Avoidable Hospitalizations Among Medicaid Recipients in Washington State

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Document No. 02-08-3401

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EXECUTIVE SUMMARY

Physicians and researchers have identified several diseases and health conditions for which timely and effective outpatient health care services, such as physician office visits, can often prevent hospitalizations. This study examines whether these "avoidable hospitalizations" are a significant issue for the Washington State Medicaid program and, if so, whether it is possible to reduce them and in turn reduce state health care expenditures.

The Washington State Institute for Public Policy (Institute) was directed by the Washington State Legislature "to research and evaluate strategies for constraining the growth in state health expenditures."[1] In consultation with legislative fiscal committee staff, an analysis of potentially avoidable hospitalizations among Medicaid recipients was identified as a useful area of research.

Key Findings

Avoidable hospitalizations are a significant issue for the Washington State Medicaid program, accounting for 13 percent of all hospitalizations in a large sample of Medicaid clients. Although this analysis suggests that not all avoidable hospitalizations can be prevented, we present scenarios under which programs to reduce avoidable hospitalizations could lead to cost savings for the state. The following findings are noteworthy:

- The majority of avoidable hospitalizations occur among individuals who qualify for Medicaid due to a severe disability.
- Factors related to a greater likelihood of having an avoidable hospitalization include cystic fibrosis, obesity, and being age 65 or older.
- It is difficult to identify which Medicaid recipients are at risk of having an avoidable hospitalization, but statistical models can predict such individuals with enough accuracy to target prevention services.
- Depending upon the cost and effectiveness of prevention services, it is possible to reduce avoidable hospitalizations and decrease state health care expenditures.

[1] ESSB 6153, Section 608(8), Chapter 7, Laws of 2001.

INTRODUCTION

Washington State health care expenditures represent only 14 percent of the total budget, yet they are expected to account for over 37 percent of the increase in the general fund-state budget in the 2001–03 biennium.[2] This disproportionate growth has prompted renewed focus on strategies to contain state health care costs.

One area experiencing high rates of expenditure growth is the Department of Social and Health Services' Medical Assistance Administration (MAA). The MAA provides health benefits to low-income individuals, the majority of whom are covered by the state and federal Medicaid program. Because of the cost implications for the state, individuals who receive health care on a fee-for-service basis are of particular interest.

Fee-for-service health care requires a payment for each service received. Individuals are permitted to see any health care provider willing to accept the level of reimbursement provided by the MAA. In this type of arrangement, no health professional acts as a central point of coordination for an individual's health care needs. Approximately 300,000 individuals (40 percent of individuals receiving health care through the MAA) are enrolled in fee-for-service arrangements.[3]

The remaining 400,000 individuals receiving health care through the MAA are enrolled in managed care plans. These plans are paid a fixed (capitated) amount regardless of the services used by an individual. Managed care plans also provide a central point of contact, sometimes referred to as a medical home, for access to various health care services. While this approach limits patient choice of physicians, it also provides for some coordination of care, an important issue for persons with chronic illnesses or disabilities.

Because fee-for-service patients do not have a central point of coordination for their health care needs, an opportunity may exist to improve health outcomes and reduce costs for at least some members of this population by providing case management services.[4] Previous

[2] See Senate Ways and Means Committee staff presentation "Medical Costs and the 2002 Supplemental Budget," <http://www.leg.wa.gov/senate/scs/wm/other/2002/TYPresentation.pdf>, accessed August 2, 2002.

[3] For fiscal year 1999–2000, average monthly enrollment in MAA programs was 717,901. In June 1999, 420,105 of these persons were enrolled in a managed care plan while the remainder received health care on a fee-for-service basis. See the 1999 MAA Annual Report, <http://fortress.wa.gov/dshs/maa/annual/1999.pdf>, accessed August 2, 2002.

[4] Research on case management is not consistently positive, but the following studies indicate improved health outcomes, lower costs, or both as a result of case management: K. Lorig et al., "Evidence Suggesting That a Chronic Disease Self-Management Program Can Improve Health Status While Reducing Hospitalization: A Randomized Trial," *Medical Care* 37, no. 1 (2000); J. Hawks et al., "The Virginia Health Outcomes Project: A Unique Approach to Lowering Medicaid Costs and Improving Health Outcomes," *American Journal of Managed Care* 2 (1996); M. Rich et al., "Multidisciplinary Intervention to Prevent the Readmission of Elderly Patients with Congestive Heart Failure," *New England Journal of Medicine* 333, no. 18 (1995).

research by the Institute[5] identified several diseases for which additional coordination of care, or disease management, has the potential to reduce costs among high-cost fee-for-service patients. As a result, the MAA is currently establishing several disease management pilot projects.

This analysis addresses a related topic: the potential for fee-for-service Medicaid clients to be hospitalized for conditions that could be prevented through regular visits to physicians and use of other outpatient care. The purpose of this study is to verify whether these avoidable hospitalizations are a significant issue for the Washington State Medicaid program and, if so, whether it is possible to reduce them and, in turn, reduce state health care expenditures.

The following issues are addressed:

- Section I defines avoidable hospitalizations and presents summary information about their frequency among fee-for-service Medicaid recipients.
- Section II provides descriptive information on Medicaid recipients with avoidable hospitalizations.
- Section III discusses the likelihood that some avoidable hospitalizations may not be avoidable.
- Section IV contains multivariate statistical analyses that identify characteristics of individuals associated with avoidable hospitalizations, predictions of Medicaid recipients likely to have avoidable hospitalizations, and cost savings under various prevention scenarios.

[5] Steve Lerch and Jim Mayfield, *High-Cost Medicaid Clients: Targeting Diseases for Case Management* (Olympia, WA: Washington State Institute for Public Policy, December 2000), <http://www.wsipp.wa.gov/hlthwelfare/pdf/HighCostMedicaid.pdf>, accessed August 2, 2002.

I. AVOIDABLE HOSPITALIZATIONS

Timely and effective outpatient health care services, such as physician office visits, can often prevent hospitalizations for certain medical conditions. Avoiding unnecessary hospitalizations can potentially reduce overall health care expenditures and improve patient health status.[6]

To determine if Washington could reduce health costs by avoiding certain hospitalizations, it is necessary to establish whether such hospitalizations are common among fee-for-service recipients of Medicaid and other state health care programs.[7] The first step in this process is to identify diseases or conditions for which hospitalization should be unnecessary if individuals have access to needed outpatient treatment. The identification of these diseases has been undertaken by researchers working with a physician panel[8] and also by a group of physicians and researchers at Stanford University, the University of California-San Francisco, and the federal Agency for Healthcare Research and Quality (AHRQ).[9] A number of conditions have been identified for which hospitalization should be preventable through adequate outpatient care. Examples of these diseases include pneumonia, asthma, and urinary tract infections.

The second step is to obtain state Medicaid billing (often referred to as claims data) and eligibility data to examine patient records for all hospitalizations associated with one of these conditions. The claims data include over 35,000,000 records that contain clinical and financial information for hospital, physician, prescription drug, and other health care services provided to Medicaid recipients for calendar years 1999 and 2000. These claims were combined with Medicaid eligibility data containing information on individual characteristics such as age, gender, and county of residence.

Because the ultimate goal of this research is to identify individuals with these conditions before they result in hospitalization, the analysis is limited to individuals with a total of 12 or more months of Medicaid eligibility during 1999 and 2000.[10] This sample design focuses the analysis on persons on Medicaid for a period long enough to potentially benefit from prevention programs. As illustrated in Exhibit 1, this design produces a sample with

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[6] A. B. Bindman et al., "Preventable Hospitalizations and Access to Health Care," *Journal of the American Medical Association* (July 26, 1995).

[7] The data used in this analysis cover fee-for-service recipients of Medicaid and other fully state-funded health care programs. Because over 91 percent of the individuals in the sample are Medicaid recipients for the entire analysis period, the population discussed in this report will be referred to as "Medicaid recipients."

[8] J. S. Weissman, C. Gatsonis, and A. M. Epstein, "Rates of Avoidable Hospitalizations by Insurance Status in Massachusetts and Maryland," *Journal of the American Medical Association* (November 4, 1992). The ICD-9-CM codes associated with these conditions are identified in the appendix.

[9] *Prevention Quality Indicators, Version 2.1* (Rockville, MD: Agency for Healthcare Research and Quality, April 2002), <http://www.ahrq.gov/data/hcup/prevqi.htm>, accessed August 2, 2002. The ICD-9-CM codes associated with these conditions are identified in the appendix.

[10] Individuals recorded as being eligible for the federal Medicare program at any time during 1999 and 2000 are excluded from the sample. The Medicaid program would have a little or no ability to target outpatient services to such individuals to prevent avoidable hospitalizations because Medicare covers outpatient services other than prescription drugs.

358,006 unique Medicaid recipients during 1999 and 2000, of which 6,181 have one or more avoidable hospitalizations.

Exhibit 1
Summary Sample Information:
Washington Medicaid Fee-for-Service Clients

	Number of Recipients	Percent of Total Sample
Full Sample*	358,006	100%
No Hospitalizations**	314,883	88%
One or More Hospitalizations	43,123	12%
One or More Avoidable Hospitalizations***	6,181	2%

*Full sample: All persons eligible for and enrolled in an MAA health care program for at least 12 months during 1999–2000. The sample is limited to persons receiving health care services on a fee-for-service basis.
**Hospitalization: Any hospital stay of one or more days.
**Avoidable hospitalization: Any hospital stay for a disease or condition as defined by Weissman et al. and/or AHRQ Prevention Quality Indicators.

