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## Estimation of direct healthcare costs of fungal diseases in the United States

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### Abstract

**Background:** Fungal diseases range from relatively minor superficial and mucosal infections to severe, life-threatening systemic infections. Delayed diagnosis and treatment can lead to poor patient outcomes and high medical costs. The overall burden of fungal diseases in the United States is challenging to quantify because they are likely substantially underdiagnosed.

**Methods:** To estimate total national direct medical costs associated with fungal diseases from a healthcare payer perspective, we used insurance claims data from the Truven Health MarketScan® 2014 Research Databases, combined with hospital discharge data from the 2014 Healthcare Cost and Utilization Project National Inpatient Sample and outpatient visit data from the 2005–2014 National Ambulatory Medical Care Survey and the National Hospital Ambulatory Medical Care Survey. All costs were adjusted to 2017 dollars.

**Results:** We estimate that fungal diseases cost more than \$7.2 billion in 2017, including \$4.5 billion from 75,055 hospitalizations and \$2.6 billion from 8,993,230 outpatient visits. Hospitalizations for *Candida* infections (n=26,735, total cost \$1.4 billion) and *Aspergillus* infections (n=14,820, total cost \$1.2 billion) accounted for the highest total hospitalization costs of any disease. Over half of outpatient visits were for dermatophyte infections (4,981,444 visits, total cost \$802 million), and 3,639,037 visits occurred for non-invasive candidiasis (total cost \$1.6 billion).

**Conclusions:** Fungal diseases impose a considerable economic burden on the healthcare system. Our results likely under-estimate their true costs because they are underdiagnosed. More comprehensive estimates of the public health impact of these diseases are needed to improve their recognition, prevention, diagnosis, and treatment.

### Abstract

**40-word summary:** To provide insight into the burden of fungal diseases in the United States, we used several administrative data sources to estimate their total direct healthcare costs. We estimate that fungal disease healthcare costs exceed \$7 billion annually.

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## Keywords

Mycoses; Costs and Cost Analysis; Hospitalization; Outpatients; United States

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## Introduction

Fungal diseases vary greatly in severity, from relatively minor infections of the skin and mucous membranes to severe, life-threatening infections affecting multiple organs. Symptoms of fungal diseases are often similar to those of other infections, resulting in delayed diagnosis and treatment, which can lead not only to poor patient outcomes, but also to unnecessary medical expenses. The overall burden of fungal diseases in the United States is unknown and is difficult to quantify because they are likely substantially underdiagnosed, and no national public health surveillance exists for most fungal diseases [1]. In the absence of comprehensive surveillance, large administrative databases offer unique opportunities to examine the burden of multiple diseases using consistent methodology.

Previous studies show that patients with invasive fungal diseases incur additional costs, experience longer hospitalizations, and have higher mortality than similar patients without these diseases.[2–4] Several analyses of hospital discharge data have estimated national numbers and costs of hospitalizations due to specific fungal diseases, [5–10] often with a focus on the highest-risk patient populations (e.g., transplant, HIV/AIDS, and cancer) [3, 4]. However, few recent studies have examined similar metrics for all patients across multiple diseases and for outpatient visits associated with fungal diseases [11, 12].

More comprehensive estimates of the nationwide inpatient and outpatient visits and costs for fungal diseases are needed to help better define their burden on the healthcare system and would be useful for resource prioritization related to their prevention, diagnosis, and treatment. We used data from large insurance claims databases to calculate average costs per inpatient and outpatient visits, combined with national-level hospital discharge data and outpatient visit data, to estimate total yearly direct US healthcare costs associated with fungal diseases.

