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Clostridium Difficile-Associated Disease in Illinois Hospitals

2004-2007

Illinois Department of PUBLIC HEALTH

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Introduction

Clostridium difficile (*C. difficile)* is a common cause of bacterial diarrhea in hospitalized patients in the United States. *C. difficile* associated diarrhea (also called *C. difficile* associated disease, or CDAD) ranges from mild to severe diarrhea and can be complicated by pseudomembranous colitis, toxic megacolon, sepsis, and death. CDAD is caused by a toxin secreted by *C. difficile* bacteria.

How CDAD is Spread in Health Care Settings

Although community–onset CDAD is increasing, this organism is usually acquired during hospitalization. *C. difficile* is found in the feces, and is transferred from patient or contaminated environmental surface to patient on the hands of hospital personnel. Patients can also become infected if they touch objects or surfaces that are contaminated with *C diffiicle* and then touch their mouth. Occasionally, transmission may occur by direct patient-to-patient contact. Although a person may have the organism in their intestines, it does not usually cause disease until antibiotics alter normal intestinal flora, promoting overgrowth with *C. difficile*.

CDAD Trends in Illinois

This report describes the overall incidence and trends in CDAD in acute care hospitals in Illinois; the dataset used does not allow determination of whether *C. difficile* was acquired at the hospital, or where CDAD was diagnosed. Therefore, the primary utility of this dataset is to follow overall trends in the burden (the number of cases, associated mortality, length of stay (LOS), and hospital charges) of CDAD in Illinois hospitals, and to understand what types of patients are most likely to be affected by CDAD.

Data Collection and Definitions

Data were abstracted from hospital discharge data routinely collected by the Illinois Department of Public Health from all acute care hospitals in Illinois for the years 1999 through 2007. The unit of analysis is the hospital discharge, not the person or patient. A person admitted to the hospital multiple times during the course of a year will be enumerated each time as a separate "discharge" from the hospital.

At the hospital level, up to 25 discharge diagnoses can be coded; however, the Department's dataset currently contain only nine codes.

The ICD-9 code 008.45, appearing anywhere in the list of discharge diagnoses, was used to identify cases for data abstraction. Throughout this report, the *C. difficile* associated disease (CDAD) rate is defined as the number of hospital discharges with a *C. difficile* diagnosis code per 1,000 discharges.

Overall CDAD rates are reported for 1999-2007. Information concerning demographic characteristics (age and sex), residency, hospital characteristics, co-morbidity and concomitant surgical procedures were available for discharges from 2004 through 2007.

Hospital type, location, size

"Teaching hospitals" are members of the Council of Teaching Hospitals. "Large urban" refers to hospitals in a Metropolitan Statistical Area with a population of 1 million or more. "Other urban" refers to hospitals in a Metropolitan Statistical Area with a population of less than 1 million and "Rural" refers to hospitals not in a Metropolitan Statistical Area.

Surgical Procedures

Cardiac surgery data reflect those cases with the following procedure codes: 35.10-35.14, 35.20-35.28, 35.31-35.35, 35.39, 35.42, 35.50-35.54, 35.60-35.63, 35.70, 35.72, 35.73, 35.81-35.84, 35.91; 36.10-36.19.

Neurosurgery cases were identified by procedure codes 01xx-05xx. Orthopedic surgery case selection was more complex, using the Clinical Classifications Software (CCS) categories used by the Health Care and Utilization Project (HCUP).

Discharged cases that did not have at least one ICD-9 procedure code listed above were defined as "stays not involving a procedure."

Co-morbid Conditions

"Inpatient hemodialysis" includes any cases coded with any listed procedure code 39.95. Asthma was indicated by diagnosis codes 493.xx and diabetes by 250.xx.

Hospital Charges

Average charges are based on the charge master value of normal charges for treatment, not adjusted by negotiation or contract with the patient or insurance company. The charges may not reflect actual payment received for services.

Results

Table 1. Number of CDAD cases and CDAD rate (CDAD cases per 1,000 discharges) in Illinois, 1999 – 2007

Year	Total number of CDAD discharges	Total number of discharges	Number of CDAD discharges per 1,000 discharges
1999	7,082	1,581,086	4.5
2000	7,586	1,636,046	4.6
2001	8,204	1,684,089	4.9
2002	10,309	1,685,051	6.1
2003	11,053	1,677,125	6.6
2004	14,066	1,710,389	8.2
2005	15,570	1,725,033	9.0
2006	15,359	1,724,612	8.9
2007	15,412	1,713,279	9.0

Table 1 presents the number of CDAD discharges between 1999 and 2007, the total number of discharges from Illinois hospitals during the same time period and the annual rate of CDAD discharges expressed as the number of CDAD discharges per 1,000 discharges.

