Is home health care a substitute for hospital care?

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Abstract

A previous study used aggregate (region-level) data to investigate whether home health care serves as a substitute for inpatient hospital care, and concluded that "there is no evidence that services provided at home replace hospital services." However, that study was based on a cross-section of regions observed at a single point of time, and did not control for unobserved regional heterogeneity.

In this paper, I use state-level employment data to reexamine whether home health care serves as a substitute for inpatient hospital care. My analysis is based on longitudinal (panel) data—observations on states in two time periods—which enable me to reduce or eliminate biases that arise from use of cross-sectional data.

I find that states that had higher home health care employment growth during the period 1998-2008 tended to have lower hospital employment growth, controlling for changes in population. Moreover, states that had higher home health care payroll growth tended to have lower hospital payroll growth. The estimates indicate that the reduction in hospital payroll associated with a $1000 increase in home health payroll is not less than $1542, and may be as high as $2315. I do not find a significant relationship between growth in utilization of home health care and growth in utilization of nursing and residential care facilities.

An important reason why home health care may serve as a substitute for hospital care is that the availability of home health care may allow patients to be discharged from the hospital earlier. I use hospital discharge data from the Healthcare Cost and Utilization Project to test the hypothesis that use of home health care reduces the length of hospital stays. I find that Major Diagnostic Categories with larger increases in the fraction of patients discharged to home health care tended to have larger declines in mean length of stay (LOS). Between 1998 and 2008, mean LOS declined by 4.1%, from 4.78 days to 4.59. The estimates indicate that this was entirely due to the increase in the fraction of hospital patients discharged to home health care, from 6.4% in 1998 to 9.9% in 2008. The estimated reduction in 2008 hospital costs resulting from the rise in the fraction of hospital patients discharged to home health care is 36% larger than the increase in the payroll of the home health care industry.

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A number of previous studies have sought to investigate whether home health care serves as a substitute for inpatient hospital care. Two types of data have been used to study this issue: patient-level data and aggregate (regional) data.

Most of these studies were based on patient-level data. At least one patient-level study found no support for the substitution hypothesis: Payne et al (2002) found that "controlling for patients' need for services, post-acute home care utilization was not associated with lower utilization rates or lower total Medicaid expenditures." However several patient-level studies have found that home health care serves as a substitute for inpatient hospital care. Stessman et al (1996) found that a home health "program provided a cost effective substitute for care in a geriatric or general hospital for Jerusalem's elderly," and that it provided a cost/benefit ratio of 5.7/1. Landi et al (1999) found that "the implementation of an integrated home care program…[had] a significant impact on hospitalization and is cost-effective." Xu et al (2009) found that "greater volume of [Medicaid Home- and Community-Based Services] services was associated with lower risk of hospitalization." Based on a systematic review and meta-analysis of individual patient data, Shepperd et al (2009) concluded that "for selected patients, avoiding admission through provision of hospital care at home yielded similar outcomes to inpatient care, at a similar or lower cost."

One study used aggregate (regional) data. Welch et al (1996) used 1993 data from Medicare's National Claims History File to examine whether metropolitan statistical areas (MSAs) with higher age- and sex-adjusted rates of home health care use had lower hospital admission rates or shorter lengths of stay. They found that MSAs "with high rates of home health care visits also have high rates of hospital use, in terms of both length of stay and rate of admission," and concluded that "there is no evidence that services provided at home replace hospital services."

Although Welch et al adjusted for age and sex, they did not adjust for other, difficult-to-measure, factors (in particular, health status or severity of illness) that are likely to influence both hospital use and home health use. It was not possible to adjust for these factors using their methodology, which was based on cross-sectional data—data on MSAs at a single point of time. Therefore, their estimates of the relationship between hospital use and home health use are likely to be biased: they were unlikely to find evidence of substitution even if substitution actually occurs.

In this paper, I will reexamine whether home health care serves as a substitute for inpatient hospital care. Like Welch et al, I will use aggregate data on U.S. regions. However, my analysis will be based on longitudinal (panel) data—observations of regions in more than one time period—rather than data from a single time period. As Hsiao (2003, pp. 6-7) and others have shown, panel data enable us to reduce or eliminate biases that arise from use of cross-sectional data.

In Section I, I postulate a simple model of the relationship between hospital use, home health care use, and health status. I explain why, due to the difficulty of measuring health status, estimates of the relationship between hospital use and home health use based on cross-sectional data are likely to be biased, but that the bias can be reduced or eliminated by using longitudinal data. In Section II, I describe the data I will use to estimate the model developed in Section I. Estimates of the model are presented in Section III.

An important reason why home health care may serve as a substitute for hospital care is that the availability of home health care may allow patients to be discharged from the hospital earlier. In Section IV, I use hospital discharge data from the Healthcare Cost and Utilization Project to test the hypothesis that use of home health care reduces the length of hospital stays. A summary and conclusions are provided in Section V.

I. A simple model of the relationship between hospital use, home health care use, and health status

Suppose that utilization of hospital care depends inversely on both utilization of home health care and on underlying health status. This implies that the coefficients β_1 and β_2 in the following equation are both negative:

$$\text{hospital\_use} = \beta_1 \text{ home\_health\_use} + \beta_2 \text{ health\_status} \qquad (1)$$

Utilization of home health care is also likely to be inversely related to underlying health status. People in worse health (1) tend to use more home health care and (2) tend to use more hospital care, conditional on the amount of home health care they use.

Measuring health status is difficult. Suppose that we don't control for health status when we analyze the relationship between hospital use and home health use, i.e. we estimate the simple regression of hospital_use on home_health_use:

$$hospital\_use = b_1\ home\_health\_use \quad (2)$$

The regression coefficient from this equation is biased:[1]

$$E(b_1) = \beta_1 + \beta_2\ \gamma \quad (3)$$

where γ is the slope of the (reverse) regression of health_status on home_health_use. Since $\beta_2 < 0$ and $\gamma < 0$, the estimate of b_1 will be biased upward. Therefore, even if greater home health use truly reduces hospital use, conditional on health status ($\beta_1 < 0$), the simple correlation between hospital use and home health use might be zero, or even positive (as Welch et al (1996) found).

Under certain conditions, the bias can be reduced or even eliminated by using longitudinal data rather than cross-sectional data. Suppose we have data on hospital use and home health use in different regions at two or more points in time. In this case, it makes sense to modify eq. (1) as follows:

$$hospital\_use_{rt} = \beta_1\ home\_health\_use_{rt} + \beta_2\ health\_status_{rt} + \pi_t \quad (4)$$

where $hospital\_use_{rt}$ = hospital use in region r during period t, etc.

The parameter π_t allows for a general shift or trend in hospital use. Suppose that health_status is still unobserved, but that health status remains constant within each region over time:

$$health\_status_{rt} = health\_status_r,\ \forall t. \quad (5)$$

Substituting (5) into (4),

$$hospital\_use_{rt} = \beta_1\ home\_health\_use_{rt} + \beta_2\ health\_status_r + \pi_t \quad (6)$$

Eq. (6) may be rewritten as follows:

$$hospital\_use_{rt} = \beta_1\ home\_health\_use_{rt} + \alpha_r + \pi_t \quad (7)$$

where $\alpha_r = \beta_2\ health\_status_r$. If health status remains constant within each region over time, we can control for the effect of unobserved health status by including a set of region fixed effects (α_r's) in the hospital_use equation. If there are just two time periods (indexed by 0 and 1), we

[1] If health status is controlled for imperfectly, rather than not at all, the estimated relationship between hospital use and home health use would still be biased, but the bias would be smaller.

can obtain a simpler estimating equation (and eliminate the region fixed effects) by calculating the first difference of eq. (7):

$$\Delta \text{hospital\_use}_r = \delta + \beta_1 \Delta \text{home\_health\_use}_r \quad (8)$$

where, for example, $\Delta \text{hospital\_use}_r = (\text{hospital\_use}_{r1} - \text{hospital\_use}_{r0})$, and $\delta = (\pi_1 - \pi_0)$. Under our assumptions, although estimates of eq. (2)—a relationship between the *levels* of hospital and home health use—are biased due to unobserved heterogeneity of health status, estimates of eq. (8)—a relationship between the *changes* in hospital and home health use—will be unbiased.

