

# Cost of atopic dermatitis and eczema in the United States

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**Background:** Atopic dermatitis/eczema (AD/E) is a common disease. Few studies have attempted to quantify the cost to third-party payers.

**Objective:** Our purpose was to identify the annual cost of medical services and prescription drugs for the treatment of AD/E to private insurance and Medicaid payers in the United States.

**Methods:** We used a retrospective study design employing claims data from 1997 and 1998 from a private insurer and a state Medicaid program to analyze costs incurred. Beneficiaries were considered to have AD/E if they had at least one claim in 1997 with a primary or secondary listing of 1 of 3 diagnosis codes: 691.8, other atopic dermatitis and related conditions; 692.9, contact dermatitis and other eczema when no cause is specified; or 373.3, noninfectious dermatoses of eyelid. Patients who did not meet the diagnosis criteria served as a control group in each payer for comparisons of expenditures with the AD/E group.

**Results:** Disease prevalence was 2.4% (private insurer) to 2.6% (Medicaid) of all eligible beneficiaries, and 3.5% to 4.1% of patients submitted at least one health care claim during the study period. Medicaid-insured patients used outpatient hospital visits and hospitalizations at a greater rate than did privately insured patients; neither used emergency departments extensively. The third-party payer cost of illness for AD/E ranged from \$0.9 billion to \$3.8 billion when projected across the total number of persons younger than 65 years insured by private insurers and Medicaid in the United States. More than one fourth of all health care costs for patients with AD/E may be attributed to AD/E and co-morbid conditions.

**Conclusions:** Annual costs of AD/E are similar to those of other diseases such as emphysema, psoriasis, and epilepsy. Patients incur significant costs associated with AD/E and co-morbid conditions. (J Am Acad Dermatol 2002;46:361-70.)

**A**topic dermatitis/eczema (AD/E) is a common disease affecting children and adults worldwide with a prevalence reported to be between 7% and 17% of the pediatric population.<sup>1,2</sup> Although disease prevalence gradually decreases

with age, AD/E may persist in 60% of adults who had the disease as children.<sup>3</sup> Unfortunately, AD/E is often considered a minor dermatologic problem and is not recognized as being associated with significant clinical co-morbidities and health care costs.<sup>4</sup>

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**Abbreviations used**

|           |  |
|-----------|--|
| AD/E:     | atopic dermatitis/eczema   |
| CI:       | confidence interval  |
| ICD-9-CM: | <i>International Classification of Diseases, Ninth Revision, Clinical Modification</i> |

Several studies have attempted to quantify the social and financial costs associated with AD/E. On a per patient basis, the annual cost may be as high as \$4635 per year (in 1997 US dollars converted from \$6099 Australian dollars)<sup>4,5</sup>; this annual cost estimate is composed of medical costs (US \$487), hospital costs (\$2213), other direct costs (\$954), and indirect costs (\$980). The total national cost for the treatment of childhood atopic dermatitis was estimated to be \$364 million in the United States in 1990, and \$721 million in the United Kingdom in 1996 (US dollars converted from UK £465 million).<sup>6,7</sup>

Research to date has relied on patients clustered in a small geographic area or single hospital catchment area. The studies tracked health care utilization and direct medical care expenditures over time. Some of these studies have also expanded the estimates of cost of illness by measuring direct nonmedical costs, such as special clothing, extra laundry expenses, and other costs related to the disease and by including indirect costs such as time off from work.<sup>5,7</sup>

However, no studies to date have examined the cost of AD/E from the perspective of the third-party payer. This particular perspective is important because payers often influence access to specialists and the choice of the prescribed treatments, while at the same time payers are at risk for costs associated with disease co-morbidities and complications. Although previous findings have attributed a high cost to AD/E to society and families, the objective of this study was to determine the annual direct medical costs of AD/E to third-party payers in the United States.

**METHODS****Data sources**

Health care claims data were obtained from 2 different payer populations: (1) a private managed care payer in the central United States with 1.5 million covered lives (representing beneficiaries continuously enrolled in the plan from January 1997 through December 1998) and (2) a state Medicaid program located in the eastern United States with 3.5 million covered lives (representing beneficiaries enrolled at any time from January to December 1997).<sup>8,9</sup> Patients enrolled in Medicaid managed care demonstration projects were excluded.

**Data elements**

Claims data consisted of 3 data sets for each payer: (1) beneficiary sociodemographic information, (2) institutional and professional claims for inpatient and outpatient services, and (3) outpatient prescription drug claims. All claims contained an encrypted patient identifier that links claims from each file to individual beneficiaries.

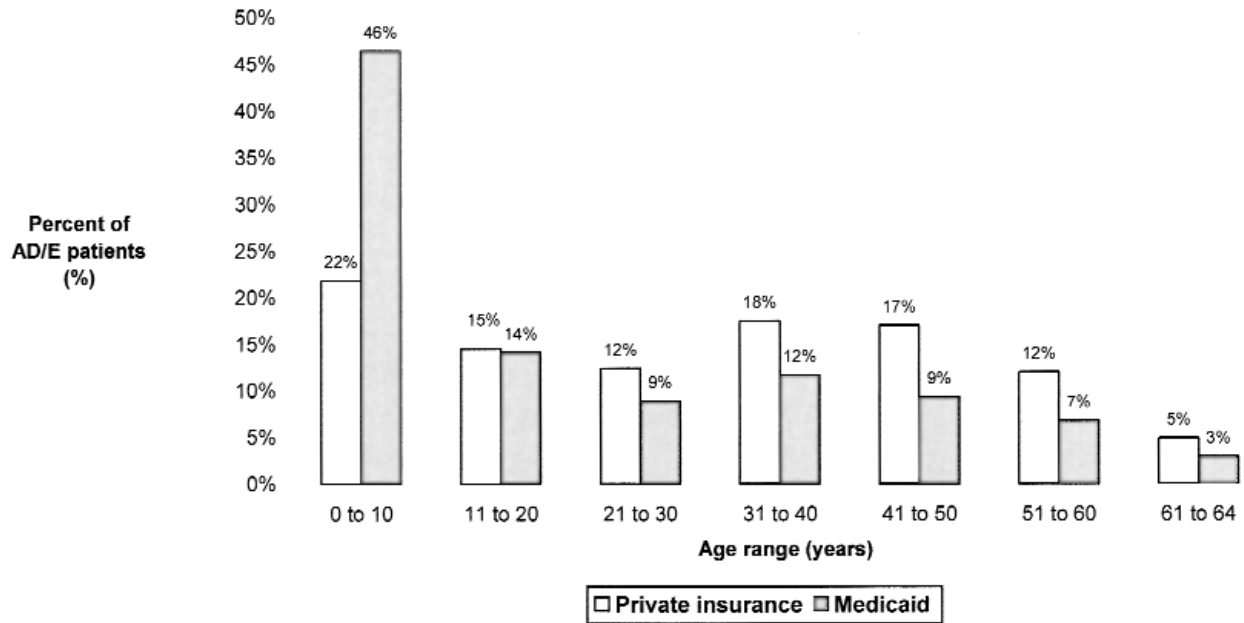
The fields of information we used were date of birth; date of service; patient primary and secondary International Classification of Diseases diagnosis codes (on hospital and physician claims); settings of care; prescription drug identification based on national drug codes; and amount reimbursed by the third-party payer, which was considered to be the expenditure incurred by the payer.