## Methods

### Data sources

We used the Truven Health MarketScan® 2014 Research Databases to obtain the average cost per hospitalization and outpatient visit among patients with private insurance, Medicare supplemental insurance, and Medicaid. The MarketScan Commercial Claims and Encounters and Medicare Supplemental Databases contain health insurance claims data for more than 50 million employees, dependents, and retirees across the United States, and the Multi-State Medicaid Database contains claims data for nearly 12 million Medicaid enrollees in 11 states. We used the 2014 Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) to estimate the total number of US fungal disease-associated hospitalizations. The NIS is the largest all-payer database of inpatient stays in the United States, covering >96% of the population and representing >94% of discharges from

community hospitals [13]. Similarly, we used the National Ambulatory Medical Care Survey (NAMCS) and National Hospital Ambulatory Medical Care Survey (NHAMCS) to estimate the average yearly number of fungal disease-associated outpatient visits nationwide. NAMCS and NHAMCS are national probability sample surveys of visits to outpatient and hospital ambulatory care departments, respectively [14]. The data are based on a systematic random sample of ambulatory physician visits and hospital outpatient, surgery, and emergency department (ED) visits, nationally weighted to describe utilization of ambulatory medical and hospital care in the United States. Because some fungal diseases are rare, we used 10 years of NAMCS and NHAMCS ED data (2005–2014) to increase total visit numbers and improve statistical reliability. NAMCS also contains data on visits to physicians at community health centers (CHC) for 2005–2011. We also included 2012 CHC data, which includes visits to both physicians and other healthcare providers and was the most recent year of available data. NAMCS/NHAMCS estimates based on <30 visits or standard error >30% are not presented.

MarketScan, HCUP, and NAMCS/NHAMCS contain preexisting, de-identified data. Because no interaction or intervention with human subjects occurred and no personally identifiable information was used, collected, or transmitted, this analysis did not involve human subjects under 45 Code of Federal Regulations 46.102(f), and was therefore not subject to review by the Centers for Disease Control and Prevention institutional review board.

#### **Disease groupings and exclusion criteria**

We used International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes 110.0–118 (excluding 112.85 and 117.0), 136.3, 321.0, 321.1, 370.05, 484.6, 484.7, 518.6, and 771.7 to identify fungal diseases (Table 1). For inpatient data, we included visits with any fungal disease listed as the principal diagnosis and invasive fungal diseases listed in any position on the record. For outpatient data, we included visits with any fungal disease code listed in any position on the record. Some insurance plans do not contribute outpatient pharmaceutical information to the MarketScan databases; we excluded patients who did not have drug data available.

#### **Visit cost calculations and national cost estimates**

We calculated insurer costs, out-of-pocket costs (deductibles, co-payments, and co-insurance), and the sum of total payments from either source for hospitalizations and outpatient visits for each disease using the MarketScan databases. Because these payment sources include third party reimbursements as well as out-of-pocket costs, we refer to them collectively as “costs.” Costs include all costs incurred at a hospitalization or outpatient visit, even if fungal infection was not the primary diagnosis. Outpatient visit costs included costs of antifungals (and antibiotics for *Pneumocystis* pneumonia prophylaxis and treatment, among patients with ICD-9-CM code 136.3) listed on prescription drug claims in the seven days before to 30 days after fungal disease-associated outpatient visits [15, 16]. We chose this time window because MarketScan data do not indicate which outpatient visit or diagnosis was associated with a prescription.

We used the NIS to estimate the proportion of payers (Medicare, Medicaid, private insurance, and “other”) for each disease. “Other” payment sources included self-pay and insurance plans such as Tricare, Veterans health care, and other government programs; we used the privately-insured average cost per case for these sources. To estimate total national costs by disease from a healthcare payer perspective, we multiplied the average cost per hospitalization and outpatient visit from MarketScan by the corresponding proportion of payers and the total number of hospitalizations and outpatient visits in the HCUP NIS and NAMCS/NHAMCS, respectively. We did not calculate national costs for diseases with fewer than five visits per payment source in MarketScan or with relative standard errors greater than 30% in HCUP, to avoid unreliable calculations based on small sample sizes. We used the Medical Care Consumer Price Index from the Bureau of Labor Statistics, US Department of Labor, to adjust costs to 2017 US Dollars [17].

## Results

We estimate that 75,055 (95% confidence interval [CI]: 71,492–78,618) fungal-disease-associated hospitalizations and 8,993,230 (95% CI: 8,131,234–9,855,226) outpatient visits occurred in 2014 (Table 1), resulting in total direct medical costs of over \$7.2 billion.

