

The Economic Impact Of Aspergillosis: Analysis Of Hospital Expenditures Across Patient Subgroups

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Purpose

To measure the impact of invasive aspergillosis infection on US hospital costs and financial performance across different patient populations.

Methods

Hospital discharge data for patients with a primary or secondary diagnosis of aspergillosis were extracted from the 2003 Nationwide Inpatient Sample (NIS) and the FY 2003 Medicare Provider Analysis and Review file (MedPAR). The data on patient demographics, length of stay (LOS), and hospital charges, estimated costs, and reimbursement levels were reported. After controlling for comorbidities, operative procedures, and DRG assignment, the clinical and economic outcomes were compared for patients with and without aspergillosis.

Results

Table 1. The NIS contains a total of over 36 million projected hospital discharges. Of these, 2,143 aspergillosis cases were identified across 171 DRGs, resulting in a US incidence rate of 58.6 per million per year. The mean age of aspergillosis patients was 55.6 years, with 53.4% male and 67.9% Caucasian. Medicare and private insurance were the largest payers of hospitalization expenses, each covering roughly 45% and 36% respectively. Median (mean) length of stay (LOS) after aspergillosis patient was 10 (17.7) days, with a median (mean) total hospital charge (THC) of \$44,845 (\$96,731).

Table 2. Of the 10,400 aspergillosis cases found in the NIS, 3,906 (37.6%) were diagnosed with pneumonia in aspergillosis. The mean LOS, THC, and mortality were all significantly higher in those who had *Aspergillus* pneumonia compared with aspergillosis patients who did not (p<0.001).

Table 3. Analysis was performed on 1,390 patients in the following high-risk DRG categories: hematologic malignancy, HIV, chemotherapy, BMT, and reticuloendothelial & immunity disorders. Altogether, these high-risk patients comprised 19.4% of the aspergillosis population. Approximately 1.1% of BMT hospitalizations were associated with a diagnosis of aspergillosis, 2.5 to 7 times higher than other high-risk DRG categories. Within the identified post-transplant patient subgroups, cases of aspergillosis were proportionally highest in hospitalizations related to complications of lung transplant (4.8%) and complications of BMT (3.4%).

Table 4. Compared to non-aspergillosis patients within the same DRG or ICD-9 category, median LOS was 1.8 to 12.4 times higher and the median THC per admission in aspergillosis patients was 2.3 to 12.7 times higher. Among the high-risk DRG subgroup, *Aspergillus*-infected BMT patients stayed in the hospital the longest (median LOS 48 days), had the most expensive hospitalizations (median THC=\$413,200). Within the post-transplant patient category, liver transplant patients with aspergillosis had the longest and most expensive hospitalizations (median LOS=62 days; median THC=\$291,158).

Table 5. In determining the most commonly assigned DRGs among the aspergillosis patients, 171 different DRG classifications were found to be associated with an aspergillosis diagnosis. The five most commonly assigned DRGs among the aspergillosis patients combined comprised 44.1% of the aspergillosis population.

Table 6. Aspergillosis patients with tracheostomy (DRG 493) had the longest hospital stay (median LOS=49.5), the highest THC (median THC=\$309,351) of all DRG categories examined.

Table 7. Within the high-risk DRG category, BMT patients with aspergillosis incurred the highest median estimated costs, \$74,945, over 3 times the amount of non-aspergillosis patients (\$33,055). However, in terms of incremental costs, both HIV and chemotherapy patients experienced relatively large increase in expenditures, over 600% and 800% respectively. Although patients within the reticuloendothelial/immunity disorder DRG displayed the lowest median costs, the aspergillosis cases results in a 162% increase in hospital cost.

Table 8. Median and mean THC and reimbursed amounts for Medicare patients with aspergillosis are listed in Table 8. As would be expected, both median and mean reimbursed amounts were higher in cases involving aspergillosis than in those not involving aspergillosis.

Table 9. The higher hospital costs associated with aspergillosis patients were not matched by similar increases in reimbursements, resulting in a greater financial loss for hospitals. Cases involving aspergillosis were on average reimbursed a lower percentage of their total cost than non-aspergillosis cases (mean RCR, 0.8 vs. 1.43). Additionally, incremental costs associated with aspergillosis were reimbursed at a very low rate, with a mean ICRCR of 0.32. The ICRCR for individual DRG categories ranged from 0.19 (respiratory infections and inflammations) to 0.52 (chemotherapy). For aspergillosis patients, the RCRs were lower than the corresponding ratios for non-aspergillosis cases in all DRG categories.