**Patient populations**

According to the opinion of a panel composed of the physician authors, beneficiaries were considered to have AD/E if they had at least one claim in 1997 with a primary or secondary listing of 1 of 3 *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* diagnosis codes: 691.8, other atopic dermatitis and related conditions; 692.9, contact dermatitis and other eczema when no cause is specified; or 373.3, noninfectious dermatoses of eyelid (which was the sole diagnosis in less than 1% of patients but was used to identify patients with eczema who had this localized condition only). Patients who did not meet these criteria were evaluated as part of a control group in each payer group for comparisons of expenditures with the AD/E group.

**Disease prevalence and cost tabulations**

Disease prevalence in each payer group was estimated by dividing the number of patients categorized as having AD/E by the total insured population and also by the number of patients who submitted at least one health care claim during the 1-year observation period. Claims with *ICD-9-CM* codes 691.8, 692.9, or 373.3 were aggregated to represent the direct medical costs attributable to AD/E; other medical costs were also determined as described below. Only costs incurred by the payers were included in the analyses; patient co-payments and nonallowed charges were not included. For patients with private insurance, we included payments for the first AD/E claim and all subsequent health care payments for 12 months (all patients were continuously enrolled during this period). Because our state Medicaid database does not indicate periods of enrollment, costs for Medicaid patients with AD/E included all costs incurred in 1997.



**Fig 1.** Age distribution of patients with AD/E by payer. The percentages of patients with AD/E by age cohort are shown for both private insurer and Medicaid claims databases.

### Estimates of costs attributable to disease-related co-morbidities and treatments

With the use of guidelines for clinician input in determining health care resource utilization,<sup>10</sup> AD/E disease-related co-morbidities and treatments were established prospectively on the basis of input from a panel of the physician authors. All *ICD-9-CM* diagnosis codes and prescription drug categories from *Multum's Medisource Lexicon*<sup>11</sup> were considered.

Panelists were asked individually and then collectively to determine the diagnosis codes or pharmacy items “most likely,” “possibly,” or “definitely not” related to the costs of identifying and treating patients with AD/E. Panel members reviewed the categorizations collectively a second time to validate the assignments and resolve differences in diagnosis code and prescription drug assignment. All categorizations of co-morbidities and drugs were done with panelists unaware of the frequency of claims and expenditures.

Claims for health services and tests (including professional, technical, hospital, diagnostic, and nonretail pharmacy services) were evaluated solely by associated diagnosis codes, not by procedure codes. Prescription drug claims did not include diagnosis codes; therefore the categorization of drug products was based on the panel’s judgment as to their relevance to AD/E. The various assignments were used to classify claims within single-payer databases to estimate the annual costs of treating

patients (Appendix). (The Appendix summarizes the co-morbidities and prescription drugs assigned to most likely and possibly related categories [possibly related categories found at [www.eblue.org](http://www.eblue.org)].)

For each payer, costs for most likely and possibly related diagnosis codes and prescription drugs were compared between the AD/E population and the non-AD/E population (used as the control group). These comparisons determined whether these items occurred more frequently in the AD/E population (co-morbidity prevalence) and whether per patient expenditures for each were greater in the AD/E population.

### Analyses

Mean costs per patient were calculated in each payer group. Costs were not inflated to present-value dollars because one of the study objectives was to describe payer costs as they were actually incurred.

Costs for each payer for AD/E were estimated by using 4 different approaches:

1. All AD/E claims plus claims for co-morbidities and prescription drugs determined by the panel to be most likely related to AD/E
2. All AD/E claims plus claims for co-morbidities and prescription drugs determined by the panel to be most likely *and* possibly related to AD/E
3. All AD/E claims plus the costs for co-morbidities and prescription drugs classified to be most like-

**Table I.** Disease prevalence by payer\*

|   | Private insurer | Medicaid    |
|---|-----------------|-------------|
| Total No. of covered patients                             | 1.5 million     | 3.5 million |
| Total No. of patients with at least one health care claim | 1.0 million     | 2.2 million |
| Patients with claim of 691.8 <sup>†</sup>                 | 5,015           | 19,664      |
| Patients with claim of 692.9 <sup>†</sup>                 | 31,508          | 73,563      |
| Patients with claim of 373.3 <sup>†</sup>                 | 383             | 203         |
| Total No. of patients with AD/E                           | 35,404          | 89,381      |
| Disease prevalence (insured population)                   | 2.4%            | 2.6%        |
| Disease prevalence (patients with a claim)                | 3.5%            | 4.1%        |

\*For description of each payer, see text; the private insurer is a single managed care organization; the Medicaid payer is from a single state.

