Patients evaluated at emergency departments often present with nonemergency conditions, an expensive practice that contributes to overcrowding and decreased continuity of care.\(^1\)\(^-\)\(^8\) Evidence suggests that emergency department overcrowding is associated with adverse clinical outcomes,\(^9\)\(^-\)\(^12\) and proposed solutions have ranged from streamlining inpatient admissions to expanding primary care and insurance coverage.\(^6\)\(^-\)\(^8\)\(^,\)\(^10\) Others regard overutilization as symptomatic of inadequate consumer engagement in medical decision making, suggesting that patients will reduce use of discretionary services if they share a greater proportion of health care costs.\(^13\)\(^-\)\(^15\)

With health care premiums continuing to increase, policy makers,\(^16\) public and private payers,\(^17\)\(^-\)\(^19\) and employers\(^20\) have shown interest in using high-deductible health plans (HDHPs) to control costs. These plans have low monthly premiums but subject most services to deductibles averaging $2985 to $4008 per year for family plans.\(^20\) As a new health insurance product offering, high-deductible–associated plans have experienced rapid expansion; the percent-dollar had increases in premiums occurring primarily in repeat visits for conditions that were not classified as high severity, and had decreases in the rate of hospitalizations from the emergency department. Further research is needed to determine long-term health care utilization patterns under high-deductible coverage and to assess risks and benefits related to clinical outcomes.

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Emergency Department Use and Subsequent Hospitalizations Among Members of a High-Deductible Health Plan

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For editorial comment see p 1126.

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age of employers offering HDHPs increased by 75% between 2005 and 2006, and membership in HDHPs has shown similar increases.

The effect of HDHPs on enrollee health and health care utilization is controversial. Some suggest that plans with high levels of cost sharing will reduce inappropriate use of medical services, improve health outcomes or have neutral effects, and engage patients in shared decision making with clinicians. Others are concerned that HDHPs will decrease utilization of necessary health care, potentially causing adverse outcomes.

Prior studies have suggested that cost sharing decreases use of both appropriate and inappropriate health services, including hospitalizations, use of essential medications, and preventive services. These effects may occasionally be associated with worse health outcomes compared with plans with lower out-of-pocket obligations. In contrast, patients primarily reduce discretionary services when emergency department care is subject to cost sharing, and adverse outcomes have not been reported. However, these findings may not apply to the current health care environment, and no rigorous studies to date have examined the association of HDHPs with emergency department use and related hospital admissions.

In March 2002, Harvard Pilgrim Health Care began offering to Massachusetts employers an HDHP that included emergency department and hospitalization costs under the deductible. We studied rates of emergency department use and subsequent hospital admissions among members whose employers switched from offering a traditional health maintenance organization (HMO) plan to offering only the HDHP and we compared rates with contemporaneous controls who remained in the HMO plan.

METHODS
Setting
Harvard Pilgrim Health Care is a health plan serving approximately 900,000 individuals in Massachusetts and New Hampshire who are enrolled primarily through employer-sponsored plans. On March 1, 2002, Harvard Pilgrim Health Care began offering an HDHP product (“Best Buy”) with annual deductibles ranging from $500 to $2000 for individuals and $1000 to $4000 for families. Members of family plans also have an individual deductible equal to half their family deductible. In these plans, full coverage begins for members if they exceed their individual deductible, or for family members if the family’s combined expenses exceed the family deductible.

Many institutional services, including emergency department care, are subject to the deductible, whereas most preventive services (e.g., immunizations, mammograms, certain laboratory tests) have first dollar coverage. A $20 copayment applies to most outpatient visits, including routine physical examinations, urgent care visits, and specialist consultations. These copayments are independent of the member’s deductible status so that they must be paid whether the member is above or below the deductible spending level. When HDHP member spending is less than the deductible, the patient is billed directly for all services subject to the deductible. After the spending level exceeds the deductible, members pay a $100 co-payment for emergency department care; if they are admitted to the hospital, the co-payment is waived. Employers purchasing the HDHPs may opt to combine them with a health reimbursement account from Harvard Pilgrim Health Care. This allows the employee to place money into an account to pay for out-of-pocket health expenses.

All Harvard Pilgrim Health Care members may seek care from any emergency department. However, the availability of urgent same-day care is practice-specific and not uniform across the provider network.

Members of the traditional HMO plans we studied had varying levels of emergency department and outpatient co-payments (between $20-$100 and $5-$25, respectively). Inpatient co-payments ranged from $0 to $1000, with a median of $100.

Study Groups
HDHP Study Group. We identified Massachusetts members aged 1 to 64 years insured by Harvard Pilgrim Health Care between March 1, 2001, and June 30, 2005, who had at least 1 year of continuous enrollment in a traditional HMO plan followed by at least 6 months in the HDHP. We chose members whose employers offered only a single choice of health plan and who remained with the same employer for the entire period. High-deductible health plan members were therefore not able to self-select their health plan. We included members from employers who purchased plans directly from Harvard Pilgrim Health Care as well as from those who purchased Harvard Pilgrim Health Care plans from independent brokers (“association” plans). We excluded members from employers who offered health plans from other insurance providers, 34 members with missing census data, and members in accounts that were in non-group, Medicare, or integrated federal employee HMO products.

We identified an index date for each member (the date the member switched to the HDHP), a 12-month baseline period that preceded the index date, and a 12-month follow-up period. To maximize the number of enrollees in the study, we also included more recent HDHP switchers if they had at least 6 months of follow-up. Our HDHP group consisted of 8724 individuals, with 85.9% having a full 12 months of follow-up.