Figure 1. CDDC discharges per 1,000 hospital discharges in Illinois, 1999 – 2007

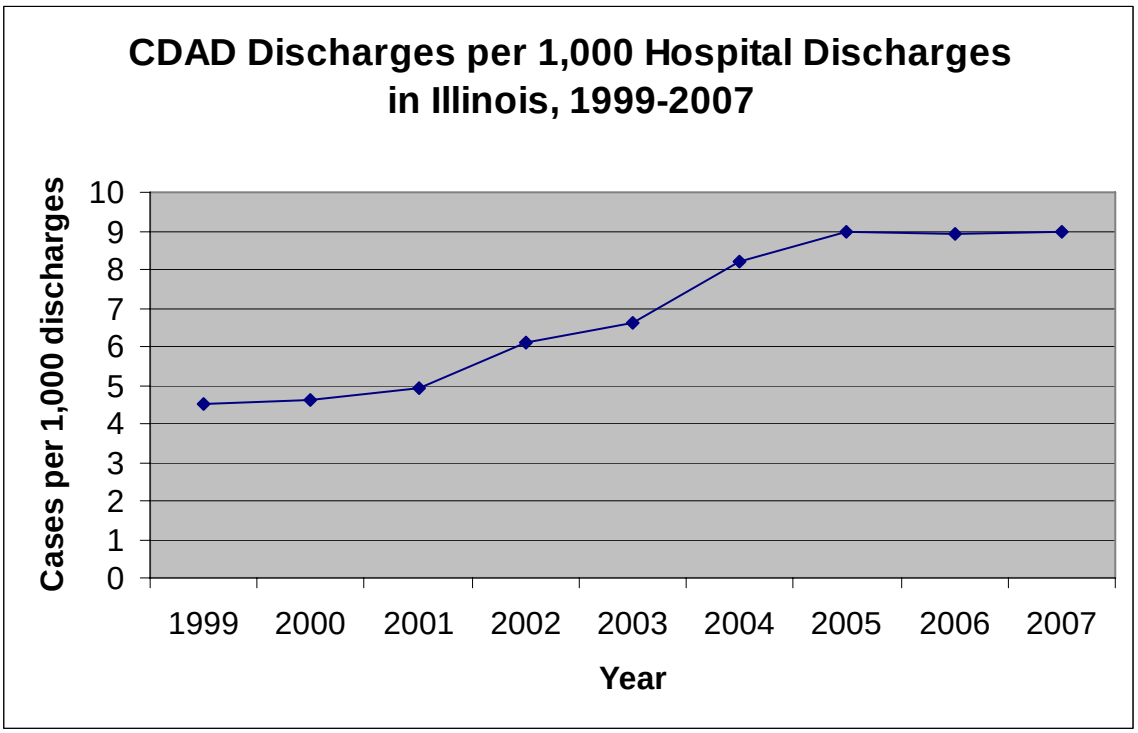


Figure 1 illustrates that between 1999 and 2007 the CDAD rate in Illinois hospitals doubled. Between 1999 and 2001, the rate increased minimally, followed by a 1.8 fold increase between 2001 and 2005. The CDAD discharge rate remained at approximately 9.0 CDAD discharges per 1,000 discharges through 2007. The findings from 1999 to 2005 in Illinois hospitals mirror those reported nationally (1-3).