<sup>†</sup>For a description of the referenced ICD-9-CM codes and other criteria for inclusion, see text.

ly related to AD/E *that exceeded the comparable amount spent for the control group*

- All AD/E claims plus the incremental costs for co-morbidities and prescription drugs classified to be most likely *and* possibly related to AD/E *that exceeded the comparable amount spent for the control group*.

The latter two approaches are referred to as the *incremental per capita costs* in the AD/E population compared with the control group.

### Projections of annual AD/E costs to payers

To project the cost of illness throughout the United States, expenditures for claims with a diagnosis code of AD/E were always included fully. Most likely and possibly related co-morbidities and prescription drugs could be included fully or included only if the incremental mean cost per patient was higher in the AD/E population.

In 1997 there were an estimated 168 million nonelderly privately insured patients and 36 million nonelderly Medicaid patients in the United States.<sup>12,13</sup> National cost projections were determined by multiplying the mean per capita costs for each payer by the number of such patients in the United States. Costs to Medicare, other government agencies, and the uninsured were not included.

## RESULTS

### AD/E population and disease prevalence

During the study period, there were 1.0 million unique patients with at least one health care claim in the private insurer database and 2.2 million patients with a claim in the Medicaid database. Within these populations, 35,404 patients in the private payer database and 89,381 patients in the Medicaid database had at least one claim with an AD/E diagnosis code. As expected, a higher percentage of patients with AD/E were children, especially in the Medicaid population (Fig 1).

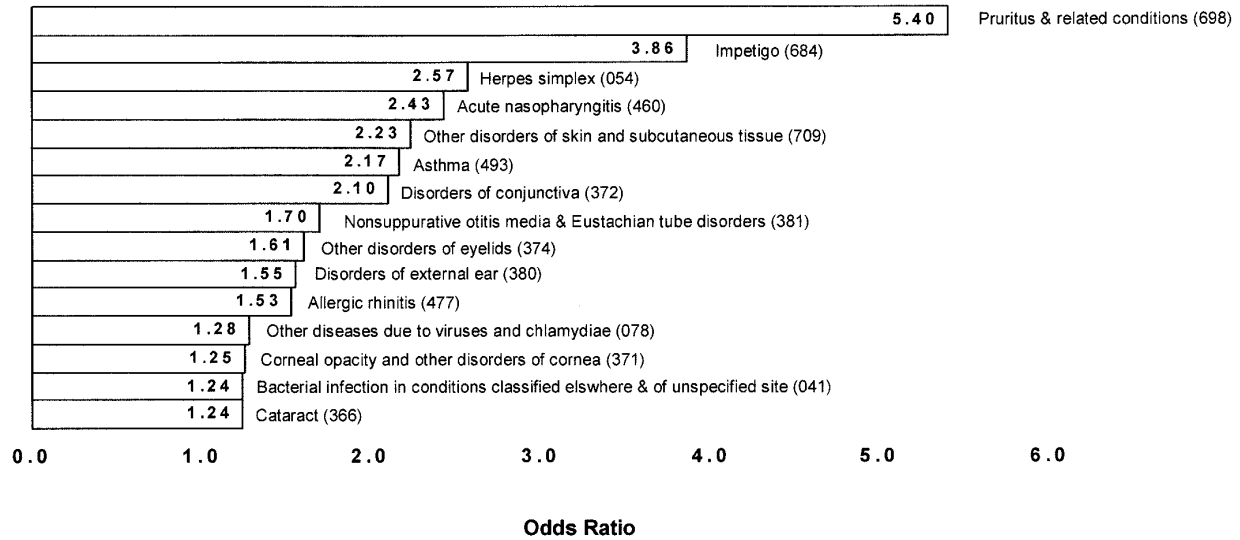
The overall prevalence of disease in the private insurer population was estimated to be 2.4% of all eligible beneficiaries and 3.5% of patients submitting at least one health care claim during the study period. Disease prevalence was similarly estimated at 2.6% to 4.1% of the Medicaid population. ICD-9-CM code 692.9 was included in most of the AD/E claims (Table I).

### Most prevalent co-morbidities and prescription drugs

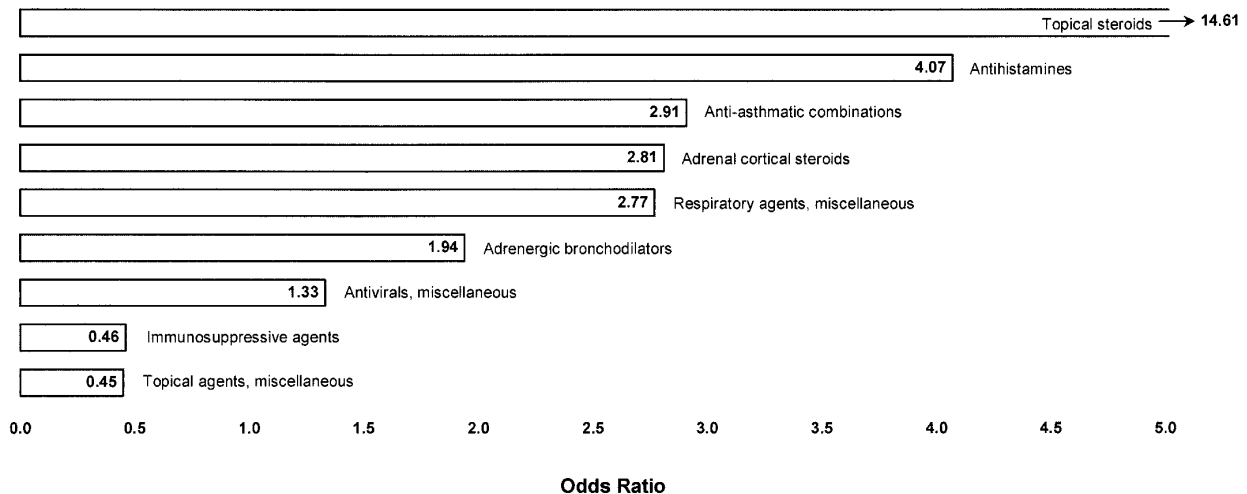
Among most likely related co-morbidities, the most frequently occurring were allergic rhinitis (experienced by 7% and 6% of patients with AD/E in the private insurer and Medicaid populations, respectively), asthma (5%, 14%), nonsuppurative otitis media and eustachian tube disorders (5%, 5%), and disorders of conjunctiva (4%, 7%). For all the most likely co-morbidities identified prospectively by the panelists, the prevalence of patients in the AD/E populations who had claims for such co-morbidities was higher than that in the control populations (Fig 2, odds ratios >1).