Exhibit 2 presents additional information on total hospitalizations and on avoidable hospitalizations. As the exhibit indicates, 43,123 individuals had a total of 70,121 hospitalizations during 1999 and 2000, of which 8,833 were for avoidable conditions. In other words, nearly 13 percent of all hospitalizations in the sample were potentially avoidable.[11] Conditions for which avoidable hospitalizations were most common in this population include pneumonia, asthma, cellulitis, urinary tract infections, and chronic obstructive pulmonary disease (chronic bronchitis).

[11] Note that this is considerably higher than the 6.3 percent of Medicaid hospitalizations identified as avoidable in a previous Institute report: Steve Lerch, *Avoidable Hospitalizations in Washington State* (November 2001). However, the previous report considered all Medicaid recipients, while this analysis is limited to fee-for-service Medicaid recipients, who are generally less healthy.

Exhibit 2

Hospitalizations Among Washington Medicaid Recipients, 1999–2000

	Recipients	Hospitalizations
All Hospitalizations	43,123	70,121
Avoidable Hospitalizations, Total	6,181	8,833
Avoidable Hospitalizations by Condition		
Pneumonia		
Definition (1)	1,735	2,009
Definition (2)	1,611	1,812
Asthma	921	1,240
Cellulitis	860	1,026
Urinary Infection		
Definition (1)	396	425
Definition (2)	645	723
Chronic Obstructive Pulmonary Disease	550	823
Congestive Heart Failure		
Definition (1)	525	733
Definition (2)	534	755
Dehydration	417	450
Diabetes: Long-Term Complications	326	464
Diabetes: Short-Term Complications		
Definition (1)	279	441
Definition (2)	223	358
Pediatric Gastroenteritis	229	237
Perforated Appendix	170	170
Perforated or Bleeding Ulcer	129	132
Angina Without Surgical Procedure	108	112
Diabetes: Uncontrolled	66	68
Hypertension		
Definition (1)	40	49
Definition (2)	55	65
Hypokalemia (potassium deficiency)	45	53
Immunizable Conditions	11	13
Gangrene	11	11
Diabetes: Lower-extremity Amputation	-	-

Avoidable hospitalization defintions from Weissman et al. and AHRQ Prevention Quality Indicators.

II. CHARACTERISTICS OF PERSONS WITH AVOIDABLE HOSPITALIZATIONS

In order to reduce the number of avoidable hospitalizations among Medicaid recipients, it is necessary to identify individuals who are most likely to have an avoidable hospitalization in the future. If specific characteristics can be associated with the likelihood of having an avoidable hospitalization, those characteristics can then be used to identify persons at risk of future avoidable hospitalizations.

A substantial body of research has documented the relationship between avoidable hospitalizations and access to care,[12] insurance status,[13] income,[14] age,[15] and race.[16] Although insurance status and income become less relevant when focusing specifically on a Medicaid population where all persons have similar health care coverage and generally low incomes, this body of research suggests that an understanding of demographic characteristics is important in determining differences between individuals with and without avoidable hospitalizations.

Exhibit 3 presents information on recipient characteristics for the entire sample, for those persons with one or more hospitalizations, and for those persons with one or more *avoidable* hospitalizations. Although such descriptive data do not clearly indicate the importance of one factor relative to another in identifying persons with an avoidable hospitalization, they do suggest factors that may be of interest for further analysis.

[12] Bindman et al., "Preventable Hospitalizations."
[13] Weissman et al., "Rates of Avoidable Hospitalizations."
[14] G. Pappas et al., "Potentially Avoidable Hospitalizations: Inequalities in Rates between U.S. Socioeconomic Groups," *American Journal of Public Health* (May 1997).
[15] L. J. Kozak, M. J. Hall, and M. F. Owings, "Trends in Avoidable Hospitalizations, 1980-1998," *Health Affairs* (March/April 2001).
[16] Pappas et al., "Potentially Avoidable Hospitalizations"; S. D. Culler, M. L. Parchman, and M. Przybylski, "Factors Related to Potentially Preventable Hospitalizations among the Elderly," *Medical Care* (June 1998).

Exhibit 3
Recipient Characteristics

	All Medicaid Fee-for Service Clients	Patients With 1 or More Hospitalizations	Patients With 1 or More Avoidable Hospitalizations
Number of Patients	358,006	43,123	6,181
Average Number of Medicaid Eligible Months	20.3	19.9	21.4
Average Age (as of 12/31/2000)	20.8	30.7	36.6
Percent under age 18	52.2%	16.8%	27.0%
Percent age 65 or older	1.7%	3.4%	7.5%
Died in 1999 or 2000	0.4%	2.1%	5.9%
Male	38.7%	24.7%	42.8%
Primary Language Not English	17.7%	23.8%	12.0%
Rural Resident*	5.7%	5.6%	5.0%
Minority Ethnicity	35.9%	42.4%	33.9%
Total Number of Chronic Diseases	0.4	1.0	2.0
4 or More Chronic Diseases	0.9%	5.8%	16.1%
Asthma	6.0%	13.8%	37.0%
Mental Disorders	5.9%	16.8%	20.9%
Alcohol or Drug Abuse	4.9%	15.3%	21.4%
Chronic Obstructive Pulmonary Disease	4.9%	13.5%	35.8%
Diabetes	3.5%	10.7%	27.6%
Epilepsy	2.9%	8.5%	12.3%
Arthritis	2.8%	7.2%	12.3%
Hereditary/Degenerative Central Nervous System Diseases	1.1%	4.0%	8.7%
Obesity	0.8%	4.4%	10.0%
Blindness/Low Vision	0.4%	0.8%	1.6%
Mental Retardation	0.3%	1.2%	2.1%
HIV/AIDS	0.3%	0.8%	1.5%
Coagulation Defects	0.3%	1.5%	3.2%
Immune Disorders (excluding HIV/AIDS)	0.2%	0.5%	1.2%
Sickle Cell Disease	0.1%	0.3%	0.3%
Cystic Fibrosis	0.1%	0.2%	0.6%

*ZIP code data were missing for 16,755 recipients. For these individuals, status as a rural or urban resident was based on the location of the community service office where they received services when feasible.

Based on previous research, we might expect persons with avoidable hospitalizations to be disproportionately in groups where access to care may be an issue, such as ethnic or racial minorities, women, or those living in rural areas. However, Exhibit 3 implies that these factors are not related to avoidable hospitalizations.

For example, 38.7 percent of the sample as a whole but 42.8 percent of those with an avoidable hospitalization are male. This suggests that males have an above-average likelihood (and females a below-average likelihood) of having an avoidable hospitalization. Persons with a primary language other than English are 17.7 percent of the entire sample but only 12 percent of those with an avoidable hospitalization, suggesting that they have a below-average likelihood (and English speakers an above-average likelihood) of an avoidable hospitalization. In fact, persons with an avoidable hospitalization are more likely to be Caucasian, to speak English as their primary language, to be male, and to live in urban areas when compared with the sample as a whole.

Data over the two-year period have also been examined to identify patients suffering from a variety of chronic (ongoing) diseases.[17] The presence of a chronic disease suggests a greater need for health care services and is often a complicating factor in the treatment of other illnesses. Not surprisingly, Exhibit 3 indicates that patients with a hospitalization are more likely to suffer from any of these chronic diseases when compared with the total population. One would expect that persons with a hospital stay would tend to be sicker than the population as a whole, and a higher prevalence of chronic diseases is certainly consistent with that expectation.