Table 2a. Distribution of Illinois CDAD cases by age category and year

Age range (years)	2004 N (%)	2005 N (%)	2006 N (%)	2007 N (%)
0-4	174 (1.2)	143 (0.9)	176 (1.1)	188 (1.2)
5-17	105 (0.7)	107 (0.7)	109 (0.7)	126 (0.8)
18-34	592 (4.2)	627 (4.0)	596 (3.9)	564 (3.7)
35-49	1,123 (8.0)	1,211 (7.8)	1,202 (7.8)	1,198 (7.8)
50-64	2,147 (15.3)	2,521 (16.2)	2,490 (16.2)	2,723 (17.7)
65 and older	9,925 (70.6)	10,961 (70.4)	10,786 (70.2)	10,613 (68.9)

Table 2b. Distribution of Illinois CDAD cases by sex and year

Sex	2004	2005	2006	2007
Male	5,705 (40.6)	6,419 (41.2)	6,513 (42.4)	6,377 (41.4)
Female	8,361 (59.4)	9,151 (58.8)	8,846 (57.6)	9,035 (58.6)

Tables 2a and 2b present the demographic profile of patients discharged with CDAD between 2004 and 2007. There were slight fluctuations in the numbers of patients across all age groups over time. The largest percentage increase in numbers of patients was between 2004 and 2005 for those aged 50-64 years (17.4%). The greatest burden of CDAD infections occurred among older patients, especially those 65 and older. Patients in this age category comprised more than 70 percent of the CDAD population. In each year, approximately 86 percent of the CDAD discharges were 50 years and older. The age distribution of non-CDAD patients was markedly different, with only 34 percent aged 65 years or older.

Women represented approximately 60 percent of those discharged with a CDAD diagnosis for each year. This is comparable to the proportion of non-CDAD cases that were women.

Table 3a. CDAD rates (per 1,000 discharges) by age category and year

Age range	2004	2005	2006	2007
0-4	0.8	0.7	0.8	0.9
5-17	1.8	1.8	1.9	2.1
18-34	2.1	2.2	2.1	2.0
35-49	4.1	4.4	4.5	4.5
50-64	7.6	8.7	8.3	8.3
65 and older	16.7	18.2	18.1	18.0
Overall	8.2	9.0	8.9	9.0

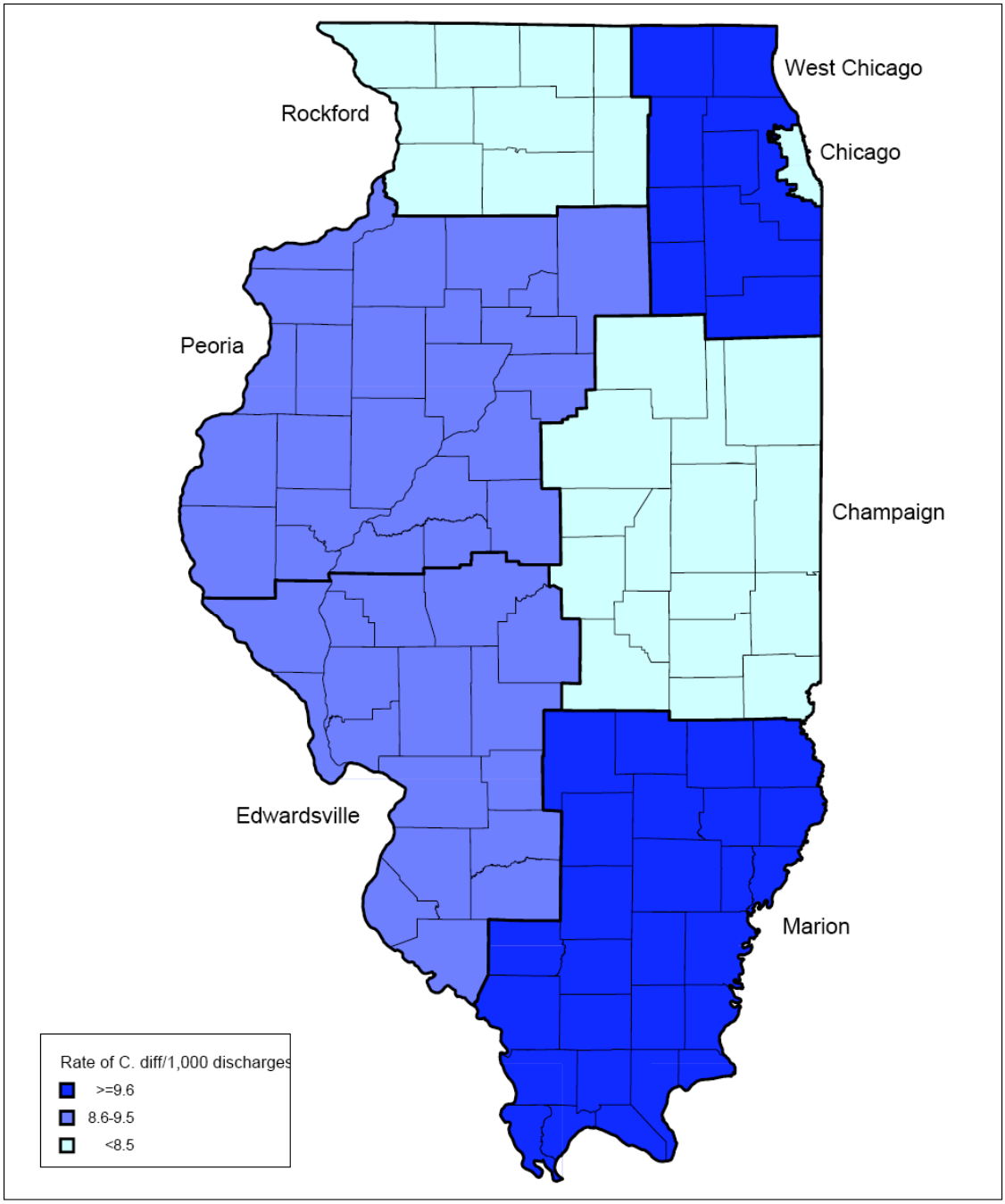
Table 3b. CDAD rates (per 1,000 discharges) by sex and year