I will therefore analyze the relationship across regions (states) between (indicators of) *changes* in hospital and home health use. In particular, I will estimate models of the form

$$\Delta \ln(\text{hospital\_emp}_s) = \beta_1 \Delta \ln(\text{home\_health\_emp}_s) + \gamma Z_s \quad (9)$$

$$\Delta \ln(\text{hospital\_pay}_s) = \beta_1 \Delta \ln(\text{home\_health\_pay}_s) + \gamma Z_s \quad (10)$$

where

$$\Delta \ln(\text{hospital\_emp}_s) = \ln(\text{hospital\_emp}_{s,2008}) - \ln(\text{hospital\_emp}_{s,1998})$$

$$\Delta \ln(\text{hospital\_pay}_s) = \ln(\text{hospital\_pay}_{s,2008}) - \ln(\text{hospital\_pay}_{s,1998})$$

hospital_emp_{st} = number of hospital employees in state s in year t (t = 1998, 2008)

hospital_pay_{st} = annual payroll of hospitals in state s in year t.

Thus $\Delta \ln(\text{hospital\_emp}_s)$ is the growth rate (per decade) of hospital employment in state s between 1998 and 2008, and $\Delta \ln(\text{home\_health\_emp}_s)$ is the growth rate of home health employment.[2] The models will include additional variables, represented by the vector Z_s in eqs. (9) and (10). All models will include the growth rate of the total state population; some will also include the growth rates of the populations of different age groups. I include the latter since utilization of both hospital care and home health care tends to rise sharply with age.

I will also examine the relationship across states between the growth of home health employment and the growth of employment in nursing and residential care facilities.

[2] 2008 is the latest year for which data are available. 1998 is the first year in which the North American Industrial Classification System (discussed below) was used.

II. Data

Data on employment and payroll of hospitals, home health care establishments, and nursing and residential care facilities were obtained from the Census Bureau's County Business Patterns (CBP; http://www.census.gov/econ/cbp/index.html). CBP provides annual detailed geographic, industry, and other information for U.S. business establishments. It covers all U.S. and Puerto Rico private business establishments with paid employees. Data consist of number of establishments, employment during the week of March 12, first quarter payroll, and annual payroll. No data are provided that would disclose the operations of an individual employer. The data are derived from the Census Bureau's Business Register, which contains the Census Bureau's most complete, current, and consistent data for U.S. business establishments. The BR is updated continuously and incorporates data from Census Bureau economic censuses and current business surveys, quarterly and annual Federal income and payroll tax records, and other Departmental and Federal statistics and administrative records programs.

CBP data are presented by geographic area, 6-digit North American Industrial Classification System (NAICS) industry, legal form of organization (U.S. only), and employment size class. The three industries we will consider are Home Health Care Services (NAICS 621610), Hospitals (NAICS 622), and Nursing and Residential Care Facilities (NAICS 623).

According to the NAICS definition, the Home Health Care Services industry "comprises establishments primarily engaged in providing skilled nursing services in the home, along with a range of the following: personal care services; homemaker and companion services; physical therapy; medical social services; medications; medical equipment and supplies; counseling; 24-hour home care; occupation and vocational therapy; dietary and nutritional services; speech therapy; audiology; and high-tech care, such as intravenous therapy." Data from the Medical Expenditure Panel Survey (MEPS) and BLS data on occupational employment suggest that home health care employees devote more time to helping patients with daily activities than they do to providing medical treatments. Data from the 2008 MEPS Home Health Visits file indicate the fractions of home health visits in which four different services were provided:

Person was helped with daily activities	66%
Person received medical treatment	51%
Person received companionship services	40%
Person was taught use of medical equipment	24%

As shown in Table 1, in 2008 more than half of home health care industry employees were either "home health aides" or "personal and home care aides."[3] These two occupations are projected to account for over 58% of home health care industry employment by 2018.

National data on employment and payroll in Home Health Care Services, Hospitals, and Nursing and Residential Care Facilities, in 1998 and 2008, are shown in Table 2.[4] The Census estimate of 2008 employment in Home Health Care Services (1035 thousand) is 8 percent higher than the BLS estimate shown in Table 1 (958 thousand). Employment in hospitals in 2008 was 5.4 times as great as employment in Home Health Care Services. Also, annual payroll per employee was about twice as high in hospitals ($49,873) in 2008 as it was in Home Health Care Services ($25,252), so the total payroll of hospitals was 11 times as high as the total payroll of Home Health Care Services.

Figure 1a shows the regional pattern of home health employment growth from 1998 to 2008, controlling for total employment growth, population growth and age structure. The map shows the residuals from the following regression:

$$\Delta\ln(\text{home\_health\_emp}_s) = \rho_0 + \rho_1 \Delta\ln(\text{total\_emp}_s) + \rho_2 \Delta\ln(\text{total\_pop}_s)$$
$$+ \rho_3 \Delta\ln(\text{pop\_65\_69}_s) + \rho_4 \Delta\ln(\text{pop\_70\_74}_s) + \rho_5 \Delta\ln(\text{pop\_75\_79}_s)$$
$$+ \rho_6 \Delta\ln(\text{pop\_80\_84}_s) + \rho_7 \Delta\ln(\text{pop\_85\_over}_s) \qquad (11)$$

More darkly colored states had more rapid growth in home health employment, given their growth in total employment and population and their change in age structure. There does not appear to be a pronounced regional pattern in home health employment growth. Figure 1b shows

[3] Home health aides "provide routine, personal healthcare, such as bathing, dressing, or grooming, to elderly, convalescent, or disabled persons in the home of patients or in a residential care facility." Personal and home care aides "assist elderly or disabled adults with daily living activities at the person's home or in a daytime non-residential facility. Duties performed at a place of residence may include keeping house (making beds, doing laundry, washing dishes) and preparing meals. May provide meals and supervised activities at non-residential care facilities. May advise families, the elderly, and disabled on such things as nutrition, cleanliness, and household utilities."

[4] The complete dataset is provided in Appendix Table 1.

the regional pattern of hospital employment growth from 1998 to 2008, controlling for total employment growth, population growth and age structure.

III. Estimates of relationships across states between utilization of home health care and utilization of (1) hospitals and (2) nursing and other residential care facilities

Estimates of relationships across states between utilization of home health care and utilization of (1) hospitals, and (2) nursing and other residential care facilities (henceforth referred to as nursing facilities), are shown in Table 3. Each regression coefficient reported in the table comes from a different model. The first four models examine relationships between *levels* of the variables in 2008. These four models also include the following other variables, whose coefficients are not shown in the table: the logarithms of total population, population age 65-69, population age 70-74, population age 75-79, population age 80-84, and population age 85+.

Model 1 indicates that states with higher home health care employment in 2008 tended to have higher hospital employment, controlling for the population variables. This is consistent with Welch et al's finding that MSAs "with high rates of home health care visits also have high rates of hospital use." Model 2 indicates that states with higher home health care employment in 2008 also tended to have higher nursing facility employment, controlling for the population variables. Models 3 and 4 indicate that the correlations between home health care *payrolls* and the payrolls of hospitals and nursing facilities are even larger than the correlations between home health care *employment* and employment of hospitals and nursing facilities.

However, as argued above, these estimates are likely to be seriously upward biased due to unobserved heterogeneity of states with respect to underlying health status and other factors. Under reasonable assumptions, this bias can be eliminated by estimating relationships between long-run *changes* in the variables. Models 5-8 examine relationships between changes of the variables between 1998 and 2008.

