDS may include prehospital care and transport, evaluation and triage in the emergency department, inpatient observation and treatment, and morgue storage and body elimination. Unfortunately, due to many medico-economic factors, current HCDSs in the US already are under a significant amount of financial strain.⁴ The hospital-based, inpatient components of HCDS have lost the flexibility to absorb sudden-onset disaster- and non-disaster-related increases in patient volumes. This current inflexibility and the potential need for massive amounts of healthcare resource expenditure during a perceived or actual biological agent release will cause an indeterminate amount of financial instability to both privately and federally supported HCDSs.³ Estimates have placed the economic impact of a biological event between (US)\$477.7 million per 100,000 persons to \$26.2 billion per 100,000 persons depending on the agent released.⁵ Moreover, the anticipated loss of profitable routine admissions and procedures specific to the institution during the responses may further economic damages.

In order to determine the financial impact of bioterrorism on an academic, tertiary, referral center and a community hospital, a model was created to estimate the daily losses in hospital charges that would occur if bioterrorism-related, diagnosis-related groups (DRGs) would replace the daily charges from the routine operations of each hospital.

Methods

The inpatient charges for the fiscal year 01 July 2002–30 June 2003 were identified by the DRG of an academic, tertiary-care, Level-1 trauma center (PUH) and a community hospital (StM) (Table 1) and the average charges were computed for the DRGs. *Per diem* charges for patients with gastroenteritis, sepsis, meningitis, tuberculosis (TB), and pneumonia were used to simulate the diagnostic coding of biological agents. Comparisons were made with routine (stroke, cardiac, intensive care) and specialized (trauma, transplantation) *per diem* hospital charges. Determination of the ratio of costs-to-charges (RCC) and Case Mix Index (CMI) were performed for each hospital.

Results

The PUH and StM CMI/RCC calculations were 2.26/0.34 and 1.40/0.41, respectively. The total average *per diem* charges per PUH patient for all 31,530 discharges were \$10,516. Specifically, the average of the charges were \$20,499 for transplants, \$14,406 for the provision of critical care, \$12,650 for cardiac care, \$11,576 for patients who received trauma/orthopedic care, and \$8,259 for service delivered to patients with a stroke. For infectious diseases, the average *per diem* charges per patient were: (1) \$6,184 for therapeutic gastroenteritis; (2) \$7,842 for those with sepsis; (3) \$10,831 for meningitis; (4) \$6,118 for TB; and

Illness Group	DRG Grouping
Gastroenteritis	182, 183
Sepsis	416
Pneumonia	089, 090
Meningitis	020, 021
Tuberculosis	080, 423, 489
Stroke	014, 015, 016, 017, 524
Cardiac	104, 105, 106, 107, 108, 109, 110, 111, 112, 115, 116, 117, 118, 121, 122, 123, 124, 125, 127, 135, 136, 137, 138, 139, 140, 143, 144, 145, 514, 515, 516, 517, 518, 525, 527
Intensive Care	087, 475, 483
Trauma	002, 027, 028, 029, 030, 083, 084, 209, 210, 211, 212, 213, 218, 219, 220, 223, 224, 228, 229, 230, 231, 235, 236, 237, 250, 251, 252, 253, 254, 255, 280, 281, 282, 439, 440, 441, 442, 443, 444, 445, 446, 484, 485, 486, 487, 491
Transplantation	103, 302, 480, 495, 512, 513

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Table 1—Diagnosis-related group (DRG) codes by illness category

(5) \$4,586 for patients with pneumonia. The total average *per diem* charges per StM patient for all 10,470 discharges were \$3,008. Specifically, \$4,965 for the delivery of critical care, \$3,022 for cardiac care, \$4,397 for providing trauma/orthopedic services, and \$3,037 for stroke services. For patients with infectious diseases, the average *per diem* charges per patient were: (1) \$2,273 for gastroenteritis; (2) \$3,047 for sepsis; (3) \$2,504 for meningitis; (4) \$2,887 for TB; and (5) \$2,652 for pneumonia (Figure 1).

Per patient per day, PUH would generate an average potential net loss of charges of: (1) 4,332 for patients manifesting with gastroenteritis; (2) \$2,674 for those with sepsis; (3) \$4,398 for TB; and (4) \$5,930 for pneumonia if they replaced a potential patient admission. Calculations for patients with meningitis demonstrated a net gain (\$315) compared to the average, but would not compensate for denial of admissions for transplant, cardiac, trauma/orthopedic, and some critical care services during the event. For StM, a similar comparison results in a net gain/loss of -\$504 for meningitis, +\$39 for sepsis, -\$120 for TB, -\$735 for gastroenteritis, and -\$356 for pneumonia (Figure 2).