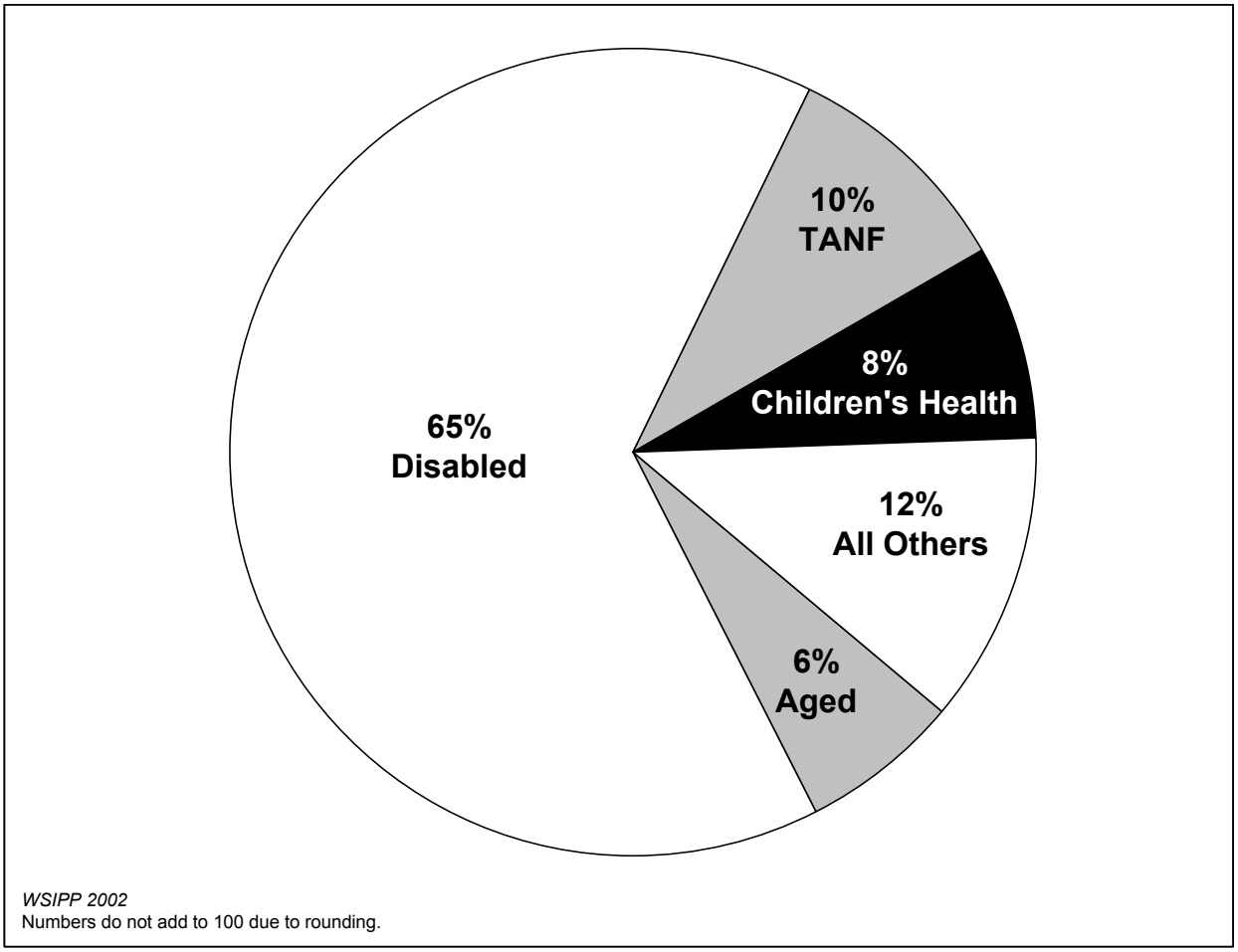
Exhibit 3 also indicates that, with the exception of sickle cell disease, the prevalence of chronic diseases is even higher for persons with avoidable hospitalizations than for all persons with a hospital stay. This suggests that the average person with an avoidable hospitalization is not only much sicker than the population as a whole but also much sicker than the average person with a hospital stay of any kind. For example, approximately 6 percent of the entire sample has asthma, but this jumps to nearly 14 percent for persons with any type of hospitalization and to 37 percent of those with an avoidable hospitalization. Persons suffering from asthma and other chronic diseases have a disproportionately high likelihood of having an avoidable hospitalization.

We can also examine whether avoidable hospitalizations are more or less common among the 14 different health care programs serving individuals in our sample. Because the eligibility criteria for these programs are based on such factors as disability status, pregnancy, and age, there may be substantial differences among individuals in the various programs. In turn, these differences could lead to higher or lower rates of avoidable hospitalization across the programs.

[17] The diagnosis codes used to identify chronic diseases are based on the Clinical Classification Software (CCS) developed by the federal Agency for Healthcare Research and Quality, <http://www.ahrq.gov/downloads/pub/ahrqqi/pqiguide.pdf>, accessed August 2, 2002. See the appendix for the ICD-9-CM codes for each disease. If an individual has one or more diagnoses, primary or secondary, for a disease at any time during 1999 or 2000, he or she is assumed to have had the disease for the entire period of the analysis.

Exhibit 4 displays the percentage distribution of all avoidable hospitalizations by health care program. The majority (65 percent) of avoidable hospitalizations are concentrated among individuals in the disabled program. These are individuals who qualify for Medicaid on the basis of a severe disability and are essentially unable to work.[18] Three other groups, Temporary Assistance for Needy Families (TANF, the state-federal welfare program), Children's Health, and Aged, each have 6 to 10 percent of avoidable hospitalizations, while the remaining 12 percent of avoidable hospitalizations are distributed across ten different programs.

Exhibit 4
Distribution of Avoidable Hospitalizations by Medicaid Program



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Numbers do not add to 100 due to rounding.

[18] During 1999 and 2000, individuals qualified for the disabled program if they had a severe disability as determined by the federal Social Security Administration and were unable to engage in "substantial gainful activity," defined as earning less than $700 per month at the time of application to the program. The recent passage of Washington State legislation implementing the federal "Ticket to Work" law alters the amount of earned income persons with disabilities may receive while continuing to qualify for Medicaid. See Steve Lerch, *Medicaid Expansion for Employed Persons With Disabilities: Costs and Benefits of the "Ticket to Work" Buy-In* (Olympia, WA: Washington State Institute for Public Policy, November 2000).

The information in Exhibits 3 and 4 suggests that persons with avoidable hospitalizations are more likely to be older, male, English speaking, non-Hispanic whites who are also more likely to suffer from a chronic disease and are receiving Medicaid benefits through the Disabled program. However, one danger of the single factor (or univariate) comparisons made in Exhibit 3 is that the true relationships may involve a combination of factors. For example, it appears that having chronic obstructive pulmonary disease (or COPD) is related to avoidable hospitalizations; nearly 36 percent of persons with an avoidable hospitalization have COPD compared with approximately 5 percent in the total sample. However, it is possible that persons with both COPD and an avoidable hospitalization are relatively old and that it is age rather than COPD that is related to avoidable hospitalizations. To disentangle such relationships, multivariate statistical techniques are used.

III. ARE AVOIDABLE HOSPITALIZATIONS TRULY AVOIDABLE?

The information in Exhibit 2 suggests that avoidable hospitalizations are a significant issue among Medicaid recipients. However, the potential to reduce Medicaid expenditures exists only if these are truly avoidable hospital stays that resulted from a lack of appropriate outpatient care. In other words, cost savings are possible only if additional, less expensive outpatient care can be used to prevent hospitals stays from occurring.

Given the much higher rate of chronic diseases and death among persons with avoidable hospitalizations (see Exhibit 3), it is reasonable to assume that this group is considerably less healthy than the sample as a whole. Thus, factors other than access to or quality of care may be responsible for some avoidable hospitalizations.[19] Finally, some avoidable hospitalizations can only be avoided if outpatient interventions are implemented well in advance. For example, avoiding hospitalizations associated with immunizable conditions requires an increase in the number of children receiving immunizations for infectious diseases. However, the associated reduction in avoidable hospitalizations would likely occur well into the future. These factors suggest that only a subset of hospitalizations identified as avoidable could be prevented through a targeted expansion of outpatient services.

One way to test if a hospitalization was avoidable is to examine the types of outpatient care that individuals received prior to hospital admission. We cannot measure the effectiveness of treatment nor can we be certain that any treatment received was provided in a timely fashion. Therefore, the existence of prior outpatient treatment related to a hospitalization does not confirm that a hospitalization was "unavoidable." However, an avoidable hospitalization is defined as a hospital stay that could have been prevented with adequate outpatient care. Thus, we would expect that individuals with a truly avoidable hospitalization *would not* have received related outpatient care immediately prior to hospitalization.

For this analysis, we examine claims for outpatient care that occurred prior to an avoidable hospitalization. Most claims contain diagnosis codes that indicate the illness associated with each health care encounter.[20] Using the Clinical Classification Software (CCS) developed by the federal Agency for Healthcare Research and Quality,[21] we can group these diagnosis codes into meaningful disease categories. To avoid confusion, the analysis is limited to the individuals with a single avoidable hospitalization (4,435 patients had a single avoidable hospitalization during the analysis period).

[19] Weissman et al.
[20] *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM); see <http://www.hcfa.gov/stats/pufiles.htm>, accessed August 5, 2002.
[21] See <http://www.ahrq.gov/data/hcup/ccsfact.htm>, accessed August 5, 2002.

For patients in each avoidable hospitalization category, all outpatient care[22] that was received one or more days prior to the start of an avoidable hospitalization was grouped into one of 131 disease groups.[23] Outpatient care was then separated by the date services were received relative to the avoidable hospitalization: one month before, two months before, three to six months before, etc.

Exhibit 5 presents the results of this analysis for two large avoidable hospitalization categories (results for additional categories are in the appendix). For each category, the exhibit displays the number and percentage of patients receiving care one or more times for a particular disease in the specified time period. For each time period, the five most commonly treated diseases or conditions are displayed.

For example, there are 1,140 patients who have an avoidable hospitalization due to pneumonia. Depending upon the time period considered, the diseases for which these individuals most commonly received outpatient treatment prior to hospitalization include respiratory infection, other lower respiratory disease, heart disease, diseases of the urinary system, and two more general categories (factors influencing health care and symptoms, signs, and ill-defined conditions).

The respiratory infection category is of particular interest because it includes pneumonia. In the 7- to 12-month period prior to hospitalization, 16 percent of patients with an avoidable hospitalization for pneumonia had one or more outpatient health care encounters related to respiratory infections, while 31 percent had prior treatment for a respiratory infection one month before the hospitalization. This suggests that some of the avoidable hospitalizations for pneumonia occurred despite relatively recent outpatient treatment for pneumonia or a related condition.

Prior outpatient care from other categories of avoidable hospitalizations implies a similar conclusion. In the month preceding an avoidable hospitalization for cellulitis, 34 percent of patients had been treated one or more times for skin and subcutaneous tissue infections (which includes cellulitis). Forty percent of patients with an avoidable hospitalization for congestive heart failure received outpatient treatment for heart disease in the prior month, and 34 percent of patients with an avoidable hospitalization for pyelonephritis or other urinary tract infections had outpatient care related to diseases of the urinary system in the month prior to hospitalization (see Exhibit A-1 in the appendix). The results in Exhibit 5 do suggest that additional outpatient care may have been insufficient to prevent some avoidable hospitalizations.