The total estimated cost of fungal disease hospitalizations was \$4.6 billion, including more than \$1.8 billion for the Medicare supplemental population, \$1.6 billion for the privately-insured, and \$591 million for the Medicaid population. *Candida* infections (26,735 hospitalizations, total cost \$1.4 billion) and *Aspergillus* infections (14,820 hospitalizations, total cost \$1.2 billion) accounted for the most hospitalizations and the highest total costs of any disease. Specifically, 84% of the total costs and 48% of the hospitalizations for *Candida* infections were due to invasive candidiasis. Average cost per hospitalization varied by payment source, but were generally highest for mucormycosis (\$106,655–\$112,849), invasive candidiasis (\$64,723–\$153,090), and uncommon and opportunistic mycoses (\$49,463–\$131,823) (Table 2).

Fungal disease outpatient visits cost an estimated \$2.7 billion, including \$1.7 billion for the Medicare supplemental population, \$538 million for the privately-insured, and \$295 million for the Medicaid population (Table 3). Over half of all outpatient visits were for dermatophyte infections (4,981,444 visits), resulting in a national cost of \$821 million. 3,639,037 outpatient visits occurred for non-invasive candidiasis at a total cost of nearly \$2.1 billion. Of those, 1,354,331 visits (37%) were for vaginal candidiasis (total cost \$368 million), 782,522 visits (22%) were for oral candidiasis (total cost \$335 million), and 792,057 visits (22%) were for candidiasis of an unspecified site. Total outpatient costs for “other and unspecified mycoses” (n=204,780 visits) were \$182 million. For all payment sources, the highest average visit costs were for mucormycosis (\$1,382–\$4,437) and esophageal candidiasis (\$708–\$1,812). Dermatophyte infections had the lowest average visit costs (\$123–\$217), and costs for vaginal candidiasis were also relatively low (\$186–\$287).

## Discussion

These estimates of direct healthcare costs associated with administratively-identified fungal diseases provide insight into their overall burden in the United States, which has not been systematically characterized. Our findings suggest that fungal diseases have direct medical costs of more than \$7 billion annually, approximately 0.22% of the total national health expenditures of \$3.3 trillion in 2016 (the most recent year of data available) [18]. Our results likely under-estimate the true cost burden of fungal diseases because they often go undiagnosed, leading to unnecessary treatment and in severe cases, substantial morbidity and death.

For most of the public, the term “fungal diseases” brings to mind superficial fungal infections, such as those from dermatophyte infections and non-invasive candidiasis. These superficial fungal infections were associated with >8 million national outpatient visits and \$2.4 billion in costs. Lesser-known diseases like invasive candidiasis and aspergillosis affect a much smaller number of people (~15,000 hospitalizations in this analysis) but result in similarly large national costs because of their severity. Patients at risk for these severe fungal diseases often have underlying conditions that can require additional healthcare expenditures, which are captured in our analysis if billed in the same outpatient visit or hospitalization with a fungal disease, and would inflate these estimates. Complete attribution of specific comorbid conditions was not feasible in this analysis.

Nonetheless, our results are generally consistent with prior estimates of costs associated with fungal diseases based on ICD codes. The national cost of aspergillosis, candidiasis, cryptococcosis, and histoplasmosis in high-risk patients was previously estimated to be \$2.6 billion in 1998, equivalent to \$5.1 billion in 2017 [4]. We found that these four diseases did in fact contribute much of the national costs (67% of total inpatient costs); however, there were several methodological differences between our analysis and the previous study. Namely, the previous study included post-hospitalization nursing home and home health care costs, which accounted for 35% of total costs, but did not include costs of outpatient visits among patients who did not require hospitalization.

Aspergillosis, candidiasis, and mucormycosis are among the most studied invasive fungal diseases in terms of their economic impact. Other studies of aspergillosis-related hospitalizations using administrative data found a median cost of \$52,803 (inflation-adjusted to \$74,653 in 2017 dollars) in 2006 [6] and a mean of \$76,235 (\$99,532 in 2017 dollars) specifically among intensive care unit patients during 2005–2008, [19] compared with a mean all-payer cost of \$82,427 in this study. In 1996, the total national costs of aspergillosis-related hospitalizations were estimated to be \$633 million, [20] equivalent to approximately \$1.3 billion in 2017, similar to our estimate of \$1.2 billion. An analysis of nationwide hospitalizations for invasive candidiasis during 2002–2012 found a median cost of \$46,684, [9] which, unadjusted for inflation, are somewhat lower than our estimates. We did not specifically examine costs associated with fungal meningitis, but another recent analysis using MarketScan data found that patients with *Candida* meningitis had comparatively high average charges (\$103,803), as did patients with cryptococcal, coccidioidal, and *Histoplasma* meningitis [21]. Other studies also support our findings that mucormycosis,