Discussion

If the hospital component of a HCDS is converted and strictly dedicated to the care of bioterrorism patients (foregoing all elective procedures, routine operations, and

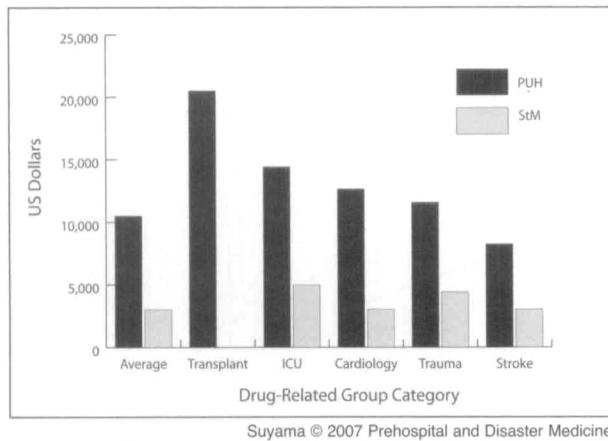


Figure 1—Total and drug-related group charges by hospital (ICU = intensive care unit)

acceptance of referral patients), the hospital will experience a decline in total charges per patient per day. Assuming that a hospital's CMI approximates the acuity of patients and level of care available, and that the RCC represents a hospital's general overhead (non-profit institutions), then an ideal CMI range exists, along with a RCC that can identify the facility that is the most economical choice to be converted during a bioterrorism event. Overall, in comparison with other hospitals that the HCDS studied, the CMI index and RCC are related inversely, and may indicate that there is an ideal range of CMI and RCC for hospitals so that response to a bioterrorism event would not be significantly destabilizing from a financial perspective (Figure 3).

In order to determine the amount of financial instability that may be introduced into the HCDS during an act of bioterrorism, baseline accounting was performed for the current routine costs and revenues. With the initial determination of an institution's DRG CMI value, an overall assessment of the level of medical acuity and complexity that a HCDS routinely provides can be established.⁶ As CMI can represent the average relative cost weight for all patients discharged during a given time frame with a particular DRG classification, it can be used to classify the financial baseline that is required for normal functioning. Although DRG outliers will exist in any DRG classification system, a properly chosen DRG coding system will minimize the number of patients that are not properly accounted for in the CMI determination. The CMI will be higher in tertiary care institutions as well as those facilities that deal with a large number of patients with chronic or complex medical conditions.

After the CMI was determined, further fiscal accounting methodologies were applied. Although multiple factors influence the accuracy with which hospital charges are converted into costs and revenues, there are standard calculations that can be performed to estimate these values. Utilizing the RCC is an accurate method for estimating the average costs per DRG for hospitalized patients.⁷ By determining the RCC for a hospital, the *per diem* base charges can be converted into a standard measure for comparing other institutions.

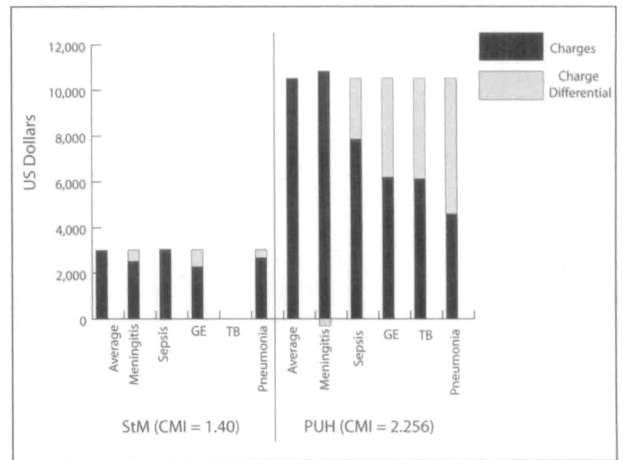


Figure 2—Charge differential based upon simulated bioterrorism related drug-related groups charges replacing routine drug-related groups charge *per diem* (GE = gastroenteritis; TB = tuberculosis)