[22] This includes outpatient services provided by clinics, physician offices, laboratories, radiology clinics, podiatrists, chiropractors, hospital outpatient departments, home health agencies, and purchases of durable medical equipment. Prescription drug claims are excluded because they do not contain diagnosis information.

[23] The Level 2 groups defined by the Clinical Classification Software were used for this analysis.

Exhibit 5

Outpatient Care Received Prior to Avoidable Hospitalization

Pneumonia	Total Patients = 1,140		Cellulitis	Total Patients = 578	
Disease Category (CCS Level 2)	**Number of Patients With Outpatient Care**	**Percent of Patients With Outpatient Care**	**Disease Category**	**Number of Patients With Outpatient Care**	**Percent of Patients With Outpatient Care**
One Month Prior to Avoidable Hospitalization			**One Month Prior to Avoidable Hospitalization**		
Respiratory infection	354	31%	Skin and subcutaneous tissue infections	194	34%
Factors influencing health care	247	22%	Factors influencing health care	138	24%
Other lower respiratory disease	163	14%	Symptoms, signs, and ill-defined conditions	66	11%
Symptoms, signs, and ill-defined conditions	120	11%	Other connective tissue disease	50	9%
Heart disease	95	8%	Non-traumatic joint disorders	50	9%
Two Months Prior to Avoidable Hospitalization			**Two Months Prior to Avoidable Hospitalization**		
Factors influencing health care	186	16%	Factors influencing health care	96	17%
Respiratory infection	114	10%	Skin and subcutaneous tissue infections	34	6%
Symptoms, signs, and ill-defined conditions	72	6%	Diabetes	33	6%
Other lower respiratory disease	69	6%	Symptoms, signs, and ill-defined conditions	32	6%
Heart disease	60	5%	Non-traumatic joint disorders	30	5%
Three to Six Months Prior to Avoidable Hospitalization			**Three to Six Months Prior to Avoidable Hospitalization**		
Factors influencing health care	318	28%	Factors influencing health care	169	29%
Respiratory infection	215	19%	Symptoms, signs, and ill-defined conditions	84	15%
Symptoms, signs, and ill-defined conditions	156	14%	Skin and subcutaneous tissue infections	74	13%
Other lower respiratory disease	126	11%	Respiratory infection	67	12%
Diseases of the urinary system	116	10%	Non-traumatic joint disorders	65	11%
Seven to Twelve Months Prior to Avoidable Hospitalization			**Seven to Twelve Months Prior to Avoidable Hospitalization**		
Factors influencing health care	295	26%	Factors influencing health care	165	29%
Respiratory infection	181	16%	Symptoms, signs, and ill-defined conditions	78	13%
Symptoms, signs, and ill-defined conditions	139	12%	Respiratory infection	77	13%
Other lower respiratory disease	130	11%	Heart disease	68	12%
Heart disease	98	9%	Other lower respiratory disease	66	11%

Disease categories: AHRQ Clinical Classification Software (CCS) Level 2 groups based on primary diagnoses for outpatient care received prior to an avoidable hospitalization. Analysis limited to individuals with a single avoidable hospitalization.

IV. USING MULTIVARIATE TECHNIQUES TO PREDICT AVOIDABLE HOSPITALIZATIONS

Identifying Key Factors Related to Avoidable Hospitalizations

Despite the results discussed above, many patients with avoidable hospitalizations did not receive any seemingly relevant outpatient care prior to the hospitalization. This suggests that it is still desirable to identify individuals most likely to experience avoidable hospitalizations in the future in order to target additional, preventive outpatient treatment.

The descriptive data in Exhibit 3 provide a first step by suggesting characteristics most (or least) common among persons with avoidable hospitalizations. However, as noted above, this type of single variable analysis can be misleading. It also provides little information as to the relative importance of certain variables in identifying individuals likely to have an avoidable hospitalization.

Multivariate statistical methods provide a way to identify relationships after accounting (or "controlling") for other important factors and for estimating the importance of those relationships. One such technique, logistic regression, enables us to examine a combination of demographic and health-related factors that increase or decrease the probability of having an avoidable hospitalization. This creates a tool to estimate the likelihood that an individual with a given set of characteristics will have an avoidable hospitalization in the future. Because the health care needs of pregnant women are very different from the rest of the Medicaid population, the model results are based on analyses that exclude patients in the pregnant women's program.

Exhibit 6 provides summary information from the logistic regression model for the full sample (excluding the pregnant women's group) and for subgroups of Medicaid recipients. Logistic regressions estimate the overall probability of an event occurring, but it is also possible to use the regression results to estimate the change in probability associated with a particular characteristic. For example, the Full Sample column indicates that a Medicaid recipient who is age 65 or over is 5.4 percent more likely to have an avoidable hospitalization than a Medicaid recipient under age 65.[24]

The results in Exhibit 6 are arranged by demographic and disease factors and are ranked within each group from highest to lowest impact (for the full sample) on the likelihood of an avoidable hospitalization. Many of the biggest predictors of an avoidable hospitalization are chronic diseases or health conditions: cystic fibrosis, obesity, and mental retardation are all associated with increases of over 2 percent in the probability of having an avoidable hospitalization. Among non-health care factors, individuals over age 40 (and especially

[24] The logistic model is nonlinear, meaning that it is incorrect to add the change in probability for two different factors to obtain their combined impact on the probability of an avoidable hospitalization. For example, the increased probability associated with an individual who is obese and over age 65 is not 4.1 percent + 5.4 percent but almost 24 percent higher compared with a non-obese person under age 65.

over age 65), those who are members of an ethnic or racial minority,[25] and males have a higher probability of an avoidable hospitalization relative to younger, white, or female Medicaid recipients.

Exhibit 6
Change in Probability of an Avoidable Hospitalization

	Full Sample	Disabled	Aged	All Children
Sample Characteristics				
Sample size	295,796	59,832	5,029	183,113
1 or more avoidable hospitalizations	5,698	3,408	364	1,632
Percent with 1 or more avoidable hospitalizations	93.6%	56.7%	6.0%	26.8%
Demographic Characteristics				
Age = 65 or older	5.4%	n/a	n/a	n/a
Age = 40 to 64	1.7%	2.8%	n/a	n/a
Ethnic/racial minority	0.4%	1.4%	1.7%	0.3%
Male	0.2%	0.3%	ns	ns
Age = 1 to 17	0.1%	2.1%	n/a	n/a
Language other than English	-0.5%	-1.5%	-2.2%	-0.3%
Infant (age under 1)	ns	ns	n/a	n/a
Live in rural area	ns	ns	ns	ns
Age in years	n/a	n/a	0.3%	-0.1%
Chronic Diseases				
Cystic Fibrosis	6.2%	12.1%	n/a	1.9%
Obesity	4.1%	10.7%	28.4%	1.6%
Mental Retardation	2.5%	5.5%	21.4%	0.5%
Hereditary/Degenerative CNS	1.4%	3.9%	3.5%	ns
Alcohol/Drug Abuse	1.4%	4.8%	13.2%	0.4%
Coagulation Defects	1.1%	4.2%	ns	ns
Blind/Low Vision	0.9%	2.4%	ns	ns
Sickle Cell Anemia	0.9%	ns	n/a	0.9%
Immune Disorders (exc. AIDS/HIV)	0.6%	2.1%	n/a	ns
Epilepsy	0.4%	0.4%	ns	0.5%
AIDS/HIV	0.4%	ns	ns	-0.5%
Arthritis	-0.1%	-0.5%	ns	ns
Mental Health	ns	-0.5%	2.7%	-0.2%
Health Care Service Utilization				
Physician visits per month	0.3%	0.7%	1.5%	0.5%
Hospital outpatient visits per month	0.3%	0.7%	0.8%	0.3%
Home health visits per month	0.2%	0.6%	1.4%	ns
Prescriptions per month	0.1%	0.2%	0.5%	0.1%
Other services per month	0.1%	0.2%	-0.5%	0.0%
Laboratory/Radiology visits per month	ns	ns	3.0%	0.7%
Nursing home days per month	ns	ns	ns	ns

ns = not statistically significant at p = .10 level; n/a = variable not appropriate for specific analysis.
NOTE: For the models that use actual age, the change in probability represents the effect of age increasing by one year, evaluated at the average age for the group. The full sample does not contain all persons with an avoidable hospitalization due to missing data for some demographic variables.

[25] Individuals who are of Hispanic origin (regardless of race), African Americans, Asian Americans, and Native Americans.

Most of these results are consistent with the descriptive information displayed in Exhibit 3, which indicates that older persons and males are more likely to have an avoidable hospitalization while persons with a primary language other than English are less likely. Also consistent with the descriptive data are the results indicating that many chronic diseases are linked to a higher probability of an avoidable hospitalization.[26]

The result that members of an ethnic or racial minority have a higher probability of an avoidable hospitalization contradicts the implication in the descriptive statistics. This is the type of relationship that multivariate statistical techniques are designed to identify—although non-Hispanic whites appear to account for a disproportionate share of avoidable hospitalizations in Exhibit 3, controlling for other demographic and illness factors indicates that ethnic and racial minorities are actually more likely to have an avoidable hospitalization.[27]

Based on the relationships identified in Exhibit 6 by the logistic regressions, it is possible to use data available from the MAA eligibility and medical claims systems to estimate the probability that specific Medicaid clients will have an avoidable hospitalization. Those clients with high estimated probabilities would then logically be candidates for additional monitoring, case management, or other prevention programs to assure they received adequate outpatient care.