Sex	2004	2005	2006	2007
Male	8.2	9.0	9.1	9.0
Female	8.3	9.0	8.7	9.0

Table 3a displays age-specific CDAD discharge rates per 1,000 discharges between 2004 and 2007. CDAD discharge rates increased with age. This trend was consistent over time. The increase in the overall rate from 8.2 to 9.0 CDAD discharges/1,000 discharges between 2004 and 2005 was primarily due to increases in the rates in the three oldest age categories. Between 2005 and 2007, there was little change in rates across all age categories.

Despite the greater number of women being discharged with a CDAD diagnosis as shown in Table 2b, the rate was equivalent to that in men in each year with the exception of 2006, when the rate in men increased to 9.1 CDAD discharges/1,000 discharges and rate in women decreased to 8.7 CDAD discharges/1,000 discharges.

Figure 2. Rate of CDAD diagnoses per 1,000 discharges by region, 2007



Source: Illinois Department of Public Health, Hospital Discharge Data

Table 4. Number of CDAD cases and CDAD rate by region, 2007

Local Health Department Region	Number of CDAD Cases	CDAD Cases per 1,000 Discharges
Chicago	3,725	8.2
West Chicago	7,403	9.9
Champaign	542	5.7
Marion	766	11.0
Edwardsville	1,390	8.1
Peoria	1,219	8.7
Rockford	580	7.9
Statewide	15,412	9.0

Figure 2 demonstrates the CDAD discharge rate per 1,000 hospital discharges by Illinois Department of Public Health Regions in 2007. The rate ranges from 5.7 in the Champaign region to 11.0 in the Marion region (Table 4). While Chicago and West Chicago do not have the highest regional rates in the state, these regions have the highest yearly burden of CDAD based on a higher volume of patient discharges in these regions compared to other areas of the state.

Table 5. Characteristics of CDAD patients and hospitals by health region, 2007

Local Health Department Region	Number of CDAD Cases	CDAD cases					
		% female	Mean Age (years)	% 65 years and older	% treated in Teaching Hospitals	% treated in Rural Hospitals	% treated in Hospitals <100 beds
Chicago	3,725	54.9%	63.8	54.8%	48.6%	0.0%	1.8%
West Chicago	7,403	59.4%	71.4	73.1%	22.9%	0.0%	2.1%
Champaign	542	57.6%	68.6	71.8%	0.0%	19.9%	11.4%
Marion	766	64.2%	74.2	78.2%	0.0%	100.0%	50.3%
Edwardsville	1,219	61.7%	73.7	77.9%	28.6%	7.5%	13.0%
Peoria	1,177	57.4%	70.0	71.4%	25.5%	34.0%	12.5%
Rockford	580	61.7%	67.8	65.9%	0.0%	41.1%	20.0%
Statewide	**15,412**	**58.6%**	**69.5**	**68.9%**	**27.0%**	**16.7%**	**7.1%**

To discern reasons for regional variations in the CDAD rate in 2007, the demographic profile and hospital characteristics were compared across the regions. When the region with the lowest CDAD rate (Champaign) was compared to the region with the highest CDAD rate (Marion), there were discernible differences. All hospitals in the Marion region were categorized as rural and approximately 50 percent of the hospitals in this region had fewer than 100 beds. This compares to 19.9 percent rural and 11.4 percent hospitals with less than 100 beds in Champaign. In addition, there was a greater proportion of CDAD patients aged 65 years and older in the Marion region (78.2%) compared to that reported in the Champaign region (71.8%).