The most frequently occurring possibly related co-morbidities were acute pharyngitis (experienced by 13% and 13% of patients with AD/E in the private insurer and Medicaid populations, respectively), acute upper respiratory tract infections of multiple or unspecified sites (12%, 30%), suppurative and unspecified otitis media (10%, 17%), and acute sinusitis (7%, 2%). Odds ratios for possibly related co-morbidities are shown in the Appendix.

The most likely related prescription drug items that were used most frequently were topical steroids (used by 46% and 66% of patients with AD/E in the private insurer and Medicaid populations, respectively), antihistamines (16%, 36%), systemic adrenal cortical steroids (16%, 11%), and adrenergic bronchodilators (8%, 21%). For most of the most likely prescription drug items identified prospectively by



**Fig 2.** Odds ratio of most likely related co-morbidities, indicated by the number within each bar. Odds ratios compare the prevalence of patients in the AD/E population who had a claim in each category with the prevalence in the control population. Odds ratios were determined independently of and subsequent to the physician panel's inclusion of the listed *ICD-9-CM* codes. The odds ratios are statistically significant because none of the confidence intervals (CIs) (see Appendix) for any of the odds ratios included 1.0. The numbers in parentheses are the categories of *ICD-9-CM* codes; the general term for each category is listed.



**Fig 3.** Odds ratio of most likely related pharmacy items, indicated by the number within the bar (except for topical steroids, which extends off the chart to 14.6). Odds ratios compare the prevalence of patients in the AD/E population who had a claim for each pharmacy item with the prevalence in the control population. Odds ratios less than 1 indicate that fewer patients in the AD/E population had a claim compared with those in the control group. The odds ratios are statistically significant because none of the CIs (see Appendix) for any odds ratios included 1. The general term for each category is listed.

the panelists, the prevalence of patients in the AD/E populations who had claims for such items was higher than that in the control group (Fig 3, those with odds ratios >1). The 2 exceptions were immunosuppressive agents and miscellaneous topical agents, which were associated with lower prevalence rates among patients in the AD/E group than among sub-

jects in the control group (Fig 3); however, the number of patients in both AD/E and control groups who had claims for these items was low.

The possibly related prescription drug items that were used most frequently were penicillins (used by 27% and 44% of patients with AD/E in the private insurer and Medicaid populations, respectively),

**Table II.** Annual costs of treating patients with AD/E by payer\*

|  | Private insurer<br>(n = 35,404) | Medicaid<br>(n = 89,381) |
|--|---------------------------------|--------------------------|
| Total health care expenditures for patients with AD/E (all claims) | \$64 million                    | \$400 million            |
| Mean expenditure per patient (all claims)                          | \$1810                          | \$4,480                  |
| Expenditures for AD/E diagnosis codes <sup>†</sup>                 | \$3 million                     | \$11 million             |
| Expenditures for most likely related                               |                                 |                          |
| Co-morbidities   | \$3 million                     | \$22 million             |
| Prescription drugs   | \$2 million                     | \$8 million              |
| Expenditures for possibly related                                  |                                 |                          |
| Co-morbidities   | \$10 million                    | \$58 million             |
| Prescription drugs   | \$3 million                     | \$13 million             |
| Total cost of all AD/E-related claims                              | \$20 million                    | \$111 million            |
| Mean expenditure per patient (all related claims)                  | \$580                           | \$1250                   |
| 95% CI (all related claims)  | \$558 to \$598                  | \$1216 to \$1275         |

Totals may vary because of rounding.

\*For a description of each payer, see text; the private insurer is a single managed care organization; the Medicaid payer is from a single state. The annual period is 12 consecutive months for the private insurer and the calendar year 1997 for Medicaid.

<sup>†</sup>For a description of *ICD-9-CM* codes for AD/E, see text. Prescription costs are not associated with diagnosis codes; therefore expenditures for AD/E diagnosis codes are mainly for services.

cephalosporins (17%, 21%), macrolides (17%, 18%), and topical anti-infective agents (14%, 36%). Odds ratios for possibly related drug items are shown in the Appendix.

#### Annual costs specific to AD/E

The claims expenditures for patients with AD/E for all covered health services were \$64 million to the private insurer and \$400 million to Medicaid (Table II). Total payer expenditures for claims solely for AD/E based on the 3 primary diagnosis codes of 691.8, 692.9, and 373.3 were \$3 million for the privately insured patients and \$11 million for the Medicaid patients (Table II). These claims are specific to AD/E because these reimbursements for professional fees, laboratory tests, therapies (such as UV therapy), and all other identifiable reimbursements (mainly for services rendered) could be linked to the 3 principal AD/E diagnosis codes. These costs do not include costs of prescription medications because they cannot be linked to a specific diagnosis code. However, prescription medication costs for these diagnoses and others are included in the following estimates because various prescription medications could be attributed to AD/E therapy under the classifications of most likely and possibly related to AD/E.