Model 5 indicates that states with higher home health care employment *growth* tended to have *lower* hospital employment growth, controlling for changes in the population variables (p-value = .008). Model 7 indicates that there is also a strong inverse correlation between home health and hospital payroll growth (p-value = .019). Models 6 and 8 indicate that the relationship between home health employment growth and nursing facility employment growth, and the

relationship between home health payroll growth and nursing facility payroll growth, are not statistically significant.

The relationship across states between home health care employment growth and hospital employment growth, controlling for changes in the population variables, is depicted in Figure 2a. The plotted values are the residuals of the regressions of both variables on the population change variables. The relationship across states between home health care payroll growth and hospital payroll growth, controlling for changes in the population variables, is depicted in Figure 2b.

The estimate from Model 5 indicates that the elasticity of hospital employment with respect to home health employment is -.145. As shown in Table 2, in 2008, there were 5.4 times as many hospital employees as there were home health employees. This implies that, evaluated at the sample mean, a 1000 employee increase in home health employment is associated with a 781 employee reduction in hospital employment (1000 * -.145 * (5,585,159 / 1,035,119) = -781). Average 2008 hospital payroll per employee was almost twice as great as average 2008 home health payroll per employee, so the estimate from Model 5 implies that, evaluated at the sample mean, a $1000 increase in home health payroll is associated with a $1542 reduction in hospital payroll (-781 * 1.98 = 1542). Model 7 implies that a $1000 increase in home health payroll is associated with an even larger ($2315) reduction in hospital payroll ($1000 * -0.217 * ($278,547,597 / $26,138,743) = -$2315).

IV. Some additional evidence based on hospital discharge data

An important reason why home health care may serve as a substitute for hospital care is that the availability of home health care may allow patients to be discharged from the hospital earlier. In other words, use of home health care may reduce the length of hospital stays.

I hypothesize that the mean length of hospital stays (LOS) of patients discharged to home health care (LOS_HH) is shorter than the mean LOS of patients not discharged to home health care (LOS_OTH), *ceteris paribus*: LOS_HH < LOS_OTH.

Data from the Healthcare Cost and Utilization Project (HCUP) compiled by the Agency for Healthcare Research and Quality (AHRQ) can be used to test the hypothesis that use of home health care reduces the length of hospital stays. One component of HCUP, The Nationwide Inpatient Sample (NIS), collects inpatient data from a national sample of over 1,000 hospitals.

AHRQ publishes statistics, based on the NIS data, on the number of hospital discharges, mean LOS, and the fraction of patients discharged to home health care, by Major Diagnostic Category[5] and year. Data for the years 1998 and 2008 are shown in Table 4.

By definition, mean LOS of all patients in a Major Diagnostic Category (MDC) is a weighted average of LOS_HH and LOS_OTH:

$$LOS = (HH\%)\ LOS\_HH + (1 - HH\%)\ LOS\_OTH$$

where HH% = the fraction of patients discharged to home health care. Hence

$$LOS = LOS\_OTH + (LOS\_HH - LOS\_OTH)\ HH\%$$

Suppose that the difference (LOS_HH – LOS_OTH) is a constant, but that LOS_OTH, HH%, and LOS vary over time and across MDCs:

$$LOS_{mt} = LOS\_OTH_{mt} + \gamma\ HH\%_{mt} \qquad (12)$$

where γ = (LOS_HH – LOS_OTH).

Moreover, suppose that LOS_OTH_{mt} is a linear function of MDC fixed effects and year fixed effects:

$$LOS\_OTH_{mt} = \alpha_m + \delta_t + \varepsilon_{mt} \qquad (13)$$

Eq. (13) allows there to be permanent differences across MDCs in the mean LOS of patients not discharged to home health care, and changes over time in the mean LOS of patients not discharged to home health care that are common to all MDCs.

Substituting (13) into (12),

$$LOS_{mt} = \gamma\ HH\%_{mt} + \alpha_m + \delta_t + \varepsilon_{mt} \qquad (14)$$

Eq. (14) implies that the 1998-2008 change in LOS_{mt} may be written as the following simple regression of ΔLOS_m on $\Delta HH\%_m$:

[5] Major Diagnosis Categories (MDCs) are broad groups of DRGs (Diagnosis Related Groups) that relate to an organ or a system (digestive system, for example) and not to an etiology. Each hospital stay has one DRG and one MDC assigned to it. Discharge status indicates the disposition of the patient at discharge from the hospital, e.g., routine (home), to another short term hospital, to a nursing home, to home health care, or against medical advice.

$$\Delta LOS_m = \gamma\, \Delta HH\%_m + \delta' + \varepsilon'_m \qquad (15)$$

where $\Delta LOS_m \equiv (LOS_{m,2008} - LOS_{m,1998})$, $\Delta HH\%_m \equiv (HH\%_{m,2008} - HH\%_{m,1998})$, $\delta' \equiv (\delta_{2008} - \delta_{1998})$, and $\varepsilon'_m \equiv (\varepsilon_{m,2008} - \varepsilon_{m,1998})$.

If the mean LOS of patients discharged to home health care is shorter than the mean LOS of patients not discharged to home health care ($\gamma < 0$), there should be a negative correlation across MDCs between the 1998-2008 change in the fraction of patients discharged to home health care and the 1998-2008 change in the mean LOS of all patients.

Eq. (15) is predicated on the assumption that the *absolute* difference between LOS_HH and LOS_OTH is constant (invariant across MDCs and over time). It may be more reasonable to assume that the *percentage* difference between LOS_HH and LOS_OTH is constant. In this case, the relationship across MDCs between changes in LOS and HH% would be

$$\Delta \ln(LOS_m) = \gamma\, \Delta HH\%_m + \delta' + \varepsilon'_m \qquad (16)$$

where $\Delta \ln(LOS_m) \equiv (\ln(LOS_{m,2008}) - \ln(LOS_{m,1998}))$.

I performed weighted least-squares estimation of eq. (16), where the weight was the mean of the number of discharges in 1998 and 2008, i.e. $(N_{m,1998} + N_{m,2008})/2$, where N_{mt} = the number of discharges in MDC m in year t. The estimate of γ was negative and significant: $\gamma = -1.16$, t-value=-2.32, p-value=0.0298, N = 25, $R^2 = .1892$). This indicates that *MDCs with larger increases in the fraction of patients discharged to home health care tended to have larger declines in mean LOS*. Figure 3 shows the bubble plot of the 1998-2008 % change in mean LOS against the 1998-2008 change in the fraction of patients discharged to home health care.[6]

As shown in Table 4, between 1998 and 2008, mean LOS of all MDCs combined declined by 4.1%, from 4.78 days to 4.59. The estimates imply that this was entirely due to the increase in the fraction of patients discharged to home health care, from 6.4% in 1998 to 9.9% in 2008 (-1.16 * (9.9% - 6.4%) = -.041).

According to HCUP, the aggregate cost of hospital care in 2008 was $365 billion.[7] This implies that the 1998-2008 increase in the fraction of patients discharged to home health care

[6] The size of the bubble is proportional to the mean of the number of discharges in 1998 and 2008.

[7] Aggregate *charges* were about three times as high: $1155 billion. "Costs" tend to reflect the actual costs of production, while "charges" represent what the hospital billed for the case. Total charges were converted to costs using cost-to-charge ratios based on hospital accounting reports from the Centers for Medicare and Medicaid Services (CMS). In general, costs are less than charges. For each hospital, a hospital-wide cost-to-charge ratio is used because detailed charges are not available across all HCUP States.

reduced 2008 hospital costs by $14.9 billion (= 4.1% * $365 billion). This is 36% larger than the $10.9 billion increase between 1998 and 2008 in the payroll of the home health care industry (see Table 2).