Table 6. Total number and rate of CDAD cases per 1,000 discharges by type of hospital, 2004-2007

Hospital	2004		2005		2006		2007	
	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
Teaching Status								
Teaching	3,976	9.5	4,179	9.9	3,873	9.2	4,159	9.7
Non-Teaching	10,090	7.8	11,391	8.7	11,486	8.8	11,253	8.8
Location								
Largest urban areas	10,575	8.4	11,784	9.3	11,618	9.1	11,664	9.2
Other urban areas	2,048	7.3	2,170	7.6	2,163	7.7	2,236	7.8
Rural	1,443	8.5	1,616	9.5	1,578	9.4	1,512	9.2
Bed size								
<100 beds	1,126	10.5	1,180	10.9	1,159	10.9	1,089	10.5
100-300 beds	4,466	6.9	5,306	8.1	5,289	8.2	4,898	7.9
>300 beds	8,474	8.9	9,084	9.5	8,911	9.2	9,425	9.5
Total	14,066	8.2	15,570	9.0	15,359	8.9	15,412	9.0

Table 6 summarizes the CDAD case numbers and rates by the type of hospital for the years 2004 through 2007. Based on these data, teaching hospitals, rural hospitals, largest urban hospitals, and small hospitals (<100 beds) have the highest rates of CDAD, as captured by the hospital discharge dataset. The overall burden of CDAD infection was greatest in non-teaching hospitals, those located in the largest urban areas and those hospitals with more than 300 beds. The largest changes in numbers occurred between 2004 and 2005 in: non-teaching hospitals (+13%); hospitals in the largest urban (+11%) and rural (+12%) areas; and in 100 to 300 bed hospitals (+19%).

Table 7. CDAD cases by selected surgical procedures, 2004-2007

Type of Hospitalization	2004	2005	2006	2007
Stays not involving a procedure				
Total	713,100	727,128	720,241	714,556
CDAD cases	5,865	6,589	6,645	6,476
Rate per 1,000 discharges	8.2	9.1	9.2	9.1
Stays involving cardiac surgery				
Total	14,014	13,381	12,557	11,810
CDAD cases	70	101	70	72
Rate per 1,000 discharges	5.0	7.5	5.6	6.1
Stays involving invasive neurosurgery				
Total	50,998	52,047	52,338	53,109
CDAD cases	292	293	248	277
Rate per 1,000 discharges	5.7	5.6	4.7	5.2
Stays involving invasive orthopedic surgery				
Total	85,977	87,705	89,229	92,113
CDAD cases	283	271	275	242
Rate per 1,000 discharges	3.3	3.1	3.1	2.6

Table 7 shows CDAD rates for patients having major cardiovascular, neurological or orthopedic surgery and those discharged without having had a surgical procedure. Patients having either coronary artery bypass graft surgery or valve surgery, neurosurgery or orthopedic surgery had lower CDAD rates than those patients not having surgical procedures.

Table 8. CDAD cases and case rates among patients with selected chronic medical conditions, 2004-2007

Medical condition	2004	2005	2006	2007
All discharges				
Total	1,710,389	1,725,033	1,724,612	1,713,279
CDAD cases	14,066	15,570	15,359	15,412
Rate per 1000 discharges	8.2	9.0	8.9	9.0
Hemodialysis Performed				
Total	31,653	33,138	34,264	34,946
CDAD cases	787	982	1,010	1,060
Rate per 1,000 discharges	24.9	29.6	29.5	30.3
Cases with asthma discharge diagnosis				
Total	104,634	111,092	114,601	113,656
CDAD cases	506	609	540	534
Rate per 1,000 discharges	4.8	5.5	4.7	4.7
Cases with diabetes discharge diagnosis				
Total	269,581	277,147	278,137	280,331
CDAD cases	2,690	2,866	2,770	2796
Rate per 1,000 discharges	10.0	10.3	10.0	10.0

Table 8 shows the number of CDAD cases and discharge rates for selected chronic medical conditions for the years 2004 through 2007. The CDAD rate for patients undergoing inpatient hemodialysis was approximately three times the rate for those not undergoing hemodialysis throughout this time period. The CDAD rate for hemodialysis patients was appreciably higher in each of the four years of observation and saw an increase from 24.9 to 30.3 CDAD discharges/1,000 discharges between 2004 and 2007. Cases with a diabetes discharge diagnosis code also had higher CDAD rates over time compared to cases without this code.