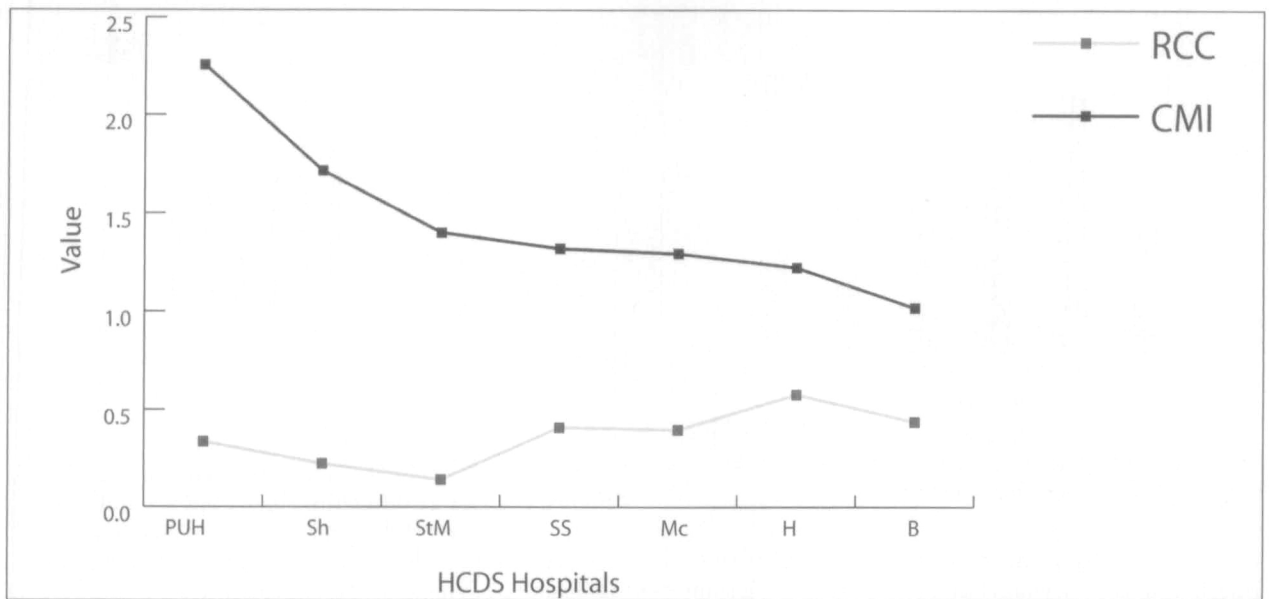
The results of this study indicate that StM, with a CMI of 1.40 and a RCC of 0.41 may be a better hospital to convert during a bioterrorism event than PUH (CMI 2.26, RCC 0.34). This is because of its ability to handle the types of patients that fall within the DRG relative weights required to handle victims of bioterrorism, at a lesser charge reduction from baseline charges (Table 2). If the RCC is used to estimate clinical and non-clinical overhead needs of the hospital, a relatively higher number may represent a facility with the capability to function more efficiently with economic constraints.

Although this analysis was performed using hospital charges, these charges are not equivalent to actual income or remuneration of services. Many other determinants to actual recovery of charges include managed care contracts, Medicaid *per diem*, and other forms of fee arrangements on high-end services including spot pricing. The charge base within this HCDS likely is different from other systems, and may not be applicable to other HCDSs.

Furthermore, although the CMIs for all hospitals are published in the Federal Register each year, a direct correlation on the presence of key bioterrorism capacity related to the CMI may be required to correlate the CMI with the true hospital bioterrorism capacity. The American Hospital Association database has data on key capacities for all hospitals that respond to the American Hospital Association annual survey, and may be a good reference to tie specific bioterrorism capacities to CMI for each hospital selected to care for bioterrorism patients during an actual event. Lastly, CMI is generated from Medicare patients only, and for completeness, the capacity for treatment of children must be addressed specifically prior to designating a hospital based upon CMI/RCC alone.

Conclusions

The financial impact of a bioterrorist event on a HCDS is largely detrimental, replacing the routine charge base with bioterrorism-related DRG charge groups. The ability of the inpatient hospital component to continue routine oper-



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Figure 3—Comparison of case mix index and ratio costs-to-charges with Health Care Delivery System Hospitals

Pneumonia	0.62–1.05
Meningitis	1.51–2.74
Gastroenteritis	0.576–3.40
Tuberculosis	0.84–3.04
Sepsis	1.59

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Table 2—Diagnosis-related group relative weights for presumed bioterrorism drug-related groups

ations will depend upon the hospital’s ability to absorb expected losses in charges. Preparedness for a biological

event must include an assessment of hospital capability and capacity to handle these types of patients, and also should consider global fiscal characteristics as determined by the CMI and RCC as determinants of the scale of potential revenue reduction and baseline overhead needs. The CMI range for a designated “bioterrorism hospital” ideally may fall between 1.2–1.6 with an RCC approximating 0.4. Hospitals within this range are poised to care for the sickest of the patients. However, they may not experience a charge reduction, which would cause financial instability to the system. Further analysis of specific hospital bioterrorism capacity and capabilities would need to be performed to ensure adequate patient care during a biological event.

References

- Office of Domestic Preparedness: A better prepared America through practice and preparation. Available at <http://www.ojp.usdoj.gov/odp/exercises.htm>.
- Center for Biosecurity of UPMC. Available at http://www.upmc-biosecurity.org/pages/events/dark_winter/dark_winter.html.
- Poste G: Facing reality in preparing for biological warfare: A conversation with George Poste. Interviewed by Jeff Goldsmith. *Health Aff (Millwood)* 2002; Suppl Web Exclusives:W219–228.
- Zuckerman S, Bazzoli G, Davidoff A, LoSasso A: How did safety-net hospitals cope in the 1990s? *Health Aff (Millwood)* 2001;20(4):159–168.
- Kaufmann AF, Meltzer MI, Schmid GP: The economic impact of a bioterrorist attack: Are prevention and postattack intervention programs justifiable? *Emerg Infect Dis* 1997;3(2):83–94.
- National Association of Children’s Hospitals and Related Institutions: Description of Methodologic and Hospital Specific Factors Affecting the Calculation of a Children’s Hospital DRG Case Mix Index, 06 February 2001.
- Shwartz M, Young DW, Siegrist R: The ration of costs to charges: How good a basis for estimating costs. *Inquiry* 1995/1996;32:476–481.