HMO Control Group. We selected controls from Massachusetts employers who were enrolled in Harvard Pilgrim Health Care’s traditional HMO plans during the same March 2001–June 2005 eligibility period and who were not offered the choice to enroll in an HDHP or any other Harvard Pilgrim Health Care plan during their eligibility. These members’ employers also did not offer health plans from insur-
ers other than Harvard Pilgrim Health Care. For each HDHP member, we randomly matched 8 contemporaneous controls based on adult/child status and whether the member was in an association plan. Each matched control member was then assigned the same index date and had the same baseline and follow-up periods as the matched HDHP member. We excluded any controls who had emergency department co-payments that changed between their baseline and follow-up periods (12.4% of the matched control pool) and 57 members with missing census data. After examining the distribution of emergency department visits, we removed outliers with more than 12 emergency department visits in the baseline year (8 control group members). Our control group consisted of 59,557 members, with 85.4% having a full 12 months of follow-up.

The study was approved by the Harvard Pilgrim Health Care Institutional Review Board.

Emergency Department Use and Classification of Visits

We used an established algorithm to identify emergency department claims from Harvard Pilgrim Health Care’s claims database. The final date of follow-up for study members was June 30, 2005. For each visit episode, we used the emergency department physician’s International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis when available to classify visits. Only 7 visits (0.02%) had missing diagnoses.

To categorize each visit’s primary ICD-9-CM diagnosis and determine the probability that a visit required emergency department care, we used an algorithm developed by the New York University Center for Health and Public Service Research.3 New York University researchers, with consultation from a panel of emergency department and primary care physicians, abstracted 5700 emergency department charts and classified them into 4 categories: nonemergent (NE); emergent, primary care treatable (EPCT); emergency department care needed, preventable/avoidable (EDCNNPA); and emergency department care needed, not preventable or avoidable (EDCNPA). The panel considered a visit to be emergent if care was needed within 12 hours and preventable/avoidable if an emergency department visit could have been avoided with timely primary care. The investigators then linked classified visits to the primary emergency department ICD-9-CM discharge diagnosis from the particular visit. The algorithm thus determines the probability of an ICD-9-CM diagnosis being in each of the 4 aforementioned categories, and together the probabilities sum to 1.0.

Diagnoses also may be categorized as unclassified if they are not included in the New York University algorithm. Eleven percent of visits in our study fell into the unclassified category.

Based on a validation of this algorithm developed by Hsu et al (unpublished data provided in a written communication by John Hsu, MD, MBA, November 1, 2006), we defined a visit as high severity if the probability that emergency department care was needed was at least 75% for the visit’s primary ICD-9-CM diagnosis (EDCNNPA + EDCNPA ≥ 0.75). Likewise, we defined a visit as low severity if the probability of needing emergency department care was less than 25% (EDCNNPA + EDCNPA < 0.25) and as indeterminate severity for those between 25% and 75%. Hsu et al found a strong association between visits classified as low and high severity and future hospitalization or death.

To group emergency department diagnoses into clinically meaningful clusters, we used the 2006 version of the Agency for Healthcare Research and Quality’s Clinical Classifications Software.35 This tool has been used to assess trends in health services utilization36-38 and was found to provide the most thorough classification of emergency department-specific ICD-9-CM codes in comparison with other systems.39

We hypothesized that when HDHP members discovered the cost of emergency department care during or after a first visit, later emergency department use might be affected. We therefore further classified visits as first visits, defined as the first visit by a member during the given study period (baseline or follow-up period), and repeat visits, defined as any subsequent visit in that study period. Repeat visits are not necessarily related to the problem or diagnosis from preceding visits.

Hospitalizations and Health Outcome Measures

We defined emergency department-related hospitalizations as those occurring within 1 day of the emergency department visit. We subcategorized these hospitalizations according to whether they followed low-, indeterminate-, or high-severity, and we used the Clinical Classifications Software diagnostic categories to group discharge diagnoses into meaningful clusters. We hypothesized that the severity of emergency department visits would be proportional to rates of associated hospitalization, so we calculated the proportion of emergency department visits resulting in hospitalization and subcategorized by preceding visit severity. We calculated length of hospital stay for all emergency department-related hospitalizations. Multiple studies have used hospitalization rates or length of hospital stay as proxy measures of patient morbidity.4,29,31,33,40-42

To assess whether HDHPs were associated with delays in needed emergency department care, we analyzed changes in hospitalizations considered preventable with timely emergency department visits.4 These “avoidable hospitalizations” include asthma (ICD-9-CM code 493), congestive heart failure (code 428), pneumonia (codes 480-487), pyelonephritis (code 590), ruptured appendicitis (codes 540.0 and 540.1), and uncontrolled hyperglycemia in diabetes (codes 250.0-250.3).

Control Variables

We used the Chronic Disease Score to estimate comorbidity for all individuals. Both pediatric and adult algo-
algorithms, developed at Group Health Cooperative of Puget Sound, Seattle, Wash, use automated ambulatory pharmacy data for case-mix adjustment. In predicting future health service cost or utilization, the adult Chronic Disease Score performs equivalently to models using diagnostic or procedural data. It has performed as well or better than the ICD-9-CM-based ambulatory care groups model in HMO settings, predicting 50% to 60% of variation in health care utilization, costs, and mortality. The pediatric model has been shown to be superior to a demographics model and is a viable alternative to the ambulatory care groups model.

To derive proxy measures of socioeconomic status, we linked members’ residential addresses to their 2000 US Census tracts block group, a subdivision of census tracts containing an average of 1000 individuals. We created previously established categorical variables of education and poverty status. Other covariates included age at index date, sex, employer size (measured by number of employees), whether members were in association plans, and whether members were in individual or family plans.