As noted earlier, individuals qualify for Medicaid under eligibility criteria that vary depending upon age, disability status, and family composition. As a result, the Medicaid population is very heterogeneous. This fact calls into question the validity of using a single set of relationships between demographic and health care factors and avoidable hospitalizations for all Medicaid recipients. Therefore, Exhibit 6 also displays logistic regression results for three specific subsets of the Medicaid population: low-income persons with a disability and under age 65, low-income persons age 65 or over, and all Medicaid-eligible children.[28] The results indicate both similarities and differences between the Medicaid population as a whole and these selected subgroups.

By looking at specific subgroups, age factors become less helpful predictors of avoidable hospitalizations. This is largely due to the fact that the subgroups themselves are partially or fully defined by recipient age—the Aged subgroup contains only individuals age 65 or older, the children's group contains only persons under age 19. It is interesting to note that, as with the entire sample, the probability of an avoidable hospitalization increases with age for the disabled and aged groups. However, for the children's subgroup, the likelihood of an avoidable hospitalization actually decreases as patients get older.

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[26] Hospitalizations for some conditions related to asthma, chronic obstructive pulmonary disease, and diabetes are considered avoidable. Therefore, the models do not include indicators for the presence of these three diseases to avoid estimating spurious impacts.

[27] The greater likelihood of an avoidable hospitalization among racial and ethnic minorities and the reduced likelihood of an avoidable hospitalization among persons who have a primary language other than English appear to be contradictory. However, over 60 percent of Medicaid recipients who are ethnic or racial minorities also speak English as their primary language.

[28] Children qualify for Medicaid under a number of different programs, including Temporary Assistance for Needy Families, Children's Health program, Foster Care, and Disabled.

The impact of other demographic factors is more consistent across the groups. Ethnic and racial minorities are more likely to have an avoidable hospitalization, as are persons whose primary language is English. In both cases, these effects are stronger among disabled and aged patients than among children. Males and residents of rural areas are no more likely to have an avoidable hospitalization, regardless of the group under consideration.

As with the full sample, it is the presence of specific chronic diseases that provide the strongest indicators for the likelihood of an avoidable hospitalization. Obesity is clearly an important predictor of avoidable hospitalizations for all subgroups, although the impact is much stronger for the aged and disabled than for children. Beyond this, there is considerable variation in which diseases are the strongest predictors of an avoidable hospitalization across the groups. In some cases, this is due to the nature of a particular disease. For example, cystic fibrosis is primarily a disease that affects children and young adults. Therefore, while it is a strong predictor of avoidable hospitalizations in the disabled and children's groups, virtually no members of the aged group have the disease, and it cannot be used as a variable in the regression model for the aged group.

Predicting the Likelihood of an Avoidable Hospitalization

The regression results in Exhibit 6 provide information about which demographic and disease factors are good predictors of avoidable hospitalizations. For example, even after adjusting for the presence of other factors that may influence the likelihood of an avoidable hospitalization, Exhibit 6 indicates that individuals who have been diagnosed as obese are more likely to have an avoidable hospitalization compared with similar individuals who are not obese.

However, that does not mean that all obese Medicaid recipients will have an avoidable hospitalization. As indicated in Exhibit 3, nearly 1 percent of the full sample, or approximately 2,800 individuals, have been diagnosed as obese. Although 10 percent of individuals with an avoidable hospitalization have been diagnosed as obese, that equals about 620 persons. Therefore, it is not possible to use a diagnosis of obesity *by itself* to identify persons who will have an avoidable hospitalization.

To make the regression results useful, they need to be converted into a tool that will specifically predict which patients are likely to have an avoidable hospitalization. This can be readily done by combining the estimated regression model(s) with an individual's characteristics and calculating a predicted probability of an avoidable hospitalization.[29]

To see how well the regression models would have predicted avoidable hospitalizations among Medicaid recipients in our sample, we have calculated predicted probabilities for each of the four models in Exhibit 6. The challenge in obtaining accurate predictions is twofold. First, avoidable hospitalizations are a relatively rare event. As indicated in

[29] Because logistic regression models predict the probability of an event, these predicted values will be between 0 and 1. In this discussion, any predicted probability greater than 0.5 is assumed to predict that an individual will have an avoidable hospitalization.

Exhibit 1, of the 358,006 persons in our full sample, only 6,181 (about 2 percent of all Medicaid recipients) had one or more avoidable hospitalizations.[30]

The second point is related to the earlier discussion of obesity. Although the models can clearly identify factors that increase the likelihood of an avoidable hospitalization, there is no single variable, but rather a combination of factors, that identify individuals most likely to have an avoidable hospitalization. Because there are a relatively small number of individuals with an avoidable hospitalization, there will also be many Medicaid recipients without avoidable hospitalizations who share some of these factors. This makes it difficult for the regression models to do a good job of sorting individuals as more likely or less likely to have an avoidable hospitalization.

Exhibit 7 displays the number of individuals the overall model and each of the subgroup models predict will have an avoidable hospitalization compared with whether or not they actually had an avoidable hospitalization. At first glance, the models' ability to accurately predict an avoidable hospitalization appears quite weak. A fairly small fraction of individuals who had an avoidable hospitalization are identified as such, with the best model correctly identifying approximately 7 percent of those with an avoidable hospitalization. In addition, each model identifies a number of individuals as having an avoidable hospitalization when in fact they did not. This group of individuals is still of interest because they fit the statistical profile for an avoidable hospitalization. In other words, these may be individuals for whom a future avoidable hospitalization is very likely.

Exhibit 7
Persons With Avoidable Hospitalizations: Regression Model Predictions

	Persons With One or More Avoidable Hospitalizations			
	Actual Count	Model Prediction: Correct	Model Prediction: Incorrect	Percent of Actuals Correctly Predicted by Model
Full Sample	5,698	337	386	5.9%
Disabled	3,408	253	225	7.4%
Aged	364	23	20	6.3%
All Children	1,632	89	100	5.5%

Predicted values obtained from regression models described in Exhibit 6.

These poor prediction results are not necessarily surprising given the difficulties cited above. They also suggest that there may be additional information, not available from Medicaid health care claims or eligibility data, which could help identify persons most likely to have an avoidable hospitalization. Such additional data may not exist under any circumstances (e.g., undiagnosed illnesses) or may be available but expensive to collect (e.g., laboratory test results or whether patients correctly take prescription medications).

[30] After excluding recipients from the pregnant women program and dropping recipients with missing information on program eligibility, ethnicity, primary language, and place of residence, the full sample contains a total of 295,796 persons of whom 5,698 had one or more avoidable hospitalizations.

Although the rate of accurate prediction is lower than desired, it is important to consider the value of the models as tools for identifying potential savings. Combining the number of persons identified (correctly or incorrectly) as having an avoidable hospitalization from the overall model and from each of the subgroup models gives a total of 890 unique Medicaid recipients. Of these, 410 persons actually had one or more avoidable hospitalizations and were therefore correctly predicted by the models. The 410 correctly identified individuals had a total of 860 avoidable hospitalizations during the years 1999 and 2000. From the actual medical claims data, we know that each avoidable hospitalization cost an average of $9,752,[31] or a total of nearly $8.4 million.

Although $8.4 million is only a fraction of total spending on avoidable hospitalizations, it is clear that the models can help to identify a substantial sum of expenses that may be avoidable. To put the value of this information into practical terms, we have displayed it in Exhibit 8 in a manner in which it could be used to predict at least a share of avoidable hospitalization expenses.

Exhibit 8
Regression Model Prediction Results

	Based on Actual 1999 and 2000 Data	Hypothetical Example
Model Prediction: Persons Expected to Have 1 or More Avoidable Hospitalizations	890	100
Actual: Number of Avoidable Hospitalizations Among All Predictions	860	N/A
Actual: Total Expense of Avoidable Hospitalizations	$8,386,900	N/A
Total Cost Per Predicted Person	$9,423	$9,423
Estimated: Number of Avoidable Hospitalizations Among All Predictions	N/A	97
Estimated: Total Expense of Avoidable Hospitalizations	N/A	$942,300

Of the 890 persons the models predicted as having an avoidable hospitalization, the data indicate there were a total of 860 avoidable hospitalizations or slightly less than one avoidable hospitalization per person. While over half these individuals did not actually have an avoidable hospitalization, many of the persons who did have an avoidable hospitalization had more than one. As noted above, these 860 avoidable hospitalizations resulted in almost $8.4 million in expenditures. If expressed as an average for each person predicted by the models to have an avoidable hospitalization, this amounts to just over $9,400.

[31] Because physicians and hospitals bill separately, there are no combined bills for a hospital stay. We define the cost of a hospital stay as the sum of the Medicaid payment to the hospital plus the Medicaid payments to any physicians providing services on or during the days covered by the hospital stay.

The following example shows how this information could be used. Applying the models to Medicaid data from a more recent time period (such as calendar year 2001), assume that 100 persons are identified as likely to have an avoidable hospitalization. Because we are trying to predict future avoidable hospitalizations, we do not know how many of these individuals will have an avoidable hospitalization or the expense if they do. However, based on our results using the actual 1999 and 2000 data, we expect that there will be an average of $9,423 in avoidable hospitalization expenses for each predicted individual. Therefore, we would expect $942,300 in total expenses for avoidable hospitalizations in this group of 100 persons who the models predict will have an avoidable hospitalization.