though a rare disease, consistently results in high average hospitalization costs (>\$100,000 in this study) due to its severity and long length of stay [10, 22]. This finding is particularly notable since mucormycosis rates doubled from 2000 to 2013 [23].

Our findings confirm that cutaneous fungal diseases and vaginal candidiasis are associated with a substantial economic and public health burden in the United States. Prior estimates of the total direct costs of cutaneous fungal diseases, including both dermatophyte infections and candidiasis of skin and nails, were \$1.7 billion in 2004, [24] with 4.1 million average yearly visits during 1995–2004, [12] compared with nearly \$1 billion and 5.3 million average yearly visits for these two groups of infections in this analysis. We also found more than twice as many vaginal candidiasis visits than a previous study of NAMCS data, which described an average of 534,000 average annual visits nationwide during 1996–2001, [11] suggesting possible increases in recognition and diagnosis, actual infections, or both, in recent years.

Even though costs attributed to healthcare for comorbid conditions could not be isolated and removed, the true economic burden of fungal diseases in the United States is likely larger than our estimates. Given the challenges with timely diagnosis, many fungal diseases likely go unrecognized. For example, studies of autopsy reports suggest that only 50% of invasive fungal diseases are diagnosed before death [25]. In addition, our analysis is subject to several limitations inherent in administrative data, notably, the potential for ICD-9-CM code misclassification. Other studies have found that ICD-9-CM codes for aspergillosis and candidemia have only modest sensitivity and sometimes poor positive predictive values [26–28]. We also observed a remarkable number of visits and high associated costs for “other and unspecified mycoses” (ICD-9-CM code 117.9), perhaps indicating a need for both better diagnostic testing and coding practices. In general, ICD-10-CM codes contain a greater level of detail than ICD-9-CM, which could help improve future administrative analyses of fungal diseases. However, in the absence of surveillance for many fungal diseases, large administrative datasets such as MarketScan, HCUP, and NAMCS/NHAMCS are some of the best data sources available. NAMCS/NHAMCS might also underestimate the number of visits for certain diseases due to the survey design, in which data are collected on the day of the visit, so initial visits for diseases that require laboratory test results to diagnose might not be captured with ICD-9-CM codes. Because HCUP and NAMCS/NHAMCS cannot identify unique patients, our analysis captures prevalent rather than incident disease and therefore represents a snapshot of yearly costs rather than average costs incurred during a patient’s entire illness episode. Specifically, our results likely under-estimate prescription drug costs because for some diseases, many patients might receive antifungal medication for longer than the time window we evaluated or receive free or discounted medication through pharmaceutical assistance programs.

Our results also underestimate the true costs associated with fungal diseases because they do not account for costs related to unnecessary testing, medical procedures, and inappropriate treatment before a fungal diagnosis is established, nor do they include costs of over-the-counter antifungal medications or nursing home care. Our estimates also do not include indirect costs such as those associated with decreased productivity, like time spent away from work due to disability, or deaths. In general, these indirect costs have not been well-

established for most fungal diseases, but several studies document the negative impacts of certain diseases on patients' quality of life [29, 30]. Such costs may be substantial and merit further study.