### Table 1. Baseline Population Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>High-Deductible Health Plan Group (n = 8724)</th>
<th>Control Group (n = 59557)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age on index date, No. (%), y</td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>1-4</td>
<td>457 (5.2)</td>
<td>3009 (5.1)</td>
<td></td>
</tr>
<tr>
<td>5-17</td>
<td>1680 (19.2)</td>
<td>11625 (19.5)</td>
<td></td>
</tr>
<tr>
<td>18-44</td>
<td>3186 (36.4)</td>
<td>25108 (42.1)</td>
<td></td>
</tr>
<tr>
<td>45-64</td>
<td>3438 (39.2)</td>
<td>19872 (33.3)</td>
<td></td>
</tr>
<tr>
<td>Female, No. (%), y</td>
<td>4448 (51.0)</td>
<td>30159 (50.6)</td>
<td>.55</td>
</tr>
<tr>
<td>In family plan, No. (%)</td>
<td>6104 (70.0)</td>
<td>43111 (72.4)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>In association plan, No. (%)</td>
<td>4685 (53.7)</td>
<td>34986 (58.7)</td>
<td></td>
</tr>
<tr>
<td>Employer size, No. (%)</td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Small (2-50 employees)</td>
<td>7000 (80.2)</td>
<td>44196 (74.2)</td>
<td></td>
</tr>
<tr>
<td>Mid (51-250)</td>
<td>1571 (18.0)</td>
<td>4444 (7.5)</td>
<td></td>
</tr>
<tr>
<td>Large (251-999)</td>
<td>41 (0.5)</td>
<td>5872 (9.9)</td>
<td></td>
</tr>
<tr>
<td>&gt;1000</td>
<td>112 (1.3)</td>
<td>5045 (8.5)</td>
<td></td>
</tr>
<tr>
<td>Diabetes, No. (%)</td>
<td>150 (1.7)</td>
<td>1175 (2.0)</td>
<td>.11</td>
</tr>
<tr>
<td>Hypertension, No. (%)</td>
<td>405 (4.6)</td>
<td>2788 (4.7)</td>
<td>.87</td>
</tr>
<tr>
<td>Asthma, No. (%)</td>
<td>88 (1.0)</td>
<td>760 (1.3)</td>
<td>.04</td>
</tr>
<tr>
<td>Chronic Disease Score Mean (SD)</td>
<td>1054.2 (1616.1)</td>
<td>1117.2 (1710.9)</td>
<td>.001</td>
</tr>
<tr>
<td>25th percentile (healthiest)</td>
<td>306.6</td>
<td>306.6</td>
<td>&gt;.99</td>
</tr>
<tr>
<td>Median</td>
<td>409.8</td>
<td>409.8</td>
<td>&gt;.99</td>
</tr>
<tr>
<td>75th percentile</td>
<td>1049.6</td>
<td>1136.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>No. (%) living in neighborhoods with below-poverty levels of</td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&lt;5%</td>
<td>5068 (58.1)</td>
<td>36578 (61.4)</td>
<td></td>
</tr>
<tr>
<td>5%-9.9%</td>
<td>2299 (26.4)</td>
<td>14544 (24.4)</td>
<td></td>
</tr>
<tr>
<td>10%-19.9%</td>
<td>1034 (11.9)</td>
<td>6085 (10.2)</td>
<td></td>
</tr>
<tr>
<td>≥20%</td>
<td>323 (3.7)</td>
<td>2350 (4.0)</td>
<td></td>
</tr>
<tr>
<td>No. (%) living in neighborhoods with less-than-high-school-education levels of</td>
<td></td>
<td></td>
<td>&lt;.005</td>
</tr>
<tr>
<td>&lt;15%</td>
<td>6958 (79.8)</td>
<td>47724 (80.1)</td>
<td></td>
</tr>
<tr>
<td>15%-24.9%</td>
<td>1212 (13.9)</td>
<td>7698 (13.3)</td>
<td></td>
</tr>
<tr>
<td>25%-39.9%</td>
<td>404 (4.6)</td>
<td>3112 (5.2)</td>
<td></td>
</tr>
<tr>
<td>≥40%</td>
<td>150 (1.7)</td>
<td>823 (1.4)</td>
<td></td>
</tr>
<tr>
<td>Emergency department co-payment, mean (SD), $</td>
<td>49.4 (11.3)</td>
<td>47.4 (9.6)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Outpatient co-payment, mean (SD), $</td>
<td>15.0 (4.6)</td>
<td>12.6 (4.8)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Inpatient co-payment, mean (SD), $</td>
<td>248.1 (196.5)</td>
<td>151.2 (162.6)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

### Statistical Analyses

We compared baseline characteristics of the 2 study groups using χ² tests, t tests, or quantile regression. We used a difference-in-differences analytic framework to examine the outcomes of interest: changes in emergency department visits and hospital admissions in the HDHP group from baseline to follow-up compared with the control group. We analyzed total visits, first visits, and repeat visits, as well as low-, indeterminate-, and high-severity first and repeat visits. We then examined percentages of admissions from the emergency department and length of hospital stay among the groups in the baseline and follow-up periods. We also assessed the odds of emergency department visits by deductible level, then examined the odds of visits occurring during membership time spans above and below the deductible. In addition, we analyzed total expenses paid for emergency department visits, as well as expenses paid by the plan members and by Harvard Pilgrim Health Care.

All models used generalized estimating equations to adjust for clustering within individuals between the baseline and follow-up periods. We used Poisson regression to model the independent association between high-deductible status and emergency department visit rates after controlling for age, sex, employer size, index date, socioeconomic status, association status, individual vs family plan, and morbidity. Because we did not follow up some members for a full year, we also adjusted for duration of follow-up. We used the same Poisson model and covariates to analyze changes in odds of visits by deductible level, expenses paid for emergency department visits, avoidable hospitalizations, hospitalization rates, and length of stay. For the latter 2 outcomes, we added a term to adjust for the severity of the emergency department visit that preceded the hospitalization. In the model examining the odds of a visit during membership spans above and below the deductible amount, we adjusted for the deductible amount as well as the duration of...
time before and after exceeding the deductible amount.