V. Summary and conclusions

A number of previous studies have sought to investigate whether home health care serves as a substitute for inpatient hospital care. Most of these studies were based on patient-level data. One study, based on aggregate (region-level) data, concluded that "there is no evidence that services provided at home replace hospital services." However, that study was based on a cross-section of regions observed at a single point of time, and did not control for unobserved regional heterogeneity.

In this paper, I used state-level employment data to reexamine whether home health care serves as a substitute for inpatient hospital care. My analysis was based on longitudinal (panel) data—observations on states in two time periods—which enabled me to reduce or eliminate biases that arise from use of cross-sectional data.

I found that states that had higher home health care employment growth during the period 1998-2008 tended to have lower hospital employment growth, controlling for changes in population. Moreover, states that had higher home health care payroll growth tended to have lower hospital payroll growth. The estimates indicated that the reduction in hospital payroll associated with a $1000 increase in home health payroll is not less than $1542, and may be as high as $2315. We did not find a significant relationship between growth in utilization of home health care and growth in utilization of nursing and residential care facilities.

An important reason why home health care may serve as a substitute for hospital care is that the availability of home health care may allow patients to be discharged from the hospital earlier. We used hospital discharge data from the Healthcare Cost and Utilization Project to test the hypothesis that use of home health care reduces the length of hospital stays. We found that Major Diagnostic Categories with larger increases in the fraction of patients discharged to home health care tended to have larger declines in mean LOS. Between 1998 and 2008, mean length of stay declined by 4.1%, from 4.78 days to 4.59. The estimates indicate that this was entirely due to the increase in the fraction of hospital patients discharged to home health care, from 6.4%

in 1998 to 9.9% in 2008. The estimated reduction in 2008 hospital costs resulting from the rise in the fraction of hospital patients discharged to home health care is 36% larger than the increase in the payroll of the home health care industry.

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Table 1

Top 10 occupations in Home health care services industry, ranked by 2008 employment

Occupation	2008		Projected 2018		Change, 2008-2018	
	Employment (in thousands)	Percent of Industry	Employment (in thousands)	Percent of Industry	Number (in thousands)	Percent
Total, all occupations	958.0	100.00	1399.4	100.00	441.4	46.1
Home health aides	285.1	29.76	465.2	33.24	180.1	63.2
Personal and home care aides	228.0	23.80	352.0	25.16	124	54.4
Registered nurses	132.4	13.82	176.4	12.61	44	33.3
Licensed practical and licensed vocational nurses	62.1	6.48	82.7	5.91	20.6	33.3
Nursing aides, orderlies, and attendants	39.1	4.09	57.5	4.11	18.4	47.0
Physical therapists	18.0	1.88	26.5	1.89	8.5	47.0
Office clerks, general	14.9	1.55	16.7	1.19	1.9	12.5
Medical and health services managers	14.0	1.46	18.6	1.33	4.6	33.2
Medical and public health social workers	13.8	1.44	20.3	1.45	6.5	47.0
General and operations managers	8.7	0.91	10.4	0.74	1.7	19.9

Source: BLS Occupational Employment Statistics program
http://www.bls.gov/oes/

Table 2

National employment and payroll in selected industries, 1998 and 2008

Industry code	Industry code description	Year	Paid employees for pay period including March 12	Annual payroll ($1,000)	Total establish ments	Annual payroll per employee
6216	Home health care services	1998	901,485	$15,244,865	19,420	$16,911
6216	Home health care services	2008	1,035,119	$26,138,743	24,129	$25,252
622	Hospitals	1998	5,011,337	$160,868,531	6,960	$32,101
622	Hospitals	2008	5,585,159	$278,547,597	7,014	$49,873
623	Nursing & residential care facilities	1998	2,511,150	$44,618,412	59,717	$17,768
623	Nursing & residential care facilities	2008	3,129,206	$78,341,232	76,827	$25,035

Source: County Business Patterns

Table 3

Estimates of relationships across states between utilization of home health care and utilization of hospitals and nursing and other residential care facilities

Model	Dependent variable	Regressor	Parameter Estimate	Standard Error	t Value	Pr > |t|
2008 Levels						
1	log(hospital employment)	log(home health employment)	0.152	0.068	2.23	0.032
2	log(nursing & resid. care fac. employment)	log(home health employment)	0.218	0.077	2.85	0.007
3	log(hospital payroll)	log(home health payroll)	0.256	0.094	2.71	0.010
4	log(nursing & resid. care fac. payroll)	log(home health payroll)	0.341	0.105	3.25	0.003
1998-2008 changes						
5	Δlog(hospital employment)	Δlog(home health employment)	-0.145	0.052	-2.79	0.008
6	Δlog(nursing & resid. care fac. employment)	Δlog(home health employment)	0.056	0.059	0.96	0.346
7	Δlog(hospital payroll)	Δlog(home health payroll)	-0.217	0.088	-2.46	0.019
8	Δlog(nursing & resid. care fac. payroll)	Δlog(home health payroll)	-0.071	0.076	-0.93	0.357

Models 1-4 include the logarithms of total population, population age 65-69, population age 70-74, population age 75-79, population age 80-84, and population age 85+.

Models 5-8 include the 1998-2008 changes in the logarithms of total population, population age 65-69, population age 70-74, population age 75-79, population age 80-84, and population age 85+.

Table 4

1998 and 2008 Hospital Discharge Statistics, by Major Diagnostic Category

Major Diagnostic Category	Total number of discharges		% of patients discharged to home health care		Mean length of stay (days)	
	1998	2008	1998	2008	1998	2008
All Major Diagnostic Categories	34,848,049	39,767,690	6.4%	9.9%	4.8	4.6
1, Diseases & Disorders Of The Nervous System	2,011,125	2,245,256	6.7%	9.9%	5.6	5.0
2, Diseases & Disorders Of The Eye	80,413	51,731	2.6%	5.6%	2.7	3.5
3, Diseases & Disorders Of The Ear, Nose, Mouth & Throat	393,035	429,449	4.6%	7.7%	3.3	3.2
4, Diseases & Disorders Of The Respiratory System	3,559,776	3,939,034	8.2%	12.9%	6.0	5.7
5, Diseases & Disorders Of The Circulatory System	5,900,983	5,918,561	8.2%	11.9%	4.8	4.3
6, Diseases & Disorders Of The Digestive System	2,890,170	3,497,613	6.2%	9.4%	5.2	4.9
7, Diseases & Disorders Of The Hepatobiliary System & Pancreas	932,704	1,136,077	5.5%	8.0%	5.6	5.2
8, Diseases & Disorders Of The Musculoskeletal System & Conn Tissue	2,611,192	3,392,908	9.2%	20.7%	4.7	4.2
9, Diseases & Disorders Of The Skin, Subcutaneous Tissue & Breast	752,236	956,503	10.3%	15.9%	4.6	4.5
10, Endocrine, Nutritional & Metabolic Diseases & Disorders	968,871	1,297,375	8.4%	10.7%	4.5	3.8
11, Diseases & Disorders Of The Kidney & Urinary Tract	1,121,554	1,662,852	7.1%	12.5%	4.9	4.8
12, Diseases & Disorders Of The Male Reproductive System	231,063	222,631	6.4%	7.3%	3.5	2.8
13, Diseases & Disorders Of The Female Reproductive System	932,711	798,632	2.4%	3.2%	3.1	2.6
14, Pregnancy, Childbirth & The Puerperium	4,252,997	4,692,998	2.2%	2.0%	2.4	2.7
15, Newborns & Other Neonates With Condtn Orig In Perinatal Period	3,871,183	4,390,527	3.1%	2.8%	3.3	3.4
16, Diseases & Disorders Of Blood, Blood Forming Organs, Immunolog Disord	339,265	470,877	5.7%	9.4%	5.0	4.7
17, Myeloproliferative Diseases & Disorders, Poorly Differentiated Neoplasm	373,771	345,112	8.8%	14.7%	6.9	7.8
18, Infectious & Parasitic Diseases, Systemic Or Unspecified Sites	689,100	1,123,904	10.3%	15.8%	6.9	7.9
19, Mental Diseases & Disorders	1,273,166	1,377,082	2.1%	1.7%	8.5	8.1
20, Alcohol/Drug Use & Alcohol/Drug Induced Organic Mental Disorders	457,603	440,121	0.9%	1.6%	5.1	4.8
21, Injuries, Poisonings & Toxic Effects Of Drugs	442,083	572,835	5.0%	8.9%	3.5	4.0
22, Burns	33,638	28,215	11.9%	15.1%	9.3	9.5
23, Factors Influencing Hlth Stat & Othr Contacts With Hlth Servcs	533,386	628,867	26.0%	32.8%	11.7	10.0
24, Multiple Significant Trauma	72,772	70,449	5.5%	8.2%	10.0	9.3
25, Human Immunodeficiency Virus Infections	123,250	78,080	7.4%	9.6%	8.9	8.8