Policy Implications

As Exhibit 8 suggests, we can use the regression models and information derived from Medicaid data to identify at least some people expected to have an avoidable hospitalization and the expenses associated with those hospitalizations. The next step is to design a policy that could prevent some of these avoidable hospitalizations.

In general, we know that avoidable hospitalizations are defined as events that occur due to a lack of timely or appropriate outpatient care. Based on the type of analysis summarized in Exhibit 5, at least some Medicaid recipients were treated for conditions the same as or similar to those for which they had an avoidable hospitalization. As noted above, this suggests that additional or targeted outpatient care may not prevent all the avoidable hospitalizations we have identified in the Medicaid population. However, the actual strategies to be used in preventing avoidable hospitalizations are not the purview of this analysis and are more appropriately designed by health care professionals. Instead, our goal is to identify, to the extent possible, individuals for whom one or more avoidable hospitalizations are likely and to suggest reasonable financial parameters for policies intended to address avoidable hospitalizations.

For purposes of illustration, we again refer to the hypothetical example of 100 persons identified as being at risk of an avoidable hospitalization. Because we do not specifically know which of those 100 persons will have one or more avoidable hospitalizations, any prevention policy must necessarily be targeted to *all* 100 persons identified by the regression models.

Using the estimate of total avoidable hospitalization expenses ($942,300) from the hypothetical example, we can construct some lower and upper bounds on the savings that could be expected for prevention programs of varying cost. Uncertainty about the level of savings comes from several sources. As noted previously, it is likely that some hospital stays we have classified as avoidable occurred after an individual did receive appropriate outpatient care. Regardless of how well designed, it is unlikely that any prevention program could avoid such hospitalizations.

There will also be situations where a seemingly avoidable hospitalization could not have been avoided through additional outpatient services. One group of researchers noted, "…not all hospitalizations for conditions such as asthma and congestive heart failure are

likely to be prevented even with timely and appropriate ambulatory care."[32] In addition, some Medicaid recipients may decline to participate in or make use of prevention programs.

Related to this is uncertainty about the expense of hospitalizations that might be avoided through a prevention program. Among individuals predicted to have an avoidable hospitalization in Exhibit 8, the average cost per avoidable hospitalization is $9,752. This average is somewhat misleading. Although it is based on a few hospital stays that cost in excess of $100,000, three-fourths of these avoidable hospitalizations cost $8,386 or less, with the median expense equal to $4,816. This suggests that an avoided cost below the average of $9,752 is appropriate when estimating cost savings from a prevention program.

Taking these uncertainties into account, Exhibit 9 examines the per person impact of prevention programs under several scenarios for each Medicaid recipient identified as likely to have one or more avoidable hospitalizations. Under a fairly pessimistic view, where only 10 percent of avoidable hospitalizations are actually prevented, and avoided expense per prevented hospitalization is $4,000 (low program effectiveness/low hospitalization expense scenario), a program that costs $250 per person would result in net savings of $138 for each person predicted to be at risk of an avoidable hospitalization. More expensive programs result in a net increase in Medicaid expenses as new prevention program costs exceed the savings from reducing some hospitalizations.

Exhibit 9
Cost-Benefit Analysis, Hypothetical Examples

				Savings Per Person Under Different Prevention Program Costs			
Scenario	Avoidable Hospitalizations Per Predicted Individual	Effectiveness (Percent of Hospitalizations Avoided)	Average Savings Per Hospitalization Avoided	Program Cost = $250 Per Person	Program Cost = $500 Per Person	Program Cost = $1,000 Per Person	Program Cost = $2,000 Per Person
Low program effectiveness/ Low expense hospitalizations	0.97	10%	$4,000	$138	-$112	-$612	-$1,612
Low program effectiveness/ Moderate expense hospitalizations	0.97	10%	$5,000	$235	-$15	-$515	-$1,515
Medium program effectiveness/ Moderate expense hospitalizations	0.97	30%	$5,000	$1,205	$955	$455	-$545
Medium program effectiveness/ High expense hospitalizations	0.97	30%	$9,000	$2,369	$2,119	$1,619	$619
High program effectiveness/ High expense hospitalizations	0.97	60%	$9,000	$4,988	$4,738	$4,238	$3,238

[32] Kozak, Hall, and Owings, "Trends in Avoidable Hospitalizations."

As assumptions about program success and the avoided expense per prevented hospitalization increase, net savings from a prevention program increase. Taking the relatively optimistic assumptions in the high effectiveness/high expense scenario, a program that costs $250 per person results in net savings of nearly $5,000 for each targeted Medicaid recipient, and even programs as expensive as $2,000 per person still result in net savings. Because the regression models and data that form the basis of the estimates in Exhibit 9 cover a two-year period, the costs of the new program should be viewed as covering a two-year period as well.

The intent here is not to identify the actual cost of an effective prevention program but rather to suggest a set of feasible "price tags" under varying assumptions. This information can be used to guide decisions about the design of prevention programs and to suggest reasonable upper limits on their costs. For example, if program designers believe that reducing avoidable hospitalizations by 30 percent is an achievable goal (as in the medium program effectiveness scenarios in Exhibit 9), prevention programs that cost up to $1,000 per targeted individual would be expected to result in net savings. Tracking avoidable hospitalizations among persons receiving prevention services will help to identify the areas in which the prevention programs are or are not successful, whether prevention goals are being met, and whether actual program costs are above or below expected costs. In turn, this information will enable program designers to modify or even suspend prevention programs to maximize savings and improve patient outcomes.

CONCLUSION

Potentially avoidable hospitalizations are a significant issue among Medicaid recipients. The existence of over 6,000 Medicaid recipients with one or more avoidable hospitalizations during 1999 and 2000 suggests the potential for reducing costs through targeted services to improve access to outpatient care. However, accurately identifying which recipients are at risk of having an avoidable hospitalization is difficult. In addition, some so-called avoidable hospitalizations cannot, in fact, be avoided.

Despite the difficulty in identifying recipients at risk of having an avoidable hospitalization, we have developed statistical models that are able to identify a portion of those persons most likely to have an avoidable hospitalization. We have also provided some financial guidelines to assist in creating targeted prevention programs to help reduce avoidable hospitalizations that in turn will reduce Medicaid expenditures.

Further research may lead to improved predictions of Medicaid recipients at risk for avoidable hospitalizations. For example, developing models to predict which individuals will have multiple avoidable hospitalizations and under what circumstances an initial avoidable hospitalization helps to predict a future one has the potential for reducing Medicaid expenditures. An in-depth analysis of the types of specific health services (for example, particular prescription drugs) received by individuals with avoidable hospitalizations also has the potential to shed additional light on this issue. Therefore, this report should be viewed as a first step in addressing the issue of avoidable hospitalizations among Medicaid recipients.

APPENDIX: DIAGNOSIS CODES

Diagnosis Codes for Avoidable Hospitalizations
Weissman et al. Definitions

CONDITION	ICD-9-CM CODES
Pneumonia	481, 482, 483, 485, 486
Congestive Heart Failure	428, 402.01, 402.11, 402.91
Asthma	493
Cellulitis	681, 682
Perforated or Bleeding Ulcer	531.0, 531.2, 531.4, 531.6, 532.0, 532.2, 532.4, 532.6, 533.0, 533.1, 533.2, 533.4, 533.5, 533.6
Pyelonephritis	590.0, 590.1, 590.8
Diabetes With Ketoacidosis or Coma	250.1, 250.2, 250.3, 251.0
Ruptured Appendix	540.0, 540.1
Malignant Hypertension	401.0, 402.0, 403.0, 404.0, 405.0, 437.2
Hypokalemia	276.8
Immunizable Conditions	032, 033, 037, 072, 045, 055
Gangrene	785.4

Note: A three-digit diagnosis code indicates that any four-digit and five-digit subdivisions are to be included; a four-digit diagnosis code indicates that any five-digit subdivisions are to be included. Only the principle diagnosis is used to define an avoidable hospitalization.

Diagnosis Codes for Avoidable Hospitalizations
Agency for Healthcare Research and Quality (AHRQ) Definitions

CONDITION	ICD-9-CM CODES
Bacterial Pneumonia	481, 482.2, 482.30, 482.31, 482.32, 482.9, 483.0, 483.1, 483.8, 485, 486 Exclude any hospitalization with a diagnosis code for sickle cell anemia or HB-S disease (282.60, 282.61, 282.62, 282.63, 282.69) and patients less than 8 weeks of age.
Dehydration	276.5
Pediatric Gastroenteritis	008.61, 008.62, 008.63, 008.64, 008.65, 008.66, 008.67, 008.69, 008.8, 009.0, 009.1, 009.2, 009.3, 558.9 Exclude patients age 18 or over.
Urinary Tract Infection	590.00, 590.01, 590.10, 590.11, 590.2, 590.3, 590.80, 590.81, 590.9, 595.0, 595.9, 599.0
Perforated Appendix	540.0, 540.1 (diagnosis in any field)
Angina Without Procedure	411.1, 411.81, 411.89, 413.0, 413.1, 413.9 Exclude patients less than age 18; any patient with a surgical procedure in any field (01.0-86.99).
Congestive Heart Failure (CHF)	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0, 428.1, 428.9 Exclude patients less than age 18; any patient with a cardiac procedure in any field (36.01, 36.02, 36.05, 36.06, 36.10 – 36.17, 36.19, 37.5, 37.70 – 37.79)
Hypertension	401.0, 401.9, 402.00, 402.10, 402.90, 403.00, 403.90, 404.00, 404.10, 404.90 Exclude patients less than age 18; any patient with a cardiac procedure in any field (36.01, 36.02, 36.05, 36.06, 36.10 – 36.17, 36.19, 37.5, 37.70 – 37.79)
Adult Asthma	493.00, 493.01, 493.02, 493.10, 493.11, 493.12, 493.20, 493.21, 493.22, 493.90, 493.91, 493.92 Exclude patients less than age 18.
Pediatric Asthma	493.00, 493.01, 493.02, 493.10, 493.11, 493.12, 493.20, 493.21, 493.22, 493.90, 493.91, 493.92 Exclude patients age 18 or over.