We used logistic regression to model the associations between the same covariates and the likelihood of first visits and low-, indeterminate-, and high-severity first visits. In the subgroup of members with at least 1 visit, we used Poisson regression to model the associations between the same covariates and the number of repeat visits, as well as in low- indeterminate-, and high-severity repeat visits. We used the same logistic model and covariates to analyze the independent association between HDHP status and percentage of emergency department visits resulting in hospitalization. All analyses were performed using SAS software, version 9.1 (SAS Institute Inc, Cary, NC).

**RESULTS**

**Baseline Characteristics**

Table 1 shows the baseline characteristics of the study groups. The average age was approximately 35 years and the sample was evenly split by sex. Most members in both groups were in family insurance plans and most were employed at small or mid-sized companies. There were no clinically significant differences in the distributions of the Chronic Disease Score; in rates of diabetes, hypertension, or asthma; or in measures of socioeconomic status.

Control group members had baseline emergency department and outpatient co-payments averaging $47 and $13, respectively, compared with $49 and $15 for the HDHP group ($<.001 for both comparisons). In the follow-up period, control group members faced essentially unchanged co-payments at $47 and $14, respectively. The average inpatient co-payment for HDHP members in the baseline period was $248 compared with $151 in the control group ($<.001). This co-payment increased to $184 for controls in the follow-up period. Uptake of health reimbursement accounts was low among nonassociation HDHP members at 1.4%. We could not measure association employer health reimbursement account prevalence but expect it to be lower among these employers, who have fewer than 10 employees.

**Emergency Department Visits**

Table 2 presents study differences in emergency department visits. At baseline, the HDHP group used the emergency department slightly less than the control group (197.5 vs 219.6 visits per 1000 members; $P=.001). After controlling for age, sex, employer size, index date, socioeconomic status, association status, individual vs family plan, and morbidity, there was a 10.0% relative decrease (absolute change, −20.2 visits per 1000) in emergency department visits in the HDHP group compared with controls from baseline to follow-up (95% confidence interval [CI], −16.6% to −2.8%; $P=.007$).

For first visits, there was a nonsignificant 4.1% relative decline in emergency department use for HDHP members compared with controls (95% CI, −11.8% to +4.3%). Both low- and high-severity first visits by the HDHP group showed little relative change from baseline to follow-up (−1.9% [95% CI, −14.6% to +12.6%] and −3.6% [95% CI, −24.1% to +22.6%], respectively).

However, for all visits that occurred after the first visit in a given study period, there was a 24.9% relative decline (absolute change, −92.6 visits per 1000 among those with a first visit) in visits in the HDHP group from baseline to follow-up (95% CI, −37.3% to −9.7%; $P=.002$). This reduction was greatest for repeat visits that were classified as low (−36.4%; 95% CI, −51.1% to −17.2%; $P<.001$) and indeterminate (−25.5%; 95% CI, −43.8% to −1.2%; $P=.04$) severity; there was a small, nonsignificant relative decline in

---

**Table 2. Use of Emergency Department by Types of Visits in HDHP and Control Groups**

<table>
<thead>
<tr>
<th>No. of Visits per 1000 Members (Total No. of Visits)</th>
<th>HD Group*</th>
<th>Control Group*</th>
<th>Change From Baseline to Follow-up, HD Group vs Controls, % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall visits‡</td>
<td>Baseline</td>
<td>Follow-up</td>
<td>Baseline</td>
</tr>
<tr>
<td>First visits‡</td>
<td>148.0 (1291)</td>
<td>141.9 (1238)</td>
<td>166.2 (9899)</td>
</tr>
<tr>
<td>Low severity</td>
<td>51.7 (451)</td>
<td>51.1 (446)</td>
<td>57.9 (3449)</td>
</tr>
<tr>
<td>Indeterminate severity</td>
<td>66.9 (584)</td>
<td>60.1 (524)</td>
<td>74.9 (4458)</td>
</tr>
<tr>
<td>High severity</td>
<td>15.8 (138)</td>
<td>16.9 (147)</td>
<td>16.9 (1006)</td>
</tr>
<tr>
<td>Unclassified</td>
<td>13.5 (118)</td>
<td>13.9 (121)</td>
<td>16.6 (986)</td>
</tr>
<tr>
<td>Repeat visits†</td>
<td>334.6 (432)</td>
<td>255.3 (316)</td>
<td>321.1 (3179)</td>
</tr>
<tr>
<td>Low severity</td>
<td>142.5 (184)</td>
<td>92.1 (114)</td>
<td>128.0 (1267)</td>
</tr>
<tr>
<td>Indeterminate severity</td>
<td>115.4 (149)</td>
<td>84.8 (105)</td>
<td>120.9 (1197)</td>
</tr>
<tr>
<td>High severity</td>
<td>46.5 (60)</td>
<td>41.2 (51)</td>
<td>37.9 (375)</td>
</tr>
<tr>
<td>Unclassified</td>
<td>30.2 (39)</td>
<td>37.2 (46)</td>
<td>34.3 (340)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; HDHP, high-deductible health plan.

*Unadjusted rates.
†Adjusted differences in differences are from Poisson models with generalized estimating equations that included age, sex, employer size, index date, socioeconomic status, association status, individual vs family plan, and morbidity.
‡Adjusted differences in differences are from a logistic model with generalized estimating equations that included age, sex, employer size, index date, socioeconomic status, association status, individual vs family plan, and morbidity.
§Rates for repeat visits are among members with a first visit to the emergency department during the particular study period.