Source: http://hcupnet.ahrq.gov/

Figure 1a

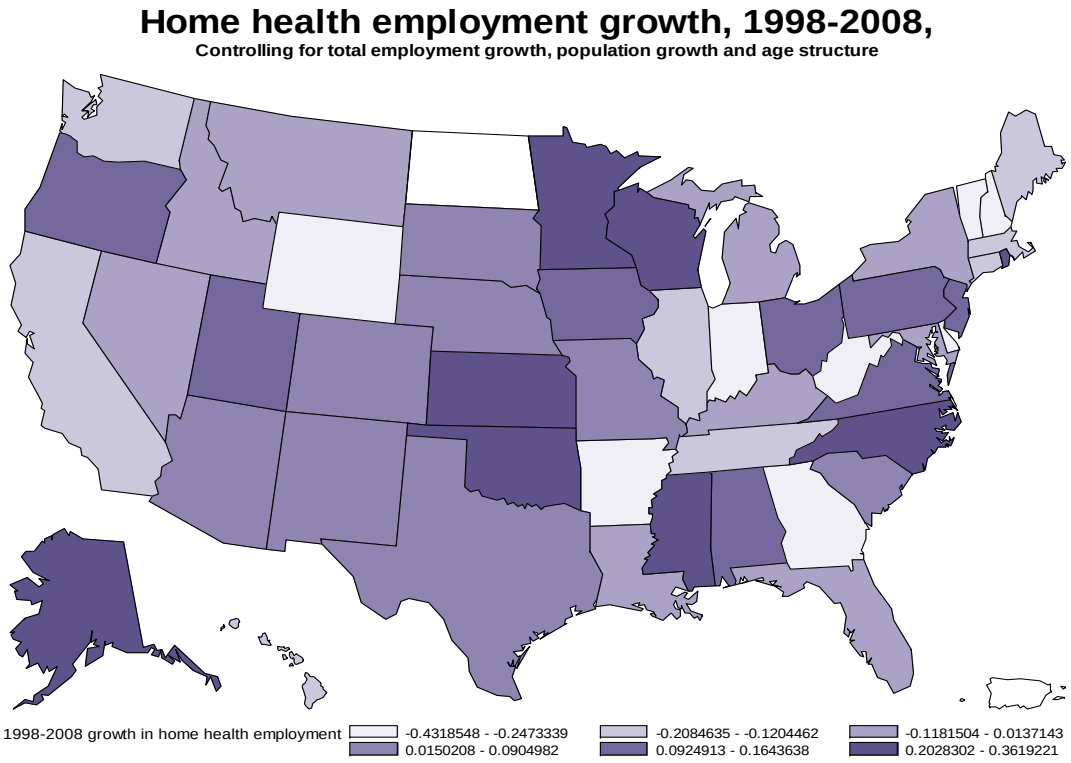


Figure 1b

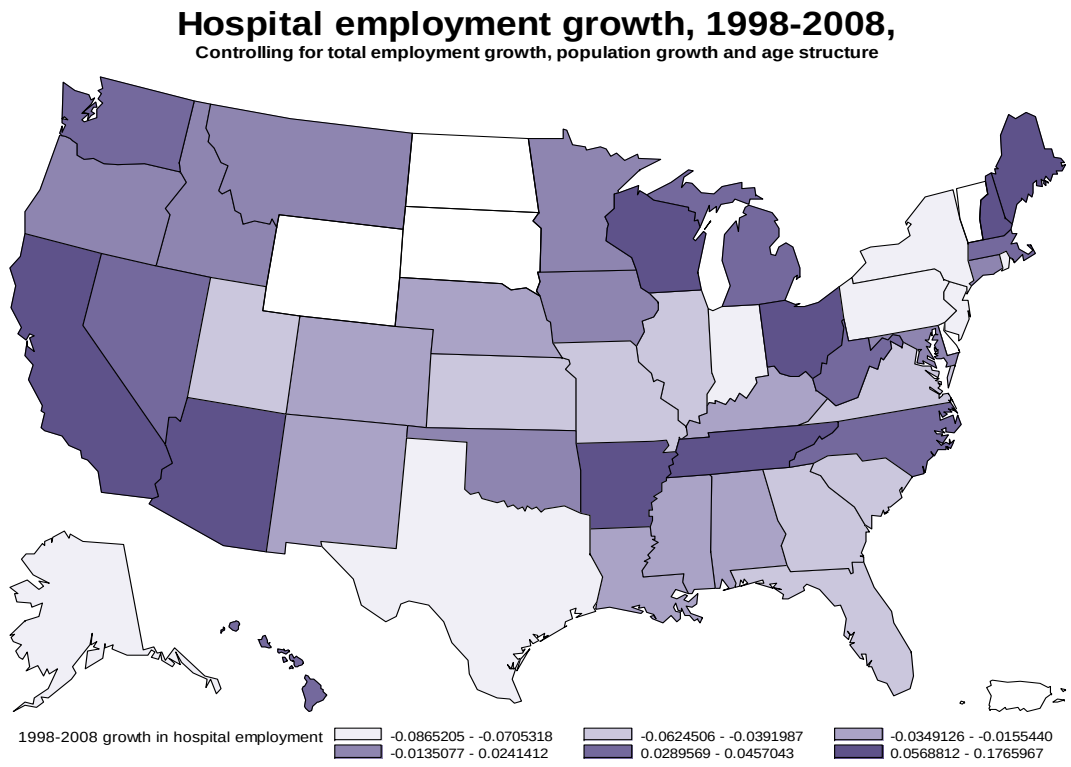
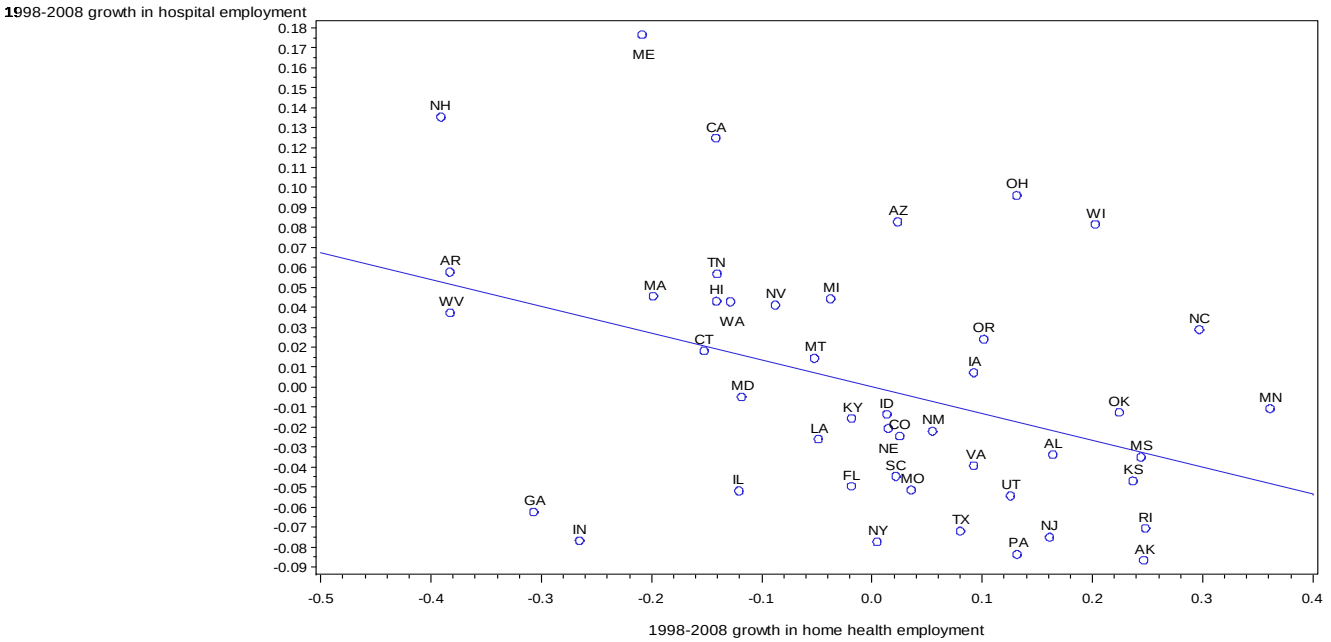