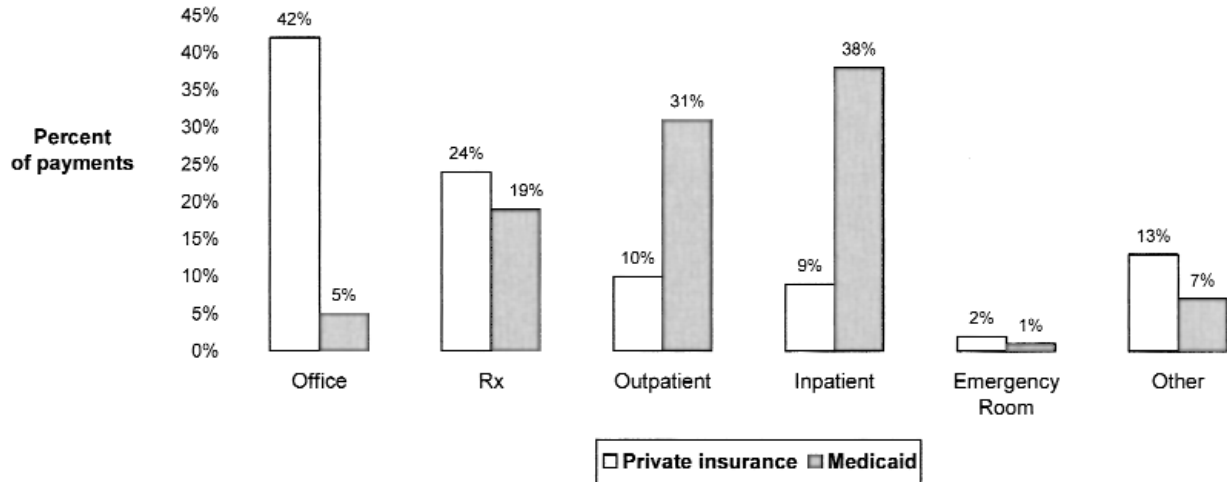
**Expenditures for AD/E most likely and possibly related claims.** With the use of the classifications developed by the physician panel, claims rated as most likely related to AD/E increased expenditures an additional \$5 million for the private insurer and \$30 million for Medicaid. Inclusion of possibly

related claims would add another \$13 million and \$71 million, respectively (Table II).

**Costs for AD/E as a percentage of total costs.** Service claims for the 3 primary AD/E diagnosis codes represented less than 5% of total payer expenditures. However, total AD/E-related claims represented 32% of all health care expenditures for patients with AD/E who had the private insurance (\$20 million/\$64 million) and 28% of Medicaid expenditures for patients with AD/E (\$111 million/\$400 million) (Table II). When analyzed by age group, AD/E-related claims for pediatric patients (age <16 years) represented a higher percentage of total health costs (45% for the private insurer and 39% for Medicaid). AD/E claims for adult patients were slightly lower as a percentage of total claims (29% for the private insurer and 24% for Medicaid).

#### Comparisons of costs by payer, setting of care, and physician visits

Payer per capita expenditures were substantially higher in the Medicaid population compared with the privately insured population (Table II). To evaluate this discrepancy, we assessed claims distribution and payer expenditures by setting of care (Table III, Fig 4). For privately insured patients, AD/E-related claims from physicians' offices and pharmacies represented 66% of total costs. In contrast, 69% of Medicaid expenditures occurred in hospitals (outpatient clinics and inpatient care), with pharmacy claims adding an additional 19%. Mean annual inpatient costs were particularly high for Medicaid



**Fig 4.** Distribution of payments by payer by setting of care; includes costs for AD/E diagnosis codes, most likely claims, and possibly related claims. Rx, Prescriptions.

**Table III.** Claims and costs by setting of care for each payer\*

| Setting of care      | Private insurer   |                     |                              | Medicaid          |                     |                              |
|----------------------|-------------------|---------------------|------------------------------|-------------------|---------------------|------------------------------|
|                      | Percent of claims | Percent of payments | Mean annual cost per patient | Percent of claims | Percent of payments | Mean annual cost per patient |
| Physician office     | 47                | 42                  | \$240                        | 14                | 5                   | \$60                         |
| Pharmacy             | 40                | 24                  | \$140                        | 51                | 19                  | \$240                        |
| Outpatient hospital  | 5                 | 10                  | \$60                         | 26                | 31                  | \$380                        |
| Inpatient hospital   | 1                 | 9                   | \$50                         | 2                 | 38                  | \$480                        |
| Emergency department | 2                 | 2                   | \$10                         | 1                 | <1                  | \$3                          |
| Other†               | 5                 | 13                  | \$70                         | 6                 | 7                   | \$90                         |
| Total                | 100               | 100                 | \$580                        | 100               | 100                 | \$1,250                      |

\*Includes all claims and costs for AD/E diagnoses and for most likely and possibly related claims. Totals may vary because of rounding. Dollar amounts are rounded to nearest \$10 unless less than \$10. For description of each payer, see text; the private insurer is a single managed care organization; the Medicaid payer is from a single state. The annual period is 12 consecutive months for the private insurer and the calendar year 1997 for Medicaid.

†Miscellaneous payments and claims for which the setting of care could not be identified.

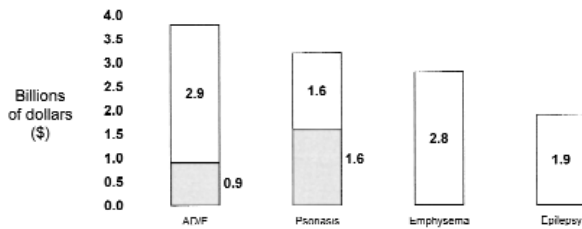
(\$480), equaling 83% of the total annual cost to the private insurer (\$580). For Medicaid, outpatient hospital visits generated 26% of all claims compared with 5% for the private insurer; conversely, physician visits accounted for 47% of claims to the private insurer but only 14% to Medicaid. Claims and costs attributed to emergency department services were low for both payers.

We also evaluated costs across payers for patients who had at least one visit to a dermatologist compared with patients who did not have any claims by a dermatologist during the study period. We found that a higher percentage of privately insured patients had at least one dermatologist's claim compared with Medicaid patients (35% vs 5%). Across both payers, however, mean annual costs per patient were higher for those

having a dermatologist claim (\$760 vs \$480 for private insurance and \$2420 vs \$1180 for Medicaid).