Further strategies to prevent fungal diseases and subsequently reduce costs are needed. Many fungal diseases, particularly those acquired from the natural environment via inhalation, are difficult to prevent. Therefore, public health efforts directed at increasing public and healthcare provider awareness and facilitating earlier diagnosis and treatment are of utmost importance. For example, coccidioidomycosis patients in Arizona who were aware of coccidioidomycosis before seeking healthcare were diagnosed faster than those who did not know about the disease, [29] and earlier diagnosis and treatment has been associated with improved outcomes [19, 31–33] and reduced costs [19] for several fungal diseases. Because non-specific signs and symptoms can make fungal diseases challenging to identify, improved diagnostic strategies are needed to detect them early. Early detection is especially important in patients at high risk for developing invasive fungal diseases; examples of existing strategies include galactomannan assay for aspergillosis and  $\beta$ -D-glucan and T2Candida for invasive candidiasis [34]. When applied in at-risk populations with higher pre-test probability of infection, diagnostic-driven strategies like these have reduced costs by 32%, [35] and reduced empiric antifungal use by 11–14% compared with standard empiric strategies [36]. Similarly, screening for cryptococcal antigenemia, an early indicator of cryptococcal infection, is not routinely performed in the United States but might prevent deaths and be cost-effective among HIV-infected persons with low CD4 T-cell counts [37].

Early prevention methods for fungal diseases include prophylaxis and empiric treatment to prevent specific fungal diseases such as aspergillosis, candidemia, and *Pneumocystis* pneumonia in certain high-risk patients. These interventions are generally recognized as cost-effective, but the benefits can depend on the specific antifungal agent, patient characteristics and underlying conditions, and the baseline invasive fungal infection rate; more research is needed to better define optimal prophylaxis strategies for certain patient populations [38]. Judicious use of antifungal agents, including use of stewardship programs, is warranted given the increasing threat of antifungal resistance, particularly in *Aspergillus* and *Candida* [39]. Echinocandins, posaconazole, and isavuconazole are some of the most expensive antimicrobials currently on the market, and costs of these medications contribute to the overall cost estimates presented here. Other prevention approaches include healthcare infection control methods such as hand hygiene for invasive *Candida* infections and environmental strategies such as indoor air quality management, especially during construction or renovation activities, for preventing invasive mold infections. Adherence to infection control methods, along with other prevention efforts such as screening case-patient contacts for colonization, is especially important for preventing infections with *Candida auris*, a globally-emerging and often multi-drug resistant organism that is difficult to identify with standard laboratory methods and spreads quickly in healthcare settings. Lastly, vaccines to prevent fungal disease do not yet exist but are being pursued for *Candida* infections and coccidioidomycosis; it is estimated that a potential coccidioidomycosis vaccine would save 1.9 quality-adjusted life days and \$33 per person among children in highly-endemic areas [40].

In conclusion, fungal diseases are known to cause considerable morbidity and mortality. We show that they are also associated with substantial direct medical costs. These estimates are important for better defining the burden of these diseases in the United States, with the ultimate goal of improving their recognition, prevention, diagnosis, and treatment.

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**Table 1.**

Estimated numbers of inpatient visits (HCUP, 2014) and outpatient visits (NAMCS/NHAMCS, 2005–2014 yearly average) for fungal diseases, United States.

Disease	ICD9-CM code(s)	Inpatient visits (95% CI)	Outpatient visits (95% CI)
<i>Aspergillus</i> infection	117.3, 484.6, 518.6	14,820 (13,690–15,950)	*
Invasive aspergillosis	117.3, 484.6	14,465 (13,356–15,574)	*
ABPA	518.6	375 (289–461)	*
Blastomycosis	116.0	950 (794–1,106)	*
<i>Candida</i> infection	112.0–112.9 excluding 112.85, 771.7	26,735 (25,669–27,801)	3,648,715 (3,212,465–4,084,966)
Invasive candidiasis	112.5, 112.81, 112.83	12,770 (11,997–13,543)	*
Non-invasive candidiasis	112.0–112.4, 112.82, 112.84, 112.89, 112.9, 771.7	13,990 (13,384–14,596)	3,639,037 (3,203,170–4,074,903)
Vaginal candidiasis	112.1	380 (295–465)	1,354,331 (1,114,767–1,593,895)
Oral candidiasis	112.0	1,090 (947–1,233)	782,522 (638,164–926,880)
Esophageal candidiasis	112.84	5,365 (5,031–5,699)	*
Candidiasis of skin and nails	112.3	410 (320–500)	359,599 (274,013–445,185)
Candidiasis of unspecified site	112.9	*	792,057 (644,084–940,030)
Coccidioidomycosis	114.0–114.9	6,670 (5,432–7,908)	*
Cryptococcosis	117.5, 321.0	4,755 (4,331–5,179)	*
Dermatophyte infections	110.0–111.9	690 (573–807)	4,981,444 (4,454,010–5,508,878)
Histoplasmosis	115.00–115.99	4,630 (4,164–5,096)	79,993 (43,064–116,922)
<i>Pneumocystis</i> pneumonia	136.3	10,590 (9,864–11,316)	*
Mucormycosis	117.7	1,140 (912–1,368)	*
Uncommon and opportunistic mycoses	116.1, 116.2, 117.1, 117.2, 117.4, 117.6, 117.8, 118, 321.1, 370.05, 484.7	5,585 (4,525–6,645)	*
Other and unspecified mycoses	117.9	1,770 (1,351–2,189)	204,780 (134,958–274,602)
<b>Total**</b>	<b>All codes listed above</b>	<b>75,055 (71,492–78,618)</b>	<b>8,993,230 (8,131,234–9,855,226)</b>