Figure 2a

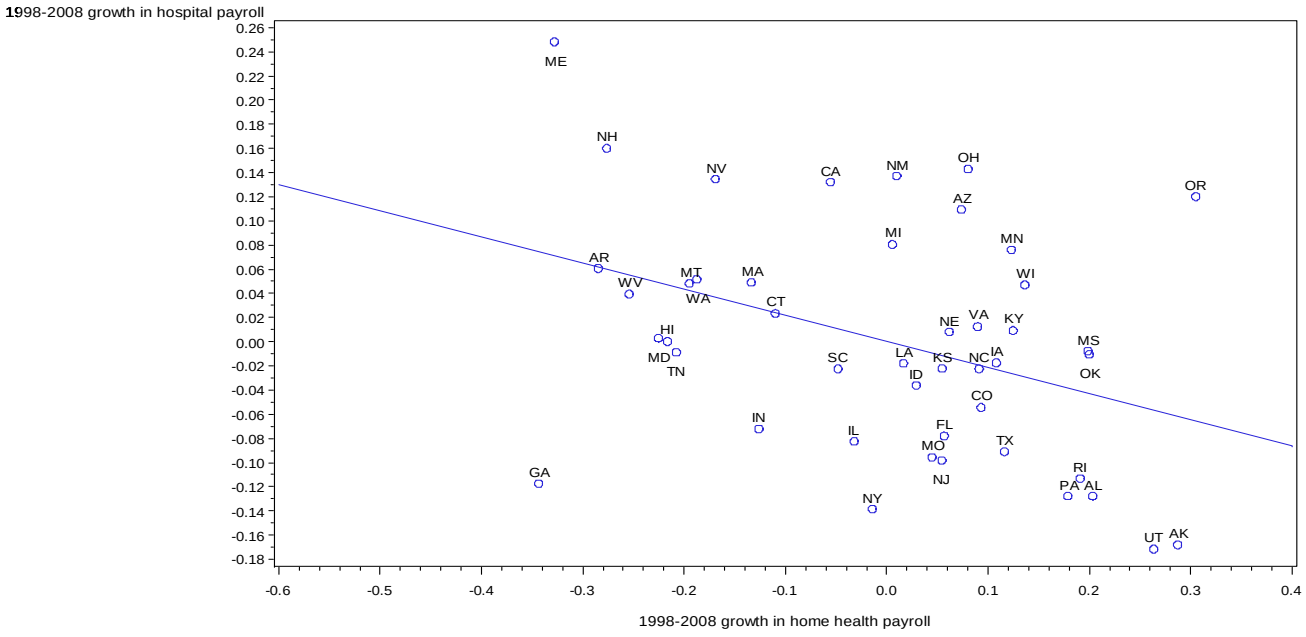
Relationship across states between home health employment growth and hospital employment growth, 1998-2008,
Controlling for total employment growth, population growth and age structure



Regression Equation:
emp_hosp_res = 3.2E-17 - 0.134231*emp_home_res

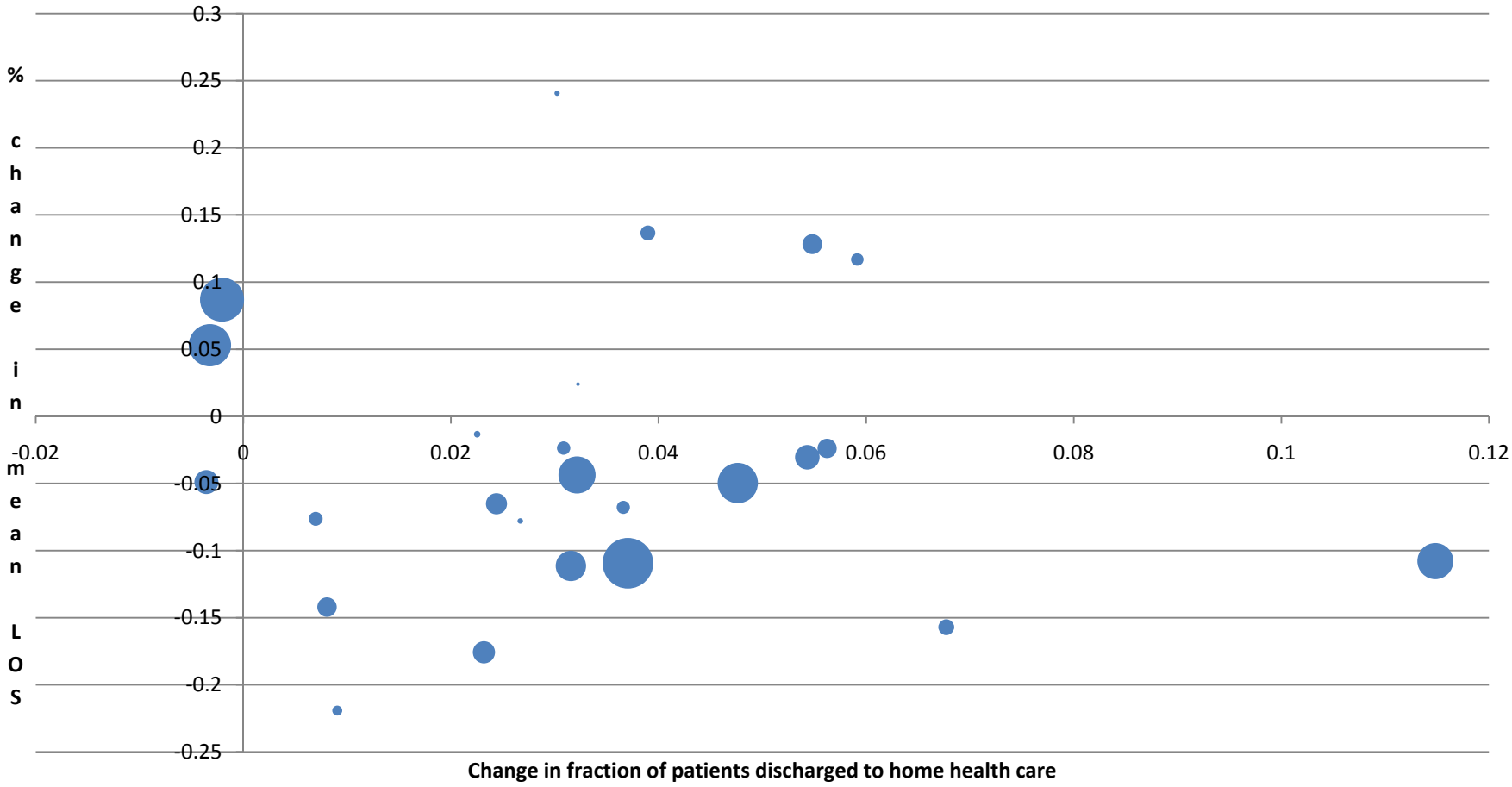
Figure 2b

Relationship across states between home health payroll growth and hospital payroll growth, 1998-2008
controlling for total payroll growth, population growth and age structure



Regression Equation:
ap_hosp_res = 8.15E-17 - 0.216362*ap_home_res

Figure 3
Relationship across Major Diagnostic Categories between 1998-2008 % change in fraction of patients discharged to home health care and 1998-2008 change in mean LOS



Note: Size of bubble is proportional to mean of the number of discharges in 1998 and 2008.