#### Projections of annual AD/E costs to payers

Under the most conservative projections, when full expenditures of AD/E claims and only the incremental costs of most likely related claims are used, the projected cost of illness is \$0.9 billion. Expanding this projection to include incremental costs associated with possibly related claims increases the total cost of illness to \$1.6 billion. The cost of illness projected on the basis of full expenditures of AD/E claims and full expenditure of most likely related claims is \$1.7 billion. When full expenditures for possibly related claims are included, the projected total cost of illness increases to \$3.8 billion (Table IV).



**Fig 5.** Comparison of the annual cost-of-illness estimate in the United States for AD/E in this study with estimates for other conditions.<sup>14-16</sup> Data for psoriasis (1992), emphysema (1996), and epilepsy (1995) were converted to 1997 dollars based on the Consumer Price Index for All Urban Consumers (CPI-U) from the Bureau of Labor Statistics of the US Department of Labor.<sup>17</sup> The shaded sections represent low estimates based solely on directly attributed costs; unshaded areas represent estimates based on broader ranges of costs. Numbers indicate billions of dollars represented by each column section.

## DISCUSSION

This study is the first to use large administrative claims databases to estimate the cost of illness for AD/E. We relied on health care claims data from 2 different third-party payers to identify a cohort of patients with AD/E and to determine the annual costs of medical care that they received. We found that atopic dermatitis is indeed a costly disease, with third-party payer costs ranging from \$0.9 billion to \$3.8 billion annually. These estimates indicate that AD/E is similar in cost, inflated to 1997 US dollars, to other diseases such as emphysema (\$2.9 billion), psoriasis (\$1.9-\$3.9 billion), and epilepsy (\$1.8 billion) (Fig 5).<sup>14-17</sup> Analyses of the economic burden of illness that include other costs (eg, out-of-pocket costs, over-the-counter preparations, and other items not covered by insurance) would yield even higher projections.

Mean annual costs per patient to Medicaid were consistently higher than the costs to the private insurer across all age groups (\$1250 vs \$580 for all patients for all AD/E-related claims, Table II; \$740 vs \$450 for pediatric patients; \$1850 vs \$630 for adult patients [data not shown]). The disparity between the expenditures by the 2 payers is even greater than it appears because, unlike the privately insured patients, not all Medicaid patients were enrolled for 12 full months.

Utilization of hospital-based services among Medicaid patients appears to be a major factor leading to increased costs. Previous studies have shown that many patients with AD/E obtain a significant part of their care through hospital emergency departments.<sup>6</sup> Surprisingly, emergency department use was not significant in the populations included

**Table IV.** National cost-of-illness projections for AD/E to private insurance and Medicaid payers in the United States annually for persons younger than 65 years

|  | With incremental costs* | With all costs† |
|--|-------------------------|-----------------|
| AD/E claims                            | \$0.5 billion           | \$0.5 billion   |
| Most likely related claims             | \$0.4 billion           | \$1.2 billion   |
| Subtotal: AD/E and most likely         | \$0.9 billion           | \$1.7 billion   |
| Possibly related claims                | \$0.7 billion           | \$2.1 billion   |
| Total: AD/E, most likely, and possibly | \$1.6 billion           | \$3.8 billion   |

\*The most conservative cost-of-illness projection is estimated at \$0.9 billion. This estimate is based on \$0.5 billion for all AD/E claims and an additional \$0.4 billion for the incremental costs associated with most likely related claims. Alternatively, if incremental possibly related claims were included, the projected cost of illness would be \$1.6 billion.

†A more encompassing approach uses all most likely related claims instead of the incremental costs. Under these circumstances, the cost-of-illness estimate is \$1.7 billion (\$0.5 billion for AD/E claims plus \$1.2 billion for all possibly related claims). If all most likely and possibly related claims were included in the projections, the cost of illness would be \$3.8 billion.

in this study. Instead, compared with the privately insured patients, Medicaid patients with AD/E more often were seen in hospital inpatient and outpatient settings, where they incurred substantially higher costs. Other factors might be important in the higher Medicaid costs; for example, the Medicaid patients might have had more severe disease, but this cannot be determined from historical insurance claims databases.

We found that a higher percentage of privately insured patients with AD/E had a claim submitted by a dermatologist in comparison with the Medicaid patients. This may be due to many factors, including the accessibility of dermatologists to these populations. Patients with private insurance who had a dermatologist's claim had higher annual costs than those who did not see a dermatologist. Even though their utilization of dermatologists was lower, patients enrolled in Medicaid also had higher annual costs if they were treated by a dermatologist. This may reflect greater disease severity among the patients who are referred to dermatologists. Our claims databases provide no information about patient disease severity, so we are unable to explore these relationships.

Cost-of-illness analyses generally need to encompass a broad array of diagnoses, procedures, and services. Any analysis only limited to claims of AD/E diagnosis codes would underestimate significantly the



overall impact of disease. For example, in the Medicaid population, mean annual costs per patient are 9-fold lower if the analysis is limited to costs for AD/E services compared with costs for services for AD/E and related co-morbidities (\$120 per patient vs \$1010 per patient, respectively, with prescription costs excluded). Clearly, AD/E patients engender significant costs associated with their co-morbid conditions.

Our cost analyses have advantages compared with those of previous studies. Findings from studies in which large claims databases are used can be generalized more accurately than findings from studies that rely on data from smaller geographic regions and single institutions. Furthermore, data are drawn from actual resource use and costs incurred by third-party payers. In contrast, studies based on patient-reported medical resource utilization and costs may be subject to recall bias, approximation, and poor compliance.<sup>18</sup>

Nevertheless, our study has limitations. The accuracy of claims coding cannot be assessed. The coding system, especially as it relates to *ICD-9-CM* diagnosis code 692.9, does not allow us to differentiate among various eczematous conditions. Some patients who were included in our analysis probably did not have AD/E; they may have been given an AD/E diagnosis in error, or the code 692.9 was used too broadly when a more specific code would have been appropriate. On the other hand, there undoubtedly were patients in the cohorts who had AD/E who were not included in our analysis because their conditions were misdiagnosed or miscoded (either by mistake or by the use of a nonspecific code such as "rash," 782.1).