\* Estimates suppressed according to NAMCS/NHAMCS and HCUP protocols.

\*\* Numbers of visits do not sum to total because some visits had more than one fungal disease listed on the record.

ABPA = allergic bronchopulmonary aspergillosis.

**Table 2.**

Mean inpatient and outpatient costs (2017 US Dollars) per fungal disease visit by payment source, MarketScan

Disease	Private insurance (\$)		Medicare supplemental (\$)		Medicaid (\$)	
	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient
<i>Aspergillus</i> infection	104,547	1,470	75,316	1,057	57,984	452
Invasive aspergillosis	106,819	1,605	76,926	1,160	58,433	538
ABPA	36,998	1,258	25,511	769	19,756	302
Blastomycosis	47,209	1,234	23,877	670	36,736	462
<i>Candida</i> infection	92,048	345	42,199	544	38,920	162
Invasive candidiasis	153,090	725	73,250	1,278	64,723	406
Non-invasive candidiasis	51,752	343	27,511	537	23,234	162
Vaginal candidiasis	20,142	287	14,819	288	17,317	186
Oral candidiasis	58,585	416	24,873	580	25,066	144
Esophageal candidiasis	22,777	1,812	20,048	1,540	12,882	708
Candidiasis of skin and nails	16,798	286	14,407	326	8,860	144
Candidiasis of unspecified site	51,954	323	39,563	500	41,282	170
Coccidioidomycosis	39,786	620	26,101	488	16,320	156
Cryptococcosis	69,586	1,034	46,197	993	39,289	436
Dermatophyte infections	48,185	217	24,947	152	12,644	123
Histoplasmosis	48,782	581	35,305	460	20,609	405
<i>Pneumocystis</i> pneumonia	63,388	1,061	43,000	632	23,342	526
Mucormycosis	108,895	4,437	106,655	3,732	112,849	1,382
Uncommon and opportunistic mycoses	131,823	970	83,171	1,074	49,463	385
Other and unspecified mycoses	91,467	992	65,834	1,005	35,430	382
Any fungal disease	84,790	281	51,365	188	38,898	146

ABPA = allergic bronchopulmonary aspergillosis.