Appendix Table 1
Complete dataset

State	Year	home health employment	hospital employment	nursing and residential care facility emp.	total employment	home health payroll	hospital payroll	nursing and residential care facility payroll	total payroll	total population	age 65-69 population	age 70-74 population	age 75-79 population	age 80-84 population	age 85+ population
Alabama	1998	9162	85599	32708	1604110	181957	2428470	504571	40330597	4358928	168870	148178	117407	75671	64153
Alabama	2008	12334	86831	43222	1714692	377144	3556282	961195	59827325	4559341	192025	152854	121045	90664	85079
Alaska	1998	571	13121	1882	196135	8665	578673	43577	6883920	606830	11819	9094	6138	3296	2311
Alaska	2008	1932	14428	2588	248387	37825	806986	77864	12113049	660693	18906	12152	8703	5672	4844
Arizona	1998	9329	63946	30567	1763508	174409	1910892	553266	49052246	4855816	189751	173810	138427	86530	63098
Arizona	2008	13857	87507	45000	2334061	394815	4582208	1187345	89799018	6385378	249083	195428	165251	129826	122985
Arkansas	1998	5961	51115	24722	944935	83626	1333230	351660	21764625	2601828	105640	93198	75982	52024	44970
Arkansas	2008	4366	60218	28902	1026005	106399	2551586	614223	33809713	2799952	121030	93571	75592	58337	58675
California	1998	56038	421533	193846	12026989	1048773	15489671	3498536	4.06E+08	32633811	999101	899650	747373	478394	395511
California	2008	59956	520383	244605	13742925	1846679	31321997	6562360	6.6E+08	35894018	1191104	935496	767115	608318	612463
Colorado	1998	11120	60677	28510	1757628	173357	1943487	504705	53790978	4060236	119800	103113	82139	53150	45773
Colorado	2008	14619	72839	39228	2121718	361319	3617261	1019306	91175156	4790603	161142	117908	94479	70279	67286
Connecticut	1998	18880	60041	51273	1493964	336637	2264857	1196887	58225763	3322419	121093	116186	100150	71311	60739
Connecticut	2008	16059	68738	63822	1551305	479381	3972627	1954045	82768724	3413247	134670	102110	88379	73737	79111
Delaware	1998	2648	.	7120	354643	46826	0	125723	11831134	756861	29985	26305	20582	12685	9837
Delaware	2008	2546	18674	10449	389510	78625	972341	293759	17566447	855377	36683	27655	23764	17468	16118
District of Columbia	1998	1758	.	.	402070	29791	0	0	17358137	558798	19626	18042	14730	9763	8474
District of Columbia	2008	2205	27245	6592	466050	47372	1686979	192109	30292302	578073	20983	15747	12633	10141	11144
Florida	1998	53959	252206	126113	5756353	1055671	7707757	2294398	1.5E+08	15482800	747721	737960	603793	391426	311174
Florida	2008	58576	286619	165664	7366571	1871679	13980005	4280749	2.67E+08	18049934	846398	689749	618955	511329	521366
Georgia	1998	17816	130714	45931	3198950	354031	3879543	740974	94687270	7752030	232717	195054	157204	101763	84183
Georgia	2008	17028	150368	59449	3633431	499268	6805795	1406134	1.43E+08	9449844	322209	231187	176476	128733	122419
Hawaii	1998	2086	18451	4318	416571	44570	712240	103894	11291978	1203858	43771	42516	33408	20346	16010
Hawaii	2008	2770	20321	6989	518168	70072	1108187	217156	18539010	1254371	49312	40373	37065	31636	31681
Idaho	1998	2642	19125	8881	423615	33920	528170	133845	10595285	1236735	39807	35154	29759	20700	16911
Idaho	2008	3499	24313	13422	537952	75898	1032858	281478	17574245	1487911	56040	41691	33163	25755	25501

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State	Year	home health employment	hospital employment	nursing and residential care facility emp.	total employment	home health payroll	hospital payroll	nursing and residential care facility payroll	total payroll	total population	age 65-69 population	age 70-74 population	age 75-79 population	age 80-84 population	age 85+ population
Illinois	1998	32457	237619	114801	5221782	561691	7681099	1954764	1.76E+08	12128601	409749	380196	312521	215803	182906
Illinois	2008	29851	247766	131740	5464130	886923	12029474	3282569	2.51E+08	12594036	458146	354273	290857	233111	238921
Indiana	1998	15276	124732	65692	2540866	239650	3601441	1123485	71435864	5925751	208235	193717	155734	104330	88445
Indiana	2008	12894	127158	80352	2619140	339632	5511778	1837438	94838015	6221884	240132	183291	151416	120350	118650
Iowa	1998	5702	62646	48604	1213285	90268	1648241	727129	30409574	2878371	110047	106019	91915	66164	64041
Iowa	2008	5659	68423	54918	1317121	148476	2752423	1148780	45228724	2927294	117673	95861	82622	69699	78699
Kansas	1998	7209	54732	35294	1081941	117834	1451441	547507	28747577	2637995	92595	87332	75124	51590	50896
Kansas	2008	8006	57021	39169	1185777	173348	2461800	837988	43984689	2731292	100310	79360	68421	56296	62319
Kentucky	1998	8746	77449	35739	1443015	182913	2071514	554141	36889001	3937164	146398	129642	101934	66189	56486
Kentucky	2008	9736	84381	45352	1570800	350038	3550953	1024797	54120319	4167695	174690	132827	104631	78960	74759
Louisiana	1998	16887	98516	39523	1577220	294022	2814051	499998	40802387	4392894	150719	136035	103957	65514	55733
Louisiana	2008	17284	99351	43679	1655151	456170	4380615	859230	62392576	4301616	163059	125896	101849	77260	72250
Maine	1998	5490	24959	19874	456715	102637	760702	308563	11559136	1247283	50398	46021	36440	24918	22286
Maine	2008	4997	33401	24939	509093	122279	1640624	572020	17684908	1276616	57977	45280	37909	29302	28719
Maryland	1998	9095	90425	50441	1938727	197517	2940372	925101	59817673	5125731	170736	153169	124728	78276	63587
Maryland	2008	9338	101237	72041	2232490	277885	5229714	2157633	99649640	5489131	209669	156132	125157	96723	91884
Massachusetts	1998	32848	156883	97402	2924913	595858	5455537	1995959	1.06E+08	6210076	222758	215592	181518	126942	111894
Massachusetts	2008	25709	181327	107381	3074569	770919	9880775	3175344	1.62E+08	6326768	241166	187759	163347	135729	143097
Michigan	1998	27288	190105	83032	3919567	540721	6157545	1443701	1.29E+08	9724721	335941	317429	254435	168516	136112
Michigan	2008	32250	208176	99525	3636241	907620	9861571	2376191	1.48E+08	9740044	388083	292016	242889	194590	186744
Minnesota	1998	18111	86767	71910	2271671	281292	2617133	1206316	70094975	4755539	154069	142431	121843	88350	83338
Minnesota	2008	27694	101474	98266	2517356	554285	5173146	2036412	1.09E+08	5080922	188268	141946	117859	95592	106854
Mississippi	1998	5165	64422	18010	937023	115522	1709160	261474	21066790	2777449	99010	87406	68826	45229	41371
Mississippi	2008	7176	64659	23710	944747	221383	2763659	538811	29276870	2873630	110810	86855	69094	52604	52235
Missouri	1998	17982	129778	65967	2310122	279666	3858432	1002073	64669474	5466257	208664	188799	155521	104958	96337
Missouri	2008	18349	135388	70445	2472902	443202	6040448	1477600	93709772	5778661	235187	180965	149382	118023	121678