Furthermore, we cannot determine definitively whether all claims are directly related to AD/E. However, a prospective review by a panel of clinicians to discard irrelevant claims was applied, and we used various assumptions about relevance to disease (most likely and possibly). National projections based on the cost of illness of an individual private and Medicaid insurer may not be representative of other payers.

Some costs that contribute to the overall cost of AD/E in the United States were excluded from this analysis including (1) costs for patients without insurance, (2) costs for elderly patients, (3) patient deductibles and copayments, (4) services rendered outside of the third-party insurance system (eg, over-the-counter preparations and travel expenses for medical care), (5) other indirect costs (eg, losses in productivity and work), and (6) administrative costs of the third-party payers (we used only their actual reimbursement expenses).

We chose to examine cost of illness from the perspective of the third-party payer because payers

often manage access to and utilization of health care services. Disease-specific cost data allow payers and providers to understand the overall scope of the disease, as well as the challenges in its management. Our study shows that costs for treating AD/E are not only comparable to those for treating other prominent diseases, they also represent more than one fourth of all health costs paid by insurers for affected patients (Table II).

Further economic and quality-of-life research exploring the burden of illness on patients, providers, payers, and society is important to further our understanding of atopic dermatitis and eczema.<sup>4,19</sup> New technologies and treatments often provide improvement in ways that cannot easily be measured in monetary terms, such as having positive effects on the quality of life of patients.<sup>3,20</sup> Therefore, decisions regarding appropriate treatments should involve considerations of cost-effectiveness and the impact on the burdens and costs of illness.

A portion of the Appendix may be found in the electronic version of the Journal at [www.eblue.org](http://www.eblue.org).

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## APPENDIX

### Most likely related co-morbidities as determined by physician panel

| <i>ICD-9-CM</i><br>diagnosis code | Description  | Odds ratio | 95% CI       |
|-----------------------------------|--|------------|--------------|
| 698                               | Pruritus and related conditions  | 5.40       | (5.12, 5.69) |
| 684                               | Impetigo   | 3.86       | (3.67, 4.06) |
| 054                               | Herpes simplex   | 2.57       | (2.42, 2.73) |
| 460                               | Acute nasopharyngitis  | 2.43       | (2.35, 2.52) |
| 709                               | Other disorders of skin and subcutaneous tissue                                | 2.23       | (2.15, 2.32) |
| 493                               | Asthma   | 2.17       | (2.13, 2.22) |
| 372                               | Disorders of conjunctiva   | 2.10       | (2.05, 2.15) |
| 381                               | Nonsuppurative otitis media and eustachian tube disorders                      | 1.70       | (1.66, 1.75) |
| 374                               | Other disorders of eyelids   | 1.61       | (1.43, 1.81) |
| 380                               | Disorders of external ear  | 1.55       | (1.50, 1.60) |
| 477                               | Allergic rhinitis  | 1.53       | (1.50, 1.57) |
| 078                               | Other diseases caused by viruses and chlamydiae                                | 1.28       | (1.23, 1.33) |
| 371                               | Corneal opacity and other disorders of cornea                                  | 1.25       | (1.11, 1.40) |
| 041                               | Bacterial infection in conditions classified elsewhere and of unspecified site | 1.24       | (1.14, 1.35) |
| 366                               | Cataract   | 1.24       | (1.17, 1.31) |

Odds ratios were determined independently of and subsequent to the physician panel's inclusion of the listed *ICD-9-CM* codes.

### Possibly related co-morbidities as determined by physician panel

| <i>ICD-9-CM</i><br>diagnosis code | Description   | Odds ratio | 95% CI       |
|-----------------------------------|---|------------|--------------|
| 705                               | Disorders of sweat glands   | 4.59       | (4.25, 4.95) |
| 693                               | Dermatitis caused substances taken internally                             | 3.53       | (3.20, 3.89) |
| 110                               | Dermatophytosis   | 3.27       | (3.19, 3.36) |
| 708                               | Urticaria   | 3.26       | (3.11, 3.41) |
| 035                               | Erysipelas  | 3.04       | (1.67, 5.57) |
| 704                               | Diseases of hair and hair follicles                                       | 3.00       | (2.86, 3.16) |
| 052                               | Chickenpox  | 2.90       | (2.73, 3.09) |
| 695                               | Erythematous conditions   | 2.88       | (2.72, 3.04) |
| 686                               | Other local infections of skin and subcutaneous tissue                    | 2.87       | (2.71, 3.03) |
| 782                               | Symptoms involving skin and other integumentary tissue                    | 2.72       | (2.66, 2.78) |
| 111                               | Dermatomycosis, other and unspecified                                     | 2.63       | (2.41, 2.87) |
| 112                               | Candidiasis   | 2.45       | (2.36, 2.55) |
| 465                               | Acute upper respiratory tract infections of multiple or unspecified sites | 2.42       | (2.39, 2.46) |
| 558                               | Other noninfectious gastroenteritis and colitis                           | 2.35       | (2.30, 2.41) |
| 680                               | Carbuncle and furuncle  | 2.08       | (1.87, 2.32) |
| 382                               | Suppurative and unspecified otitis media                                  | 2.02       | (1.99, 2.06) |