Conclusion

Aspergillosis affects a wide range of patient groups and has a negative economic impact across many DRGs. Aspergillosis particularly affects drug, accommodation (LOS), and ICU expenditures. While much of the attention paid to aspergillosis has been directed towards patients who are severely immunocompromised, more should be directed towards other subgroups such as the chronically ill or ICU patients in terms of both preventative and therapeutic interventions. With reimbursement of aspergillosis-related cases at less than a third of hospital expenditures, providers are faced with the unenviable position of confronting a life-threatening and costly disease with poor outcomes while facing difficult economic constraints. The findings of this study underscore the critical need for more research to identify settings of care and specific risk factors that drive increased expenditures, and to focus on development of more cost-effective approaches to the disease, including new therapies as well as prophylactics which may reduce the onset of infection.

Table 1. The Economic Impact of Aspergillosis: Analysis of Hospital Expenditures Across Patient Subgroups from the 2003 Nationwide Inpatient Sample

Characteristic	Aspergillosis Patients		Non-Aspergillosis Patients	
	Mean # of Cases	SD or %	Mean # of Cases	SD or %
Number of Cases, unweighted	2,143		7,975,565	
Number of Cases, weighted	10,400		38,214,191	
Mean Age	55.6 years	± 19.0 years	48.2 years	± 21.6 years
Age Distribution				
< 18 years	403	4.7%	60,645	11.7%
18 - 44 years	2,109	20.2%	147,623	28.6%
45 - 64 years	3,888	37.6%	177,265	34.4%
65 - 80 years	3,870	37.2%	150,016	29.2%
Gender				
Male	5,657	53.6%	200,113	38.2%
Female	4,443	46.4%	255,240	45.7%
Race				
White	5,418	51.7%	245,426	38.1%
Black	1,388	17.0%	88,054	21.3%
Hispanic	741	9.3%	60,154	14.9%
Other	456	5.7%	25,365	6.1%
Payer				
Medicare	4,856	44.8%	181,661	35.2%
Medicaid	1,448	14.1%	100,880	19.4%
Private Insurance	3,736	35.6%	188,660	37.4%
Self-Pay	200	2.1%	13,483	2.6%
Other	211	2.0%	21,860	4.2%
Mean Length of Stay	17.7 days	± 13.8 days	7.9 days	± 11.4 days
Total Hospital Charges	\$84,721	± \$154,473	\$44,845	± \$78,470

Values are weighted to project national estimates. Missing values resulted in sample variations across variables; percentages were calculated after discarding missing values.

Table 2. Length of Stay, Total Hospital Charges, and Mortality in Aspergillosis Patients with and without *Aspergillus* Pneumonia from the 2003 National Inpatient Sample

Aspergillus Patients (n=10,400)	with <i>Aspergillus</i> pneumonia		without <i>Aspergillus</i> pneumonia		p-value
	Number of Cases (%)	Mean LOS (SD)	Number of Cases (%)	Mean LOS (SD)	
Number of Cases (%)	3,906 (37.6%)	6.488 (8.214)	6,494 (62.4%)	7.975 (11.361)	< .0001
Mean LOS, days (SD)	12.8 (9.0-16.0)	9.1 (5.1-13.0)	10.4 (8.0)	10.4 (8.0)	< .0001
Mean LOS, days (SD)	28.8 (20.5)	15.8 (9.2)	10.4 (8.0)	10.4 (8.0)	< .0001
Mean THC, \$ (SD)	\$6,102 (\$59,941)	\$6,284 (\$1,864,880)	\$44,845 (\$96,731)	\$44,845 (\$96,731)	< .0001
Mean THC, \$ (SD)	100,000 (140,000)	82,000 (100,000)	44,845 (\$96,731)	44,845 (\$96,731)	< .0001
% Hospital Mortality	15.1%	12.4%	12.4%	12.4%	< .0001

Data from 2003 NIS. Missing values resulted in sample variations across variables; percentages were calculated after discarding missing values.

Table 3. Contribution of Various DRG and ICD-9-DM Categories to Total Cases of Aspergillosis for High-Risk DRG Categories and Post-Transplant ICD-9 Categories in the 2003 National Inpatient Sample

High-Risk DRG Category	Number of Cases		Rate of Aspergillosis Cases (Subgroup %)	% of Total Aspergillosis Cases (n=10,400)
	Asp	Non-Asp		
Hematologic Malignancy	503	124,224	0.40	4.8
HIV	380	87,854	0.43	3.7
Chemotherapy	283	144,515	0.20	2.7
Bone Marrow Transplant	114	10,517	1.1	1.1
Reticuloendothelial/Immunity Disorders	110	72,811	0.15	1.1
Post-Transplant ICD-9 Categories	1,390	405,251	0.33	13.4
Complications of Bone Marrow Transplant	259	6,584	3.4	3.3
Complications of Lung Transplant	283	5,701	4.8	2.7
Complications of Kidney Transplant	43	36,361	0.17	0.41
Complications of Heart Transplant	59	5,148	0.56	0.58
Complications of Liver Transplant	25	8,287	0.29	0.24
Total Post-Transplant ICD-9 Categories	621	62,962	1.0	6.1