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Montana	1998	2221	17166	8435	277144	24915	469976	125582	5960687	880689	32557	29649	24667	17530	14494
Montana	2008	2480	21997	10997	359812	41702	948099	225944	11077819	937861	41162	30725	25382	19797	20246
Nebraska	1998	2435	39702	22072	720252	41430	1150514	367479	18178238	1682874	60798	56972	47341	34001	33512
Nebraska	2008	2319	43031	27399	805791	65376	2025232	590543	28239392	1737562	64409	52688	45721	37021	41008
Nevada	1998	3385	20995	5613	800861	76846	617050	109805	21847334	1828750	69485	58280	41608	23177	15421
Nevada	2008	4844	29184	10037	1156080	141346	1612042	293495	43761567	2543600	99815	71229	54673	39070	31930
New Hampshire	1998	5411	20963	11930	518526	83651	637139	217507	14863829	1191155	41292	36929	29827	20040	17425
New Hampshire	2008	4500	28013	14358	595384	115891	1350078	398508	24970440	1275536	51095	38095	31743	24565	24480
New Jersey	1998	28176	150806	63841	3368365	509322	5487044	1373431	1.26E+08	8191763	302515	285781	233856	156929	128093
New Jersey	2008	34125	155514	87583	3640654	855411	8473189	2626916	1.85E+08	8477860	331032	254129	216640	173830	175310
New Mexico	1998	4880	28561	10571	540186	74169	863974	167085	13133707	1774519	62210	53133	40739	26447	21559
New Mexico	2008	8444	30872	13382	640894	169918	1718983	308169	22260582	1937226	76525	60816	49748	37113	35849
New York	1998	132685	415858	192781	6993814	2286171	16288638	4697219	2.75E+08	18534720	668123	616205	496742	335685	295076
New York	2008	145799	418115	237370	7617164	3693843	24246437	7446732	4.41E+08	19018530	746953	585140	487896	389729	397954
North	1998	27326	138859	76867	3223178	448132	4331861	1214646	86780877	7720501	283140	249447	196394	124274	100931
North	2008	43930	164281	107577	3585123	843161	7894395	2337376	1.32E+08	9003946	352401	265799	212041	160757	148054
North Dakota	1998	722	.	11838	249476	11016	0	158609	5533810	643476	23639	22904	18967	14533	14251
North Dakota	2008	.	18290	14288	304906	0	780488	298538	10054513	623857	23475	20108	17915	15006	17772
Ohio	1998	36871	228633	138893	4806046	631102	6962477	2474680	1.4E+08	11187736	413671	395149	318061	210176	169640
Ohio	2008	46106	261002	161991	4728416	1073781	12401282	3821919	1.82E+08	11192891	451852	355342	296170	238824	228649
Oklahoma	1998	13533	62411	35129	1167709	204840	1675205	452215	28667008	3371865	129476	113399	92331	61107	56485
Oklahoma	2008	16362	67547	38040	1335622	383592	2985908	737161	47993796	3567002	144793	113914	92145	69961	69824
Oregon	1998	3838	47251	29776	1310750	65063	1544135	488766	37722920	3307772	114524	108018	94454	64099	54548
Oregon	2008	4714	57944	41973	1482968	157839	3191490	921274	56824167	3676406	150590	111434	91201	74544	76229
Pennsylvania	1998	33552	280357	155519	4906190	608310	8996155	2894021	1.46E+08	12156093	502013	503288	414305	282907	224894
Pennsylvania	2008	37100	277131	197031	5231026	1060036	12991236	5192850	2.16E+08	12137927	511478	410127	367015	311709	310242

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State	Year	home health employment	hospital employment	nursing and residential care facility emp.	total employment	home health payroll	hospital payroll	nursing and residential care facility payroll	total payroll	total population	age 65-69 population	age 70-74 population	age 75-79 population	age 80-84 population	age 85+ population
Rhode Island	1998	4523	23664	15893	402485	75477	802488	291464	11115638	1022799	37739	39416	33251	23221	19962
Rhode Island	2008	4919	24820	19831	433562	122356	1240654	501883	17468919	1023560	39280	30699	27526	24140	26001
South Carolina	1998	6216	69441	27671	1526106	122725	2051509	441517	38559169	3875727	146284	124109	97664	59555	46461
South Carolina	2008	9602	71859	36479	1654414	241731	3386645	847547	55089431	4374944	186718	139888	110358	82727	76604
South Dakota	1998	639	.	11886	289422	6895	0	172972	6403476	741946	27579	26119	22517	15748	15487
South Dakota	2008	699	24427	13567	337816	10868	1081981	279346	10608240	783548	31112	24569	21817	17957	20645
Tennessee	1998	15537	114327	47078	2299348	349374	3489317	770784	62441176	5497062	203877	176578	141844	92332	78817
Tennessee	2008	16242	135688	60016	2492746	507731	6077319	1391481	90853613	6071750	255188	193656	151673	112947	106162
Texas	1998	134103	321878	129858	7570820	1626886	9643939	2043709	2.29E+08	19940976	604534	523657	405630	262351	227557
Texas	2008	172331	359206	161355	9231955	3230480	17543754	3680769	3.95E+08	23766864	753795	578658	462278	344620	332872
Utah	1998	3616	31159	13812	866146	60406	916169	222294	22199933	2144929	53474	46936	38352	25813	20357
Utah	2008	5890	37849	20617	1114716	174365	1625120	442952	39438430	2683722	74236	57352	46695	35021	32898
Vermont	1998	2646	.	6692	239034	43273	0	115741	5907989	591978	21027	19266	15207	10522	9657
Vermont	2008	2385	18444	7524	272488	59117	647718	220749	9467118	600702	26515	19286	15889	12595	12364
Virginia	1998	15421	105741	50391	2700589	252114	3134966	825028	81261075	6802938	232503	201944	159359	100102	82177
Virginia	2008	21061	117095	67031	3184234	503789	5837841	1743591	1.39E+08	7584376	294970	218647	173786	131481	121693
Washington	1998	11455	81834	49647	2134598	192095	2893201	879630	73268188	5685561	177160	160800	140679	94412	79725
Washington	2008	12145	104027	56539	2536645	319926	5676061	1395013	1.15E+08	6360324	240224	176055	141569	111169	114860
West Virginia	1998	4989	40679	17265	547234	81687	1213183	251248	13278895	1798199	78059	73765	57105	37715	30977
West Virginia	2008	3295	44830	20653	592022	91429	1996346	447682	19168311	1765205	83376	66406	54077	42706	38502
Wisconsin	1998	12429	92260	65259	2319343	185838	2738108	1076547	64912499	5244868	186068	174726	144438	104267	92167
Wisconsin	2008	16154	114754	76522	2496850	352004	5002191	1677466	95115917	5475246	212700	165968	141108	113216	117154
Wyoming	1998	650	.	.	163791	11304	0	0	3980094	484244	16498	14464	11192	7478	6286
Wyoming	2008	515	10993	5597	221971	11974	541016	140792	8869219	516185	20233	15147	12044	9205	8985