Cont'd

| <i>ICD-9-CM</i><br>diagnosis code | Description   | Odds ratio | 95% CI       |
|-----------------------------------|---|------------|--------------|
| 682                               | Other cellulitis and abscess  | 1.93       | (1.86, 2.00) |
| 535                               | Gastritis and duodenitis  | 1.83       | (1.77, 1.90) |
| 375                               | Disorders of lacrimal system  | 1.78       | (1.64, 1.93) |
| 528                               | Diseases of the oral soft tissues, excluding lesions specific for gingiva and tongue      | 1.74       | (1.62, 1.87) |
| 472                               | Chronic pharyngitis and nasopharyngitis   | 1.71       | (1.63, 1.79) |
| 279                               | Disorders involving the immune mechanism  | 1.68       | (1.48, 1.91) |
| 480                               | Viral pneumonia   | 1.67       | (1.46, 1.90) |
| 703                               | Diseases of nail  | 1.64       | (1.55, 1.73) |
| 053                               | Herpes zoster   | 1.62       | (1.46, 1.80) |
| 312                               | Disturbance of conduct, not elsewhere classified  | 1.61       | (1.50, 1.72) |
| 701                               | Other hypertrophic and atrophic conditions of skin  | 1.58       | (1.49, 1.67) |
| 038                               | Septicemia  | 1.55       | (1.42, 1.70) |
| 079                               | Viral and chlamydial infection in conditions classified elsewhere and of unspecified site | 1.55       | (1.50, 1.60) |
| 681                               | Cellulitis and abscess of finger and toe  | 1.53       | (1.44, 1.63) |
| 462                               | Acute pharyngitis   | 1.42       | (1.39, 1.44) |
| 300                               | Neurotic disorders  | 1.41       | (1.37, 1.44) |
| 466                               | Acute bronchitis and bronchiolitis  | 1.38       | (1.34, 1.41) |
| 490                               | Bronchitis, not specified as acute or chronic   | 1.37       | (1.33, 1.41) |
| 313                               | Disturbance of emotions specific to childhood and adolescence                             | 1.33       | (1.24, 1.42) |
| 379                               | Other disorders of eye  | 1.29       | (1.22, 1.37) |
| 288                               | Diseases of white blood cells   | 1.27       | (1.14, 1.42) |
| 370                               | Keratitis   | 1.27       | (1.15, 1.40) |
| 232                               | Carcinoma in situ of skin   | 1.24       | (0.99, 1.55) |
| 369                               | Blindness and poor vision   | 1.23       | (1.05, 1.44) |
| 478                               | Other diseases of upper respiratory tract   | 1.22       | (1.16, 1.30) |
| 365                               | Glaucoma  | 1.20       | (1.14, 1.26) |
| 368                               | Visual disturbances   | 1.20       | (1.14, 1.26) |
| 311                               | Depressive disorder, not elsewhere classified   | 1.13       | (1.08, 1.17) |
| 250                               | Diabetes mellitus   | 1.10       | (1.06, 1.13) |
| 309                               | Adjustment reaction   | 1.08       | (1.05, 1.12) |
| 473                               | Chronic sinusitis   | 1.06       | (1.03, 1.10) |
| 361                               | Retinal detachments and defects   | 0.99       | (0.85, 1.16) |
| 471                               | Nasal polyps  | 0.87       | (0.72, 1.06) |
| 461                               | Acute sinusitis   | 0.81       | (0.79, 0.84) |
| 305                               | Nondependent abuse of drugs   | 0.76       | (0.72, 0.80) |

Odds ratios were determined independently of and subsequent to the physician panel's inclusion of the listed *ICD-9-CM* codes.

#### Most likely related pharmacy items as determined by physician panel

| Pharmacy item                     | Odds ratio | 95% CI         |
|-----------------------------------|------------|----------------|
| Topical steroids                  | 14.61      | (14.43, 14.79) |
| Antihistamines                    | 4.07       | (4.02, 4.13)   |
| Anti-asthmatic combinations       | 2.91       | (2.58, 3.28)   |
| Adrenal cortical corticoids       | 2.81       | (2.75, 2.86)   |
| Respiratory agents, miscellaneous | 2.77       | (1.97, 2.93)   |
| Adrenergic bronchodilators        | 1.94       | (1.91, 1.97)   |
| Antiviral agents, miscellaneous   | 1.33       | (1.27, 1.39)   |
| Immunosuppressive agents          | 0.46       | (0.38, 0.55)   |
| Topical agents, miscellaneous     | 0.45       | (0.40, 0.50)   |

Odds ratios were determined independently of and subsequent to the physician panel's inclusion of the listed pharmaceuticals.

## Possibly related pharmacy items as determined by physician panel

| Pharmacy item                                    | Odds ratio | 95% CI       |
|--|------------|--------------|
| Topical anti-infective agents                    | 5.00       | (4.93, 5.07) |
| Psoralens  | 4.21       | (2.97, 5.95) |
| Antifungal agents                                | 3.03       | (2.97, 3.09) |
| Decongestants                                    | 2.96       | (2.87, 3.06) |
| Ophthalmic lubricants and irrigations            | 2.71       | (2.56, 2.87) |
| Ophthalmic nonsteroidal anti-inflammatory agents | 2.47       | (2.29, 2.66) |
| Ophthalmic agents, miscellaneous                 | 2.43       | (2.32, 2.55) |
| Otic anti-infective agents                       | 2.19       | (1.81, 2.66) |
| Ophthalmic anti-infective agents                 | 2.07       | (2.02, 2.12) |
| Antiseptics and germicides                       | 1.77       | (1.69, 1.86) |
| Otic steroids                                    | 1.70       | (1.65, 1.76) |
| Cephalosporins                                   | 1.69       | (1.66, 1.71) |
| Penicillins                                      | 1.60       | (1.58, 1.62) |
| Ophthalmic steroids                              | 1.58       | (1.52, 1.64) |
| Tetracyclines                                    | 1.51       | (1.45, 1.57) |
| Antibiotics, miscellaneous                       | 1.46       | (1.43, 1.49) |
| Macrolides                                       | 1.45       | (1.43, 1.47) |
| Quinolones                                       | 1.32       | (1.28, 1.36) |
| H <sub>2</sub> antagonists                       | 1.23       | (1.20, 1.26) |
| Biologic agents, miscellaneous                   | 1.04       | (0.69, 1.56) |
| Antidepressants                                  | 0.92       | (0.90, 0.94) |
| Benzodiazepines                                  | 0.90       | (0.87, 0.93) |
| Ophthalmic glaucoma agents                       | 0.87       | (0.81, 0.94) |
| Topical agents, miscellaneous                    | 0.45       | (0.40, 0.50) |

Odds ratios were determined independently of and subsequent to the physician panel's inclusion of the listed pharmaceuticals.