Table 4. Length of Stay and Total Hospital Charges by Associated DRG or ICD-9 Category, Aspergillosis vs. Non-Aspergillosis Patients for High-Risk DRG Categories and Post-Transplant ICD-9 Categories in the 2003 National Inpatient Sample

High-Risk DRG Category	Length of Stay				Total Hospital Costs					
	Median, days (IQR, Min-Max)		Mean, days (SD)	p-value	Median, \$ (IQR, Min-Max)		Mean, \$ (SD)	p-value		
	Asp	Non-Asp	Asp	Non-Asp	Asp	Non-Asp	Asp	Non-Asp		
Hematologic Malignancy	9.0 (5.1-17.2)	8.0 (5.0-18.0)	24.8 (11.4)	8.3 (11.4)	< .0001	148,291 (23,191-387)	25,217 (2,922-242)	19,219 (163,205)	45,264 (67,000)	< .0001
HIV	11.0 (5.1-17.2)	8.0 (5.0-18.0)	14.2 (8.1)	8.1 (8.1)	< .0001	47,222 (23,191-387)	25,217 (2,922-242)	22,941 (163,205)	35,373 (67,000)	< .0001
Chemotherapy	8.0 (4.0-12.0)	8.0 (5.0-18.0)	18.9 (8.1)	8.1 (8.1)	< .0001	19,706 (5,448)	16,025 (2,922-242)	27,294 (163,205)	28,245 (67,000)	< .0001
Bone Marrow Transplant (BMT)	9.0 (5.1-17.2)	8.0 (5.0-18.0)	58.9 (26.1)	28.1 (19.1)	< .0001	413,200 (15,721)	11,274 (4,223)	333,620 (163,205)	30,811 (67,000)	< .0001
Reticuloendothelial & Immunity Disorders	9.0 (5.1-17.2)	8.0 (5.0-18.0)	18.9 (8.1)	8.1 (8.1)	< .0001	76,703 (23,191-387)	15,279 (2,922-242)	102,541 (163,205)	28,811 (67,000)	< .0001
Post-Transplant ICD-9 Categories										
Complications of BMT	9.0 (5.1-17.2)	8.0 (5.0-18.0)	23.6 (11.5)	11.5 (11.5)	< .0001	85,227 (15,721)	33,217 (4,223)	103,443 (163,205)	80,215 (67,000)	< .0001
Complications of Lung Transplant	11.0 (5.1-17.2)	8.0 (5.0-18.0)	28.8 (14.0)	11.5 (11.5)	< .0001	98,229 (23,191-387)	36,217 (4,223)	137,764 (163,205)	81,528 (67,000)	< .0001
Complications of Kidney Transplant	9.0 (5.1-17.2)	8.0 (5.0-18.0)	28.8 (14.0)	11.5 (11.5)	< .0001	300,289 (15,721)	19,219 (4,223)	191,886 (163,205)	35,712 (67,000)	< .0001
Complications of Heart Transplant	9.0 (5.1-17.2)	8.0 (5.0-18.0)	15.1 (8.1)	11.5 (11.5)	0.011	86,227 (23,191-387)	21,219 (4,223)	88,889 (163,205)	50,811 (67,000)	< .0001
Complications of Liver Transplant	9.0 (5.1-17.2)	8.0 (5.0-18.0)	10.3 (10.3)	11.5 (11.5)	< .0001	28,118 (15,721)	33,217 (4,223)	28,118 (15,721)	54,715 (67,000)	< .0001

Missing values resulted in sample variations across variables; percentages were calculated after discarding missing values.

Table 5. Contribution of Various DRG and ICD-9-DM Categories to Total Cases of Aspergillosis for the Top 5 Most Common DRGs in the 2003 National Inpatient Sample

Top 5 Most Common DRGs	Number of Cases		Rate of Aspergillosis Cases (Subgroup %)	% of Total Aspergillosis Cases (n=10,400)
	Asp	Non-Asp		
Medicine & Pediatric Diseases	2,314	23,552	8.3	19.4
CR Proc. for Medicine & Pediatric Diseases	1,687	10,304	1.1	10.5
Tracheostomy	471	217,338	0.22	4.5
Resp. System Diagn. with Vent. Support	471	217,338	0.22	4.5
CCPD	471	217,338	0.22	4.5
Total, Top 5 Most Common DRGs	4,944	1,358,230	10.1	44.1

Table 6. Length of Stay and Total Hospital Charges by Associated DRG or ICD-9 Category, Aspergillosis vs. Non-Aspergillosis Patients for the Top 5 Most Common DRGs in the 2003 National Inpatient Sample