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Table 3 shows the 5 major diagnostic clusters in each category of repeat visits by severity level. Visits classified into these clusters represent 38.3%, 62.3%, and 43.8% of repeat visits in the low-, indeterminate-, and high-severity categories, respectively. Aggregate changes experienced by the HDHP group from baseline to follow-up in these subgroups were similar to changes in overall repeat visits (−39.8%, −24.1%, and −3.5% adjusted differences in differences, respectively).

We also examined utilization patterns by income category. High-deductible health plan members in the lowest 2 income categories experienced a 25% decline in high-severity visits from baseline to follow-up compared with HMO members in the same income categories (95% CI, −59.1% to 36.1%; P = .34). In comparison, there was a 1.3% decline among members of the highest 2 income categories (95% CI, −21.3% to 23.8%; P = .91).

Table 4 shows utilization patterns by deductible level. The percentages of HDHP members in individual/family plans who had deductibles of $500/ $1000, $1000/$2000, and $2000/$4000 were 9.9%/23.3%, 13.9%/ 32.3%, and 6.2%/14.3%, respectively.

Of members in individual HDHPs, 28.3%, 18.4%, and 6.3%, respectively, of members with $500, $1000, and $2000 deductibles exceeded their deductible during the follow-up period. For those in family plans, 41.9%, 22.2%, and 9.9%, respectively, of members with $1000, $2000, and $4000 deductibles exceeded their individual or family deductible. Eighty-three percent of all emergency department visits by HDHP members in the follow-up period and 89% of first visits occurred while members were below their deductible level.

There was little difference in the odds of a visit in the follow-up period compared with the baseline period by deductible level. However, members in individual plans whose spending exceeded the deductible level had non-significantly higher odds of visiting the emergency department compared with the odds during time spans when members remained below deductible levels (odds ratio, 1.4; 95% CI, 0.95-1.9), with the highest odds of emergency department visits among members with $500 deductibles (odds ratio, 1.5; 95% CI, 0.92-2.4). In contrast, members of family plans did not have higher odds of emergency department visits after exceeding their deductible (odds ratio, 0.93; 95% CI, 0.72-1.2).

Hospitalization Rates and Length of Stay

Table 5 shows population rates of emergency department–related hospitalization, percentages of emergency department visits resulting in admissions, and lengths of hospital stay, with the latter 2 subcategorized by the severity of the emergency department visits they followed. The percentage of emergency department visits resulting in hospitalizations declined by

Table 3. Repeat Visits by Severity Level Showing the 5 Most Frequent Diagnostic Clusters

<table>
<thead>
<tr>
<th>Visits Classified by Modified CCS Diagnostic Clusters (No. of Visits in Category)</th>
<th>No. of Repeat Visits per 1000 Members (Total No. of Repeat Visits)*</th>
<th>HDHP Group‡</th>
<th>Control Group‡</th>
<th>Change From Baseline to Follow-up, HDHP Group vs Controls, % (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low severity:</strong> upper respiratory tract infections and acute bronchitis (375); neck and back pain syndromes (230); headache, including migraine (170); nausea, vomiting, diarrhea, and gastroenteritis (167); otitis media and related conditions; otitis externa; otalgia (156)**</td>
<td>58.1 (75)</td>
<td>39.6 (49)</td>
<td>45.7 (452)</td>
<td>53.1 (522)</td>
</tr>
<tr>
<td>Indeterminate severity: abdominal pain (416); open wounds of extremities, head, neck, and trunk (355)**; nonspecific chest pain (313); superficial injury; contusion (298); sprains and strains (270)</td>
<td>74.3 (96)</td>
<td>53.3 (66)</td>
<td>76.8 (760)</td>
<td>74.2 (730)</td>
</tr>
<tr>
<td><strong>High severity:</strong> asthma (104); renal tract calculus and renal colic (74); fluid and electrolyte disorders (74); cardiac dysrhythmias (58); depressive disorder and adjustment reaction with brief depressive reaction (58)**</td>
<td>20.9 (27)</td>
<td>18.6 (23)</td>
<td>16.1 (160)</td>
<td>16.1 (158)</td>
</tr>
</tbody>
</table>

Abbreviations: CCS, Clinical Classifications Software; CI, confidence interval; HDHP, high-deductible health plan.

*Adjusted differences in differences are from Poisson models with generalized estimating equations that included age, sex, employer size, index date, socioeconomic status, association status, individual vs family plan, and morbidity.

†Includes diagnoses of “otitis media and related conditions; otitis externa; otalgia” as well as ICD-9-CM codes for “diarrhea” and “other and unspecified noninfectious gastroenteritis and colitis.”

‡Includes diagnoses from the CCS category “open wounds of extremities” and “open wounds of head, neck, and trunk.”
24.7% (with an absolute rate difference of −2.6%) from baseline to follow-up in the HDHP group compared with the control group (95% CI, −41.0% to −3.9%; P = .02). The odds of a visit resulting in a hospitalization were greater for high- (odds ratio, 6.1; 95% CI, 5.4-6.9) and indeterminate- (odds ratio, 2.9; 95% CI, 2.6-3.2) severity visits than for low-severity visits.

The HDHP group experienced a 27.0% relative decline (with an absolute rate difference of −7.7%) in population rates of hospitalizations that followed emergency department visits from baseline to follow-up (95% CI, −41.4% to −9.0%; P = .005). Potentially avoidable hospitalizations declined by 29.6% in the HDHP group compared with the control group from baseline to follow-up (95% CI, −63.6% to +36.1%).