**Table 3.**

Estimated total inpatient and outpatient costs by payment source, United States

Disease	Private insurance (\$)		Medicare supplemental (\$)		Medicaid (\$)		Other payment source (\$)		Total (\$)		Percent of total fungal disease costs	
	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient	Outpatient	Inpatient and Outpatient	
<i>Aspergillus</i> infection	446,841,070	12,839,459*	553,960,403	15,890,078*	140,499,827	2,238,847*	80,257,862	2,306,116*	1,221,559,161	33,274,501*	17%	
Invasive aspergillosis	442,681,293	5,650,145*	553,811,378	7,091,038*	138,364,739	1,082,713*	80,347,041	1,025,506*	1,215,204,451	14,849,402*	17%	
ABPA	5,179,233	8,454,944*	4,082,156	5,906,029*	1,185,346	871,365*	554,967	905,968*	11,001,702	16,138,305*	0%	
Blastomycosis	15,826,969	1,461,367*	n/a	902,506*	n/a	223,839	4,556,589	420,728*	20,383,558	3,008,440*	0%	
<i>Candida</i> infection	450,591,119	230,527,371	668,675,721	1,176,010,880	175,743,403	99,595,206	136,087,869	69,624,050	1,431,098,112	1,575,757,507	41%	
Invasive candidiasis	426,962,153	1,532,546*	486,034,050	6,424,624*	167,863,985	798,446*	115,146,844	413,310*	1,196,007,032	9,168,927*	17%	
Non-invasive candidiasis	109,326,427	188,408,371	253,749,411	1,288,966,937	44,660,334	80,805,709	37,866,041	65,256,674	445,602,212	1,623,437,691	29%	
Vaginal candidiasis	2,244,941	114,077,438	2,552,632	176,978,941	1,052,898	40,225,444	714,126	36,288,527	6,564,598	367,570,351	5%	
Oral candidiasis	15,593,985	79,501,316	12,492,855	209,079,126	6,420,647	26,506,078	3,825,060	19,500,937	38,332,546	334,587,457	5%	
Esophageal candidiasis	21,678,237	11,880,455*	65,579,141	34,703,110*	10,387,413	3,931,580*	7,649,705	4,192,314*	105,294,496	54,707,458*	2%	
Candidiasis of skin and nails	1,091,594	16,306,328	3,961,829	78,745,383	531,460	7,583,049	168,044	2,510,249	5,752,927	105,145,008	2%	
Candidiasis of unspecified site	n/a	46,542,441	n/a	108,022,489	n/a	61,322,810	n/a	23,271,220	n/a	239,158,960	3%	
Coccidioidomycosis	63,051,899	4,059,240*	68,645,512	5,301,322*	29,946,670	1,183,250*	24,679,405	1,588,844*	186,323,486	12,132,656*	3%	
Cryptococcosis	75,375,122	2,696,042*	84,109,486	4,349,829*	52,215,642	1,393,727*	36,297,853	1,298,313*	247,998,103	9,737,911*	4%	
Dermatophyte infections	6,263,852	203,937,154	7,983,570	350,677,518	2,402,654	169,279,653	2,410,453	78,479,000	19,060,529	802,373,326	11%	
Histoplasmosis	69,317,014	14,261,580	75,062,421	16,886,634	15,266,836	5,185,051	16,713,780	3,438,765	176,360,051	39,772,029	3%	
<i>Pneumocystis</i> pneumonia	178,292,626	1,630,534*	110,382,541	886,434*	86,269,038	1,062,448*	95,993,394	877,885*	470,937,600	4,457,302*	7%	
Mucormycosis	42,654,497	327,752*	38,032,358	251,006*	36,831,788	85,094*	7,113,221	54,657*	124,631,863	718,510*	2%	
Uncommon and opportunistic mycoses	253,778,258	5,930,461*	200,437,028	8,226,405*	41,796,380	1,034,779*	53,376,628	1,247,341*	549,388,295	16,438,986*	8%	
Other and unspecified mycoses	48,018,540	60,221,513	53,660,574	94,735,364	10,980,641	13,704,048	10,976,591	13,766,077	123,636,346	182,427,002	4%	
Any fungal disease**	1,561,698,461	619,341,968	1,815,405,002	795,389,705	607,543,161	273,841,778	481,110,039	190,799,726	4,465,756,664	1,879,373,178		
<b>Total***</b>	<b>1,650,010,967</b>	<b>537,892,470</b>	<b>1,860,949,615</b>	<b>1,674,117,977</b>	<b>591,952,878</b>	<b>294,985,943</b>	<b>468,463,645</b>	<b>173,101,777</b>	<b>4,571,377,104</b>	<b>2,680,098,168</b>	<b>100%</b>	

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\* Cost calculation based on <30 NAMCS/NHAMCS visits or relative standard error >30%; interpret with caution.

\*\* Costs of visits for one or more of the fungal diseases listed in the table.

\*\*\* The sum of costs for every disease category in the table. This value is subject to double counting of visits where multiple fungal disease codes were listed at a single visit, and excludes sub-categories and the "any fungal disease" category.

ABPA = allergic bronchopulmonary aspergillosis.

n/a = Costs not calculated for <5 visits per payment source in MarketScan or HCUP relative standard error >30%.