Chronic Obstructive Pulmonary Disease (COPD)	491.0, 491.1, 492.0, 491.20, 491.21, 491.8, 491.9, 492.8, 494, 494.0, 494.1, 496 (466.0, 490 also qualify if accompanied by secondary diagnosis from above list.) Exclude patients less than age 18.
Uncontrolled Diabetes	250.02, 250.03 Exclude patients less than age 18 or with a secondary diagnosis of short-term or long-term complication (250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33, 250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93).
Diabetes Short-Term Complications	250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33 Exclude patients less than age 18.
Diabetes Long-Term Complications	250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93 Exclude patients less than age 18.
Lower-Extremity Amputation Among Patients With Diabetes	(Note: Procedure code for lower-extremity amputation in any field and diagnosis code for diabetes in any field.)
Lower-Extremity Amputation	84.10 – 84.19
Diabetes	250.00, 250.01, 250.02, 250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33, 250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93 Exclude patients less than age 18.

Note: Use principle diagnosis only to define avoidable hospitalization unless noted otherwise. For all conditions, exclude transfers from other institutions and hospitalizations for childbirth.

Procedure codes are ICD-9-CM codes; these were cross-walked to CPT-4 procedure codes for purposes of this analysis.

Chronic Disease Definitions

The following are based on the level 2 disease groups in the AHRQ Clinical Classification Software (CCS). A patient with one or more claims that contained *any* diagnosis (primary or secondary) at *any time* that is included in a disease definition was considered to have the disease for the entire 1999 and 2000 period. The CCS group number and title are in parentheses.

AIDS/HIV (5: HIV infection): 042, 042.0, 042.1, 042.9, 043.0, 043.1, 043.2, 043.3, 043.9, 044.0, 044.9, 079.53, 279.10, 279.19, 795.71, 795.8, V08

Diabetes (49: Diabetes mellitus without complication and 50: Diabetes mellitus with complication): 250.00, 250.01, 250.02, 250.03, 250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33, 250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93, 790.2, 791.5, 791.6

Asthma (128: Asthma): 493.00, 493.01, 493.02, 493.10, 493.11, 493.12, 493.20, 493.21, 493.22, 493.90, 493.91, 493.92

Mental Retardation (65: Mental retardation): 317, 318.0, 318.1, 318.2, 319

Alcohol/Drug Abuse (66: Alcohol-related mental disorders; and 67: Substance-related mental disorders *except tobacco use diagnoses*): 291.0, 291.1, 291.2, 291.3, 291.4, 291.5, 291.8, 291.81, 291.89, 291.9, 292.0, 292.11, 292.12, 292.2, 292.81, 292.82, 292.83, 292.84, 292.89, 292.9, 303.00, 303.01, 303.02, 303.03, 303.90, 303.91, 303.92, 303.93, 304.00, 304.01, 304.02, 304.03, 304.10, 304.11, 304.12, 304.13, 304.20, 304.21, 304.22, 304.23, 304.30, 304.31, 304.32, 304.33, 304.40, 304.41, 304.42, 304.43, 304.50, 304.51, 304.52, 304.53, 304.60, 304.61, 304.62, 304.63, 304.70, 304.71, 304.72, 304.73, 304.80, 304.81, 304.82, 304.83, 304.90, 304.91, 304.92, 304.93, 305.00, 305.01, 305.02, 305.03, 305.20, 305.21, 305.22, 305.23, 305.30, 305.31, 305.32, 305.33, 305.40, 305.41, 305.42, 305.43, 305.50, 305.51, 305.52, 305.53, 305.60, 305.61, 305.62, 305.63, 305.70, 305.71, 305.72, 305.73, 305.80, 305.81, 305.82, 305.83, 305.90, 305.91, 305.92, 305.93

Mental Health (68: Senility and organic mental disorders; 69: Affective disorders; 70: Schizophrenia and related disorders; and 71: Other psychoses): 290.0, 290.10, 290.11, 290.12, 290.13, 290.20, 290.21, 290.3, 290.40, 290.41, 290.42, 290.43, 290.8, 290.9, 293.0, 293.1, 293.81, 293.82, 293.83, 293.84, 293.89, 293.9, 294.0, 294.1, 294.10, 294.11, 294.8, 294.9, 295.00, 295.01, 295.02, 295.03, 295.04, 295.05, 295.10, 295.11, 295.12, 295.13, 295.14, 295.15, 295.20, 295.21, 295.22, 295.23, 295.24, 295.25, 295.30, 295.31, 295.32, 295.33, 295.34, 295.35, 295.40, 295.41, 295.42, 295.43, 295.44, 295.45, 295.50, 295.51, 295.52, 295.53, 295.54, 295.55, 295.60, 295.61, 295.62, 295.63, 295.64, 295.65, 295.70, 295.71, 295.72, 295.73, 295.74, 295.75, 295.80, 295.81, 295.82, 295.83, 295.84, 295.85, 295.90, 295.91, 295.92, 295.93, 295.94, 295.95, 296.00, 296.01, 296.02, 296.03, 296.04, 296.05, 296.06, 296.10, 296.11, 296.12, 296.13, 296.14, 296.15, 296.16, 296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 296.40, 296.41, 296.42, 296.43, 296.44, 296.45, 296.46, 296.50, 296.51,

296.52, 296.53, 296.54, 296.55, 296.56, 296.60, 296.61, 296.62, 296.63, 296.64, 296.65, 296.66, 296.7, 296.80, 296.81, 296.82, 296.89, 296.90, 296.99, 297.0, 297.1, 297.2, 297.3, 297.8, 297.9, 298.0, 298.1, 298.2, 298.3, 298.4, 298.8, 298.9, 299.00, 299.01, 299.10, 299.11, 299.80, 299.81, 299.90, 299.91, 300.4, 301.11, 301.13, 310.0, 310.1, 310.2, 310.8, 310.9, 331.0, 331.1, 331.2, 797

Obesity (58 [partial]: Other nutritional, endocrine, and metabolic disorders *except disorders of mineral metabolism; other unspecified metabolic, nutritional and endocrine disorders*): 278.0, 278.00, 278.01

Cystic Fibrosis (56: Cystic fibrosis): 277.00, 277.01

Coagulation Defects (62 [partial]: Coagulation and hemorrhagic disorders *except hemorrhagic diseases*): 286.0, 286.1, 286.2, 286.3, 286.4, 286.5, 286.6, 286.7, 286.9

Immunity Disorders (57: Immunity disorders): 279.00, 279.01, 279.02, 279.03, 279.04, 279.05, 279.06, 279.09, 279.11, 279.12, 279.13, 279.2, 279.3, 279.4, 279.8, 279.9

Sickle Cell Anemia (61: Sickle cell anemia): 282.5, 282.60, 282.61, 282.62, 282.63, 282.69

Epilepsy (83: Epilepsy, convulsions): 345.0, 345.00, 345.01, 345.1, 345.10, 345.11, 345.2, 345.3, 345.4, 345.40, 345.41, 345.5, 345.50, 345.51, 345.6, 345.60, 345.61, 345.7, 345.70, 345.71, 345.8, 345.80, 345.81, 345.9, 345.90, 345.91, 780.3, 780.31, 780.39

Hereditary/Degenerative CNS (79: Parkinson's disease; 80: Multiple sclerosis; 81: Other hereditary and degenerative nervous system conditions): 330.0, 330.1, 330.2, 330.3, 330.8, 330.9, 331.3, 331.4, 331.7, 331.81, 331.89, 331.9, 332.0, 333.0, 333.1, 333.2, 333.3, 333.4, 333.5, 333.6, 333.7, 333.81, 333.82, 333.83, 333.84, 333.89, 333.90, 333.91, 333.92, 333.93, 333.99, 334.0, 334.1, 334.2, 334.3, 334.4, 334.8, 334.9, 335.0, 335.10, 335.11, 335.19, 335.20, 335.21, 335.22, 335.23, 335.24, 335.29, 335.8, 335.9, 336.0, 336.1, 336.2, 336.3, 336.8, 336.9, 337.0, 337.1, 337.3, 337.9, 340

Arthritis (202: Rheumatoid arthritis and related diseases and 203: Osteoarthritis): 714.0, 714.1, 714.2, 714.30, 714.31, 714.32, 714.33, 714.4, 714.81, 714.89, 714.9, 715.00, 715.04, 715.09, 715.10, 715.11, 715.12, 715.13, 715.14, 715.15, 715.16, 715.17, 715.18, 715.20, 715.21, 715.22, 715.23, 715.24, 715.25, 715.26, 715.27, 715.28, 715.30, 715.31, 715.32, 715.33, 715.34, 715.35, 715.36, 715.37, 715.38, 715.80, 715.89, 715.90, 715.91, 715.92, 715.93, 715.94, 715.95, 715.96, 715.97, 715.98, 720.0, V13.4