Table 9. In-hospital mortality by CDAD status: 2004 – 2007

	2004	2005	2006	2007
Number of inpatient discharges with CDAD	14,066	15,570	15,359	15,412
Number without CDAD	1,696,323	1,709,463	1,709,253	1,697,867
Hospital mortality with CDAD	1,122	1,293	1,195	1,217
Mortality rate per 1,000 discharges with CDAD	79.8	83.0	77.8	79.0
Hospital mortality without CDAD	31,425	31,554	31,001	29,934
Mortality rate per 1,000 discharges without CDAD	18.5	18.5	18.1	17.6

Table 9 illustrates the markedly increased risk of dying while in the hospital for those patients who had a discharge code of *C. difficile* compared to those patients discharged without a *C. difficile* code. In 2004, the risk of dying was 4.3 greater in CDAD patients compared with non-CDAD patients. On average, the risk of dying between 2004 and 2007 was 4.4 greater in CDAD patients compared to non-CDAD patients.

Table 10. Distribution of discharges (%) by payer source and CDAD status: 2004 – 2007

	% of Cases discharged with CDAD(+) and without CDAD(-)							
Payer Source	**2004**		**2005**		**2006**		**2007**	
	CDAD Status		CDAD Status		CDAD Status		CDAD Status	
	+	-	+	-	+	-	+	-
Medicaid	7.1	19.7	7.4	20.2	7.9	21.0	8.1	20.7
Medicare	69.4	36.4	68.9	36.7	68.4	36.2	66.6	35.5
Privately Insured	20.0	36.9	20.1	36.3	20.4	35.9	22.3	36.5
Uninsured	3.4	7.0	3.7	6.8	3.2	6.9	3.0	7.2

Table 10 summarizes the payer source by CDAD status [present (+) or absent (-)] over time. Compared to patients discharged without CDAD, patients discharged with a CDAD code were more likely to be covered by Medicare and less likely to be privately insured or on Medicaid. Fewer CDAD patients are uninsured than non-CDAD patients. The high proportion of patients covered by Medicare is a reflection of the high percentage of patients more than 65 years of age.

Table 11. LOS and hospital charges by CDAD status: 2004 – 2007

	2004	2005	2006	2007
Hospital charges, mean $				
- with CDAD	48,601	50,095	52,831	59,320
- without CDAD	19,351	20,851	22,552	24,394
Length of stay, mean days				
- with CDAD	11.5	11.4	11.0	11.3
- without CDAD	4.5	4.5	4.5	4.5

Table 11 summarizes the mean hospital charges for those discharges listing a CDAD compared to non-CDAD discharges. Hospital charges for CDAD discharges were 2.4 times greater than for non-CDAD discharges. This difference was constant over time. CDAD cases were hospitalized for an average of 11.5 days in 2004 compared to an average length of stay of 4.5 days among non-CDAD cases.

Discussion

This paper looks at trends in Illinois hospitals to evaluate the incidence of CDAD. Illinois hospital incidence of CDAD has more than doubled since 1999, from 4.5 to 9.1 CDAD discharges/1,000 hospital discharges. The age distribution of patients discharged with CDAD reveals that more than 70 percent are 65 years and older – two times more than all other age groups combined This mirrors a national trend of rapidly increasing CDAD (1-3), with a disproportionate number of elderly people becoming infected (1, 2).

While the trends in overall CDAD incidence rate and age- and sex-specific CDAD rates in Illinois parallel those observed nationally between 1999 and 2005, the rate in Illinois in 2005 (9.0/1,000 discharges) was higher than the national average (8.0/1,000 discharges) and that reported for the Midwest region of the United States (8.3/1,000 discharges) (1). In 2005, in-hospital mortality associated with CDAD was lower in Illinois (8.3%) than in the United States as a whole (9.5%) (1).