The most common hospitalization discharge diagnosis clusters included non-specific chest pain (407 admissions over the study period in the HDHP and control groups; data not shown), gastrointestinal diagnoses (366 admissions), cardiac diagnoses (306 admissions), respiratory diagnoses (284 admissions), and psychiatric conditions (265 admissions). Our ability to analyze meaningful changes in these clusters was limited by small absolute numbers of diagnoses in the HDHP group.

The average length of hospital stay declined from 4.4 days to 3.6 days among the HDHP group, representing a relative reduction of 21.3% from baseline to follow-up (95% CI, −36.3% to −3.2%; P = .02). Hospitalization rates and lengths of stay from baseline to follow-up declined among HDHP mem-

### Table 4. Utilization Among HDHP Members Stratified by Individual vs Family Plan and Deductible Level

<table>
<thead>
<tr>
<th>Deductible Level</th>
<th>HDHP Members in Plan, % (No.)*</th>
<th>HDHP Members Exceeding Deductible, % (No.)*</th>
<th>Odds of Emergency Department Visit Among HDHP Members During Follow-up Period vs Baseline Period (95% CI)†</th>
<th>Odds of Emergency Department Visit Among HDHP Members During Above-Deductible vs Below-Deductible Time Spans (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual plans, $</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>9.9 (863)</td>
<td>28.3 (244)</td>
<td>1.0</td>
<td>1.9 (0.95-1.9)</td>
</tr>
<tr>
<td>1000</td>
<td>13.9 (1215)</td>
<td>18.4 (223)</td>
<td>1.0 (0.73-1.4)</td>
<td>1.1 (0.60-2.0)</td>
</tr>
<tr>
<td>2000</td>
<td>6.2 (542)</td>
<td>6.3 (34)</td>
<td>1.3 (0.86-2.0)</td>
<td>0.67 (0.11-4.2)</td>
</tr>
<tr>
<td>Family plans, $</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>23.3 (2037)</td>
<td>41.9 (854)</td>
<td>1.0</td>
<td>1.0 (0.75-1.3)</td>
</tr>
<tr>
<td>2000</td>
<td>32.3 (2816)</td>
<td>22.2 (626)</td>
<td>0.90 (0.75-1.1)</td>
<td>0.73 (0.48-1.1)</td>
</tr>
<tr>
<td>4000</td>
<td>14.3 (1251)</td>
<td>9.9 (124)</td>
<td>1.2 (0.96-1.6)</td>
<td>0.86 (0.31-2.4)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; HDHP, high-deductible health plan.
*Unadjusted values.
†Odds ratios are from Poisson models with generalized estimating equations that included age, sex, deductible level, employer size, index date, socioeconomic status, association status, individual vs family plan, and morbidity.
‡Adjusted differences in differences are from Poisson models with generalized estimating equations that included age, sex, employer size, index date, socioeconomic status, association status, individual vs family plan, and morbidity.

### Table 5. Hospitalization Rates and Length of Stay in the HDHP and Control Groups

<table>
<thead>
<tr>
<th></th>
<th>HDHP Group*</th>
<th>Control Group*</th>
<th>Change in HDHP Group From Baseline to Follow-up vs Controls, % (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>Follow-up</td>
<td>Baseline</td>
<td>Follow-up</td>
</tr>
<tr>
<td>Emergency department visits resulting in hospitalizations, % (No. of hospitalizations)†</td>
<td>11.8 (204)</td>
<td>10.9 (170)</td>
<td>11.9 (1560)</td>
</tr>
<tr>
<td>Low severity</td>
<td>6.0 (38)</td>
<td>5.0 (28)</td>
<td>6.3 (295)</td>
</tr>
<tr>
<td>Indeterminate severity</td>
<td>11.7 (86)</td>
<td>10.8 (68)</td>
<td>11.4 (642)</td>
</tr>
<tr>
<td>High severity</td>
<td>25.8 (51)</td>
<td>22.7 (45)</td>
<td>28.8 (298)</td>
</tr>
<tr>
<td>Unclassified</td>
<td>18.5 (29)</td>
<td>17.4 (45)</td>
<td>17.0 (225)</td>
</tr>
<tr>
<td>Hospitalizations per 1000 members (total No. of hospitalizations)¶</td>
<td>23.4 (204)</td>
<td>19.5 (170)</td>
<td>26.2 (1560)</td>
</tr>
<tr>
<td>Potentially avoidable hospitalizations¶</td>
<td>2.6 (23)</td>
<td>1.9 (17)</td>
<td>3.0 (177)</td>
</tr>
<tr>
<td>Mean duration of hospitalization, d (No. of hospitalizations)$</td>
<td>4.4 (204)</td>
<td>3.6 (170)</td>
<td>4.1 (1560)</td>
</tr>
<tr>
<td>After low-severity visit</td>
<td>3.2 (38)</td>
<td>3.0 (28)</td>
<td>4.5 (295)</td>
</tr>
<tr>
<td>After indeterminate-severity visit</td>
<td>3.9 (86)</td>
<td>2.9 (68)</td>
<td>3.4 (642)</td>
</tr>
<tr>
<td>After high-severity visit</td>
<td>5.7 (61)</td>
<td>4.1 (45)</td>
<td>4.2 (398)</td>
</tr>
<tr>
<td>After unclassified visit</td>
<td>4.7 (29)</td>
<td>4.7 (29)</td>
<td>5.2 (225)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; HDHP, high-deductible health plan.
*Unadjusted rates.
†Adjusted differences in differences are from Poisson models with generalized estimating equations that included age, sex, deductible level, employer size, index date, socioeconomic status, association status, individual vs family plan, and morbidity.
‡Model also included a term to adjust for the severity of the preceding emergency department visit.
¶Only hospitalizations resulting from emergency department visits are shown.
$Includes all hospitalizations, not only those through the emergency department.
bers compared with controls whether they followed first or repeat visits of any severity (data not shown). We therefore chose not to analyze admissions based on the first-visit/repeat-visit distinction.