Top 5 Most Common DRGs	Length of Stay				Total Hospital Costs					
	Median, days (IQR, Min-Max)		Mean, days (SD)	p-value	Median, \$ (IQR, Min-Max)		Mean, \$ (SD)	p-value		
	Asp	Non-Asp	Asp	Non-Asp	Asp	Non-Asp	Asp	Non-Asp		
Medicine & Pediatric Diseases	8.0 (4.0-12.0)	8.0 (5.0-18.0)	10.4 (8.8)	8.8 (8.8)	< .0001	29,878 (15,721)	12,862 (2,922-242)	52,224 (163,205)	27,211 (67,000)	< .0001
CR Proc. for Medicine & Pediatric Diseases	10.0 (5.1-17.2)	8.0 (5.0-18.0)	16.9 (8.1)	8.1 (8.1)	< .0001	82,443 (23,191-387)	36,217 (4,223)	103,443 (163,205)	28,811 (67,000)	< .0001
Tracheostomy	10.0 (5.1-17.2)	8.0 (5.0-18.0)	16.9 (8.1)	8.1 (8.1)	< .0001	17,710 (5,448)	16,025 (2,922-242)	27,294 (163,205)	28,245 (67,000)	< .0001
Resp. System Diagn. with Vent. Support	10.0 (5.1-17.2)	8.0 (5.0-18.0)	16.9 (8.1)	8.1 (8.1)	< .0001	17,710 (5,448)	16,025 (2,922-242)	27,294 (163,205)	28,245 (67,000)	< .0001
CCPD	10.0 (5.1-17.2)	8.0 (5.0-18.0)	16.9 (8.1)	8.1 (8.1)	< .0001	17,710 (5,448)	16,025 (2,922-242)	27,294 (163,205)	28,245 (67,000)	< .0001

Missing values resulted in sample variations across variables; percentages were calculated after discarding missing values.

Table 7. Total Hospital Costs by Associated DRG, Aspergillosis vs. Non-Aspergillosis Patients in the 2003 MEDPAR

High-Risk DRG Category	Median Costs, \$ (Min-Max)		Mean Costs, \$ (SD)		Incremental Median Cost	% Increase
	Asp	Non-Asp	Asp	Non-Asp		
Hematologic Malignancy	47,349 (9,447-251)	6,673 (9,447-251)	55,203 (21,425-427)	11,573 (16,880-26)	41,730 (4)	359.8%
HIV	15,944 (9,447-251)	5,905 (9,447-251)	23,731 (26,886-76)	10,177 (14,794-25)	13,554 (0)	133.0%
Chemotherapy	45,211 (20,718-80)	4,917 (9,388-31)	48,038 (26,115-36)	7,746 (8,147-58)	40,292 (4)	819.5%
Bone Marrow Transplant (BMT)	74,945 (20,920-215)	33,055 (10,848-76)	102,100 (20,246-42)	42,848 (42,848)	41,693 (7)	130.7%
Reticuloendothelial & Immunity Disorders	11,970 (9,388-31)	4,201 (9,388-31)	16,288 (20,220-48)	6,287 (9,447-58)	6,081 (4)	143.1%
Top 5 Most Common DRGs						
Medicine & Pediatric Diseases	4,856 (162-419)	4,870 (158-251)	15,042 (18,175-50)	8,901 (51,227-84)	4,866 (0)	94.3%
CR Proc. for Medicine & Pediatric Diseases	19,338 (9,174-71)	12,006 (9,174-71)	26,334 (29,266-82)	19,764 (22,717-27)	7,206 (4)	37.4%
Tracheostomy	87,739 (49,438-89)	44,845 (1,500-86)	101,584 (89,168-48)	81,148 (89,168-48)	22,765 (0)	25.9%
Resp. System Diagn. with Vent. Support	24,252 (9,241-39)	14,471 (9,174-65)	37,871 (21,486-48)	15,840 (16,683-84)	12,772 (0)	94.8%
CCPD	15,944 (9,447-251)	5,905 (9,447-251)	23,731 (26,886-76)	10,177 (14,794-25)	13,554 (0)	133.0%

Table 8. Total Hospital Charges and Reimbursed Amounts by Associated DRG, Aspergillosis vs. Non-Aspergillosis from the 2003 MEDPAR

High-Risk DRG Category	Number of Cases	Total Hospital Charges		Reimbursed Amounts		p-value				
		Median, \$ (IQR, Min-Max)	Mean, \$ (SD)	Median, \$ (IQR, Min-Max)	Mean, \$ (SD)					
Hematologic Malignancy	517	80,517	159,120	182,166	38,222	22,271	9,208	14,271	12,216	< .0001
HIV	381	33,214	6,673	7,746	23,228	6,673	22,271	6,673	16,554	< .0001
Chemotherapy	283	20,215	11,925	14,817	15,513	24,484	26,703	5,407	35,211	< .0001
Bone Mar										