The CDAD rate in Illinois escalated rapidly between 1999 and 2005, and stabilized between 2005 and 2007. Postulated explanations for the increasing national rates of CDAD include: 1) potentially new and evolving patterns of antimicrobial prescribing e.g. increased use of fluoroquinolones, that have been implicated in some outbreaks of CDAD; 2) use of alcohol-based, waterless hand sanitizers, which are not as effective as soap and water for removal of *C. difficile*; and 3) the emergence of new, more virulent, strains of *C. difficile* (BI/027/NAP1) (2).

This report documents the striking difference in CDAD rates among age groups, most notably the elevated rate among those aged 65 years and older. Possible explanations for this finding, which has been reported nationally (1), are: 1) increased exposure to both acute care and long-term care facilities and antimicrobial drugs; 2) decreased host defenses in older persons (2); and 3) co-morbidities that result in increased likelihood of hospitalization.

Regional differences in CDAD rates were identified over time. To discern reasons for regional differences in the CDAD rate in 2007, the demographic profile and hospital characteristics were compared across the regions. Table 5 illustrates distinct differences between regions which may contribute to differences in the CDAD rates. A study measuring the statewide incidence of CDAD in Oregon (3) also reported differences by region and hospital capacity. Further investigation and analysis is warranted to better understand the reasons for these differences, including demographic factors and facility characteristics.

Patients undergoing cardiac surgery, neurosurgery or orthopedic surgery were not at greater risk of CDAD. Patients undergoing these procedures may be younger and have fewer co-morbid conditions. Additional analysis is warranted to better understand this finding.

Patients with chronic medical conditions such as renal disease and diabetes experienced higher CDAD rates and may be candidates for specialized or more intensive prevention strategies.

This report illustrates the scope and magnitude of CDAD in Illinois. In comparison to the Illinois MRSA rate for 2006 (6.2 MRSA discharges/1,000 discharges), the CDAD rate is considerably higher (8.9 CDAD discharges/1,000 discharges). The average in-hospital cost and length of stay for CDAD cases far exceed those for MRSA cases. In 2006, the average costs for MRSA and CDAD were $26,237 and $52,831, respectively and the average length of stay was 6.8 days for MRSA cases compared to 11.3 days for CDAD. The risk of mortality is approximately four times higher for CDAD cases compared to MRSA cases. These striking findings underline the importance of supporting relevant infection control efforts in health care settings.

Limitations:

A limitation of this analysis is its reliance on discharge data. While a recent study (4) evaluating the validity of ICD-9 codes in the surveillance of CDAD found high sensitivity (78%) and specificity (99.7%), the code of CDAD may be included in the listing of discharge diagnoses on the basis of clinical suspicion without the benefit of positive laboratory findings (4). Optimally, effective statewide surveillance of CDAD should require confirmation using standardized laboratory protocols.

Additional limitations of using discharge data include the inability to ascertain the impact of readmission on CDAD rates, and the inability to determine whether or not the CDAD was health care associated or was community acquired.

Teaching hospitals, rural hospitals and hospitals with fewer than 100 beds experienced greater CDAD rates. Reasons for differences in observed rates between facility characteristics cannot be determined given limitations of the discharge dataset. The observed differences may have been influenced by a variety of factors including actual differences in CDAD rates, coding practices, variation in infection control practices that limit CDAD transmission and truncation of discharge codes. While up to 25 discharge diagnosis codes can be entered by hospital coders, the Department currently receives only the first nine codes. Use of only the first nine diagnosis codes could potentially lead to a higher estimate of CDAD in hospitals treating less-complicated, lower-risk patients such as those seen in rural or smaller bed hospitals, resulting in regional rate differences. Further analysis is necessary to discern whether coding practices could bias CDAD estimates. Inclusion of 25 discharge diagnoses in the Department's Hospital Discharge Dataset, beginning in 2008, should reduce bias introduced by the current practice of truncating the discharge diagnoses at nine codes.

Summary

In summary, this report indicates that Illinois has experienced a twofold increase in CDAD rates between 1999 and 2007. Advanced age and underlying illness were identified as important risk factors. Of note, the 2006 Illinois CDAD rate was 1.4 times higher than the MRSA rate and the in-hospital mortality rate was four times greater for CDAD than the rate for MRSA. The burden of CDAD on the health care system, and the impact on hospitalized patients is substantial.

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