**Expenses**

The average yearly Harvard Pilgrim Health Care emergency department expense per HDHP member decreased from $75 in the baseline year to $36 in the follow-up period, compared with an increase from $81 to $94 for control members, an absolute decline of $52, representing a 58.5% relative decline after adjustment for member characteristics (95% CI, −64.4% to −51.5%; P < .001). The average yearly member out-of-pocket emergency department payment by HDHP members increased from $8 in the baseline year to $49 in the follow-up period compared with $9 for control members in both periods. This absolute increase of $41 was a 491% relative increase for HDHP members after adjustment (95% CI, 441%-547%; P < .001). The average out-of-pocket cost for a first visit in the follow-up period among HDHP members was $304 (SD, $272). Overall, total emergency department expenses paid per member (including health plan and member payments) increased from $83.3 to $85.5 in the HDHP group and from $90.1 to $103.0 in the control group, resulting in a 10% nonsignificant relative decline (95% CI, −19.9% to +0.4%) for HDHP members from baseline to follow-up.

**COMMENT**

To our knowledge, this is the first study to examine emergency department visits and hospitalization in a modern HDHP. Overall, we found that in a cohort of HMO members who were offered no choice of employer-based health plans, transition to an HDHP was associated with reductions in emergency department visits, hospitalizations associated with emergency department visits, and duration of hospitalization. Specifically, the switch to high-deductible coverage was associated with a 10% relative decline in total emergency department visits. The HDHP was not significantly associated with a decreased odds of a first emergency department visit; rather, the decrease in total visits was primarily related to a 25% decrease in repeat visits by the HDHP group. Among such repeat visits, the decline occurred primarily among those classified as low and indeterminate severity, although there was a small, nonsignificant decrease in high-severity visits.

Among HDHP members with emergency department visits, there was a 25% relative decline in the proportion admitted to the hospital compared with controls. Combined with reductions in emergency department visits, there was a 27% relative decline in population hospitalization rates in the HDHP cohort from baseline to follow-up. Once admitted to the hospital, the length of stay for HDHP members was 21% less than controls. However, the absolute magnitude of these differences in the follow-up period was small, with the HDHP group having 169 fewer emergency department visits, 34 fewer emergency department–related hospitalizations, and a 0.8-day shorter length of hospital stay than in the baseline period.

Studies conducted during previous insurance eras have shown a similar association with utilization. Cost sharing has been found to reduce overall and inappropriate emergency department visits while having a lesser impact on appropriate care. Costs for hospitalization and emergency department care are typically shared by the patient, and the impact of cost sharing is likely to be less in these settings. The RAND Health Insurance Experiment, co-payments had a more pronounced effect on reducing "less urgent" than "more urgent" emergency department visits. Similarly, 2 studies have demonstrated that among HMO members, the introduction of co-payments was associated with a decline in emergency department use, mostly for conditions unlikely to be emergencies. No increases in adverse events such as hospitalizations were detected.

The RAND study also found that cost-sharing members experienced 24% fewer hospitalizations compared with those with free care. While similar reductions in “appropriate” and “inappropriate” admissions occurred, no adverse events were noted. Studies have also detected lower admission rates among patients facing higher out-of-pocket expenses.

Our study indicates that these utilization patterns may hold true in modern employer-sponsored HDHP arrangements. Most HDHP members did not forgo high-severity emergency department visits and seemed able to distinguish low-severity conditions not requiring emergency department care. The observed reductions in low- and indeterminate-severity repeat emergency department visits may imply that HDHP members who become aware of their degree of cost sharing (after registering at the emergency department or being billed for their initial visit) become less willing to return, though longer-term behavior is uncertain.

However, the stability of repeat high-severity visits among HDHP members from baseline to follow-up suggests that even after understanding their cost-sharing obligation, HDHP members continue to use the emergency department appropriately. In contrast, reductions in indeterminate-severity repeat emergency department visits may imply some risk of worse outcomes, given that visits in this category have been found to have a higher odds of 30-day mortality and hospitalization than low-severity visits (unpublished data provided by written communication from John Hsu, MD, MBA, November 1, 2006).

Our study had limited ability to detect associations between HDHPs and morbidity or delays in seeking care. Decreases that we observed in commonly used health outcome proxy measures (hospitalizations and length of hospital stay) might suggest the absence of detrimental health outcomes. However, this may not hold true in our study, given that reductions could be related to cost sharing rather than improved health care. Observed declines in utilization among the HDHP group would be worrisome if they reflect...
needed care that was forgone because of an untenable economic trade-off.

However, we believe that reductions in hospitalizations and shorter stays may reflect unnecessary utilization among controls, rather than inappropriate discharges from the emergency department or hospital among HDHP members. If patients in HDHPs were being discharged when they actually required further care, we would expect to observe higher rates of subsequent indeterminate- or high-severity emergency department visits as well as higher admission rates and longer lengths of stay following repeat visits. The fact that we did not detect such changes may imply that, in the short-term at least, HDHP members may be reducing mostly unnecessarily excessive utilization.

These data must be interpreted carefully when deriving implications about health outcomes. On average, we followed members for slightly less than a year; longer follow-up would be more likely to detect adverse outcomes if members are deferring care, especially if patients do not fully understand their cost-sharing levels until after first contact with the health system. Furthermore, we were unable to assess mortality changes. In the comparatively healthy, working-age population we studied, such outcomes would be difficult to detect without a substantially larger sample size.