Chronic Obstructive Pulmonary Disease (127: Chronic obstructive pulmonary disease and bronchiectasis): 490, 491.0, 491.1, 491.2, 491.20, 491.21, 491.8, 491.9, 492.0, 492.8, 494, 494.0, 494.1, 496

Blind/Low Vision (89 [partial]: Blindness and vision defects *except 367 – Disorders of refraction, accommodation; 368 – Visual disturbances*): 369.00, 369.01, 369.02, 369.03, 369.04, 369.05, 369.06, 369.07, 369.08, 369.10, 369.11, 369.12, 369.13, 369.14, 369.15, 369.16, 369.17, 369.18, 369.20, 369.21, 369.22, 369.23, 369.24, 369.25, 369.3, 369.4, 369.60, 369.61, 369.62, 369.63, 369.64, 369.65, 369.66, 369.67, 369.68, 369.69, 369.70, 369.71, 369.72, 369.73, 369.74, 369.75, 369.76, 369.8, 369.9

Table A-1

Outpatient Care Received Prior to an Avoidable Hospitalization

Urinary Tract Infection (AHRQ) or Pyelonephritis
Total Patients = 462

Disease Category	Number of Patients With Outpatient Care	Percent of Patients With Outpatient Care
1 Month Prior to Avoidable Hospitalization		
Diseases of urinary system	156	34%
Factors influencing health care	112	24%
Symptoms, signs, and ill-defined conditions	95	21%
Respiratory infections	46	10%
Other lower respiratory disease	22	5%
2 Months Prior to Avoidable Hospitalization		
Factors influencing health care	93	20%
Diseases of urinary system	62	13%
Symptoms, signs, and ill-defined conditions	33	7%
Normal pregnancy and/or delivery	26	6%
Diseases of female genital organs	19	4%
3 to 6 Months Prior to Avoidable Hospitalization		
Factors influencing health care	149	32%
Diseases of urinary system	94	20%
Symptoms, signs, and ill-defined conditions	72	16%
Respiratory infections	58	13%
Spondylosis, intervertebral disc, other back disorders	36	8%
7 to 12 Months Prior to Avoidable Hospitalization		
Factors influencing health care	120	26%
Diseases of urinary system	81	18%
Symptoms, signs, and ill-defined conditions	53	11%
Respiratory infections	51	11%
Heart diseases	34	7%

Table A-1 (continued)

Congestive Heart Failure
Total Patients = 247

Disease Category	Number of Patients With Outpatient Care	Percent of Patients With Outpatient Care
1 Month Prior to Avoidable Hospitalization		
Heart disease	100	40%
Factors influencing health care	56	23%
Other lower respiratory diseases	36	15%
Diabetes	33	13%
Diseases of urinary system	29	12%
2 Months Prior to Avoidable Hospitalization		
Heart disease	63	26%
Factors influencing health care	38	15%
Diabetes	36	15%
Symptoms, signs and ill-defined conditions	22	9%
Hypertension	20	8%
3 to 6 Months Prior to Avoidable Hospitalization		
Heart disease	91	37%
Factors influencing health care	82	33%
Diabetes	62	25%
Hypertension	47	19%
Other lower respiratory diseases	35	14%
7 to 12 Months Prior to Avoidable Hospitalization		
Heart disease	81	33%
Factors influencing health care	71	29%
Diabetes	53	21%
Hypertension	39	16%
Other lower respiratory diseases	36	13%

Table A-1 (continued)

Pediatric Gastroenteritis
Total Patients = 173

Disease Category	Number of Patients With Outpatient Care	Percent of Patients With Outpatient Care
1 Month Prior to Avoidable Hospitalization		
Symptoms, signs, and ill-defined conditions	41	24%
Factors influencing health care	35	20%
Respiratory infections	31	18%
Noninfectious gastroenteritis	30	17%
Ear conditions	26	15%
2 Months Prior to Avoidable Hospitalization		
Factors influencing health care	28	16%
Respiratory infections	22	13%
Ear conditions	20	12%
Other nutritional, endocrine, and metabolic disorders	13	8%
Symptoms, signs, and ill-defined conditions	11	6%
3 to 6 Months Prior to Avoidable Hospitalization		
Factors influencing health care	43	25%
Respiratory infections	33	19%
Ear conditions	25	14%
Symptoms, signs, and ill-defined conditions	25	14%
Immunizations and screening for infectious diseases	16	9%
7 to 12 Months Prior to Avoidable Hospitalization		
Respiratory infections	24	14%
Factors influencing health care	23	13%
Symptoms, signs, and ill-defined conditions	12	7%
Immunizations and screening for infectious diseases	12	7%
Other gastrointestinal disorders	10	6%

Table A-1 (continued)

Diabetes With Ketoacidosis or Coma (Weissman)
Total Patients = 135

Disease Category	Number of Patients With Outpatient Care	Percent of Patients With Outpatient Care
1 Month Prior to Avoidable Hospitalization		
Diabetes	41	30%
Factors influencing health care	18	13%
Symptoms, signs, and ill-defined conditions	10	7%
Respiratory infections	9	7%
Eye disorders	6	4%
2 Months Prior to Avoidable Hospitalization		
Diabetes	23	17%
Factors influencing health care	10	7%
Symptoms, signs, and ill-defined conditions	7	5%
Hypertension	7	5%
Diseases of urinary system	7	5%
3 to 6 Months Prior to Avoidable Hospitalization		
Diabetes	48	36%
Factors influencing health care	21	16%
Eye disorders	15	11%
Heart disease	12	9%
Symptoms, signs, and ill-defined conditions	11	8%
7 to 12 Months Prior to Avoidable Hospitalization		
Diabetes	40	30%
Factors influencing health care	28	21%
Eye disorders	10	7%
Respiratory infections	9	7%
Symptoms, signs, and ill-defined conditions	9	7%

Table A-2

Parameter Estimates: Logistic Regression Models

	Full Sample		Disabled		Aged		All Children	
	Estimate	Std Error	Estimate	Std Error	Estimate	Std Error	Estimate	Std Error
Intercept	-5.16	0.040	-4.41	0.056	-7.20	0.621	-4.60	0.060
Demographic Characteristics								
Age = 65 or older	1.85	0.074	N/A		N/A		N/A	
Age = 40 to 64	1.04	0.042	0.74	0.052	N/A		N/A	
Ethnic/racial minority	0.33	0.032	0.35	0.046	0.32	0.122	0.43	0.057
Male	0.18	0.030	0.08	0.040	0.23	0.119	0.04	0.053
Age = 1 to 17	0.11	0.045	0.50	0.071	N/A		N/A	
Language other than English	-0.54	0.052	-0.46	0.083	-0.41	0.126	-0.58	0.082
Infant (age under 1)	0.07	0.384	0.64	1.075	N/A		N/A	
Live in rural area	-0.02	0.065	0.05	0.086	0.01	0.488	-0.05	0.114
Age in years	N/A		N/A		0.05	0.008	-0.09	0.005
Chronic Diseases								
Cystic Fibrosis	1.95	0.226	1.55	0.245	N/A		1.40	0.312
Obesity	1.59	0.059	1.48	0.064	2.20	0.30	1.27	0.336
Mental Retardation	1.21	0.115	0.96	0.119	1.85	0.73	0.63	0.256
Alcohol/Drug Abuse	0.85	0.040	0.91	0.049	1.39	0.30	0.55	0.163
Hereditary/Degenerative CNS	0.83	0.060	0.76	0.065	0.53	0.23	0.32	0.197
Coagulation Defects	0.70	0.102	0.78	0.109	-0.48	0.43	-0.03	0.521
Blind/Low Vision	0.60	0.124	0.51	0.141	0.44	0.38	0.29	0.306
Sickle Cell Anemia	0.62	0.312	0.23	0.334	N/A		0.89	0.449
Immune Disorders (ex. AIDS/HIV)	0.46	0.176	0.45	0.191	N/A		0.27	0.425
AIDS/HIV	0.33	0.137	0.21	0.150	1.27	1.274	-1.41	0.855
Epilepsy	0.31	0.051	0.10	0.055	-0.22	0.322	0.61	0.112
Arthritis	-0.14	0.050	-0.13	0.056	-0.21	0.147	0.25	0.568
Mental Health	0.00	0.041	-0.13	0.045	0.44	0.162	-0.31	0.176
Health Care Service Utilization								
Physician visits per month	0.24	0.010	0.18	0.012	0.25	0.049	0.63	0.033
Hospital outpatient visits per month	0.22	0.022	0.18	0.025	0.15	0.079	0.38	0.070
Home health visits per month	0.16	0.028	0.16	0.029	0.24	0.102	-0.21	0.329
Prescriptions per month	0.07	0.004	0.06	0.005	0.09	0.017	0.13	0.026
Other services per month	0.09	0.007	0.06	0.009	-0.11	0.049	0.08	0.012
Laboratory/radiology per month	0.01	0.044	0.03	0.046	0.46	0.166	0.79	0.249
Nursing home days per month	0.00	0.005	0.01	0.005	-0.02	0.012	-0.16	0.196
Likelihood Ratio Chi-square	10,965.90		4,046.98		324.18		2,531.86	
Re-scaled R^2	0.21		0.18		0.15		0.14	
Sample Characteristics								
Total Sample Size	295,796		59,832		5,029		183,113	
Persons with 1+ AH	5,698		3,408		364		1,632	

N/A = Variable not appropriate for specific analysis