Our finding that HDHP members from lower-income areas experienced statistically nonsignificant decreases in high-severity visits deserves particular attention. The affordability of HDHPs makes broad uptake within this demographic group more likely, and the RAND Health Insurance Experiment demonstrated detrimental health outcomes for the poorest and sickest patients subject to cost sharing compared with free care. 27 However, our results should be interpreted within the context that, given the rising cost of traditional plans, employers may forgo purchasing health insurance altogether without the availability of less expensive coverage.

Our study has several other limitations. Employers may have chosen plans based on knowledge of their employees’ health plan preferences, health status, or prior expenditures. While this could have been associated with an element of selection bias, we were able to minimize the larger problem of member self-selection by restricting the study population to individuals who had only a single choice of plan in the follow-up period. The data do not represent individuals working for larger employers or those with choices of health plans. However, HDHPs are increasingly offered at both small and large employers, 20 so our findings may be relevant to a large segment of the health insurance industry. Furthermore, we studied a population with a relatively high socioeconomic status, typical of employed, commercially insured populations. Our data also do not represent longer-term experiences with emergency department utilization decisions in HDHPs; whether HDHP members persist in distinguishing low- and high-severity conditions when deciding to visit the emergency department is unknown.

Taken together, reductions in repeat emergency department visits, rates of admission, and lengths of stay following emergency department visits suggest a strong association between HDHPs and decisions to reduce utilization. Before entering the health care system, HDHP members may be making decisions with or without assistance from medical professionals; once within the system, they may be negotiating with medical staff regarding decisions to be admitted or discharged. Whether these decisions are appropriate remains uncertain, but it suggests that clinicians may be required to participate in greater levels of shared decision making about medical necessity and affordability of care as HDHPs expand.

CONCLUSIONS

Our findings imply that, at least in the short term, HDHPs may be associated with reduced overall emergency department utilization without significantly affecting the highest-severity visits. Although we did not detect adverse outcomes, broad decreases in emergency department and hospital utilization raise concerns about long-term effects on health. In addition, we detected reductions in high-severity visits among HDHP members living in low-income areas that could imply worse outcomes compared with counterparts in traditional plans. Further study is needed regarding long-term utilization patterns in HDHPs, the effect of HDHPs on health outcomes, and effects on low-income populations.
REFERENCES

other base credentials but does not provide for license portability.

There are many important issues pertaining to physician response during disasters, including licensing, credentialing, liability, safety, and compensation. This study focused strictly on licensure of private-sector physicians during declared states of emergency. The finding that 18 states do not currently have policies allowing accelerated physician licensure indicates the potential for suboptimal medical care in the event of a large-scale disaster. Although the issuance of executive orders and “federalization” of physicians may be useful as reactive measures, a policy of accelerated licensure during states of emergency may enhance the rapidity and magnitude of physician response.

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Department of Pediatrics
Kansas University
Kansas City

Author Contributions: Dr Boyajian-O’Neill had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Boyajian-O’Neill, Gronewold, Glaros, Elmore.

Acquisition of data: Boyajian-O’Neill, Gronewold.


Drafting of the manuscript: Boyajian-O’Neill, Gronewold, Glaros.

Critical revision of the manuscript for important intellectual content: Boyajian-O’Neill, Gronewold, Glaros, Elmore.

Statistical analysis: Glaros.

Administrative, technical, or material support: Boyajian-O’Neill, Gronewold, Glaros, Elmore.

Study supervision: Boyajian-O’Neill.

Financial Disclosures: None reported.


CORRECTION

Incorrect Data in Table and Text: In the Original Contribution entitled “Emergency Department Use and Subsequent Hospitalizations Among Members of a High-Deductible Health Plan” published in the March 14, 2007, issue of JAMA (2007;297[10]:1093-1102), the third and fifth columns of Table 4 contained mis-calculated data. The corrected table appears below. In addition, the third and fourth full paragraphs on page 1098 of the article should read as follows:

“Table 4 shows utilization patterns by deductible level. The percentages of HDHP members in individual/family plans who had deductibles of $500/$1000, $1000/$2000, and $2000/$4000 were 9.9%/23.3%, 13.9%/32.3%, and 6.2%/14.3%, respectively. Of members in individual HDHPs, 32.2%, 19.8%, and 5.7%, respectively, of members with $500, $1000, and $2000 deductibles exceeded their deductible during the follow-up period. For those in family plans, 41.4%, 19.4%, and 8.5%, respectively, of members with $1000, $2000, and $4000 deductibles exceeded their individual or family deductible. Eighty-four percent of all emergency department visits by HDHP members in the follow-up period and 90% of first visits occurred while members were below their deductible level.

There was little difference in the odds of a visit in the follow-up period compared with the baseline period by deductible level. However, members in individual plans whose spending exceeded the deductible level had a statistically significant higher odds of visiting the emergency department compared with the odds during time spans when members remained below deductible levels (odds ratio, 1.8; 95% CI, 1.4-2.4), with the highest odds of emergency department visits among members with $2000 deductibles (odds ratio, 2.9; 95% CI, 1.1-7.7). Members of family plans showed similar patterns of utilization after reaching their deductible level compared with members in individual plans.”

Table 4. Utilization Among HDHP Members Stratified by Individual vs Family Plan and Deductible Level

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<th>Deductible Level</th>
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<th>HDHP Members Exceeding Deductible, % (No.)*</th>
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<td>5.7 (31)</td>
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</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>23.3 (2037)</td>
<td>41.4 (844)</td>
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<td>14.3 (1251)</td>
<td>8.5 (106)</td>
<td>1.2 (0.96-1.6)</td>
<td>2.7 (1.4-5.4)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; HDHP, high-deductible health plan.

*Unadjusted values.

†Odds ratios are from Poisson models with general estimating equations that included age, sex, deductible level, employer size, index date, socioeconomic status, association status, and morbidity.