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Medically recognized urinary incontinence and risks of hospitalization, nursing home admission and mortality

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Abstract

Objectives: this study examined the association between medically recognized urinary incontinence and risk of several disease conditions, hospitalization, nursing home admission and mortality.
Design: review and abstraction of medical records and computerized data bases from 5986 members, aged 65 years and older, of a large health maintenance organization in northern California.
Results: there was an increased risk of newly recognized urinary incontinence following a diagnosis of Parkinson's disease, dementia, stroke, depression and congestive heart failure in both men and women, after adjustment for age and cohort. The risk of hospitalization was 30% higher in women following the diagnosis of incontinence [relative risk (RR) = 1.3, 95% confidence interval (CI) = 1.2–1.5] and 50% higher in men (RR = 1.5, 95% CI = 1.3–1.6) after adjustment for age, cohort and co-morbid conditions. The adjusted risk of admission to a nursing facility was 2.0 times greater for incontinent women (95% CI = 1.7–2.4) and 3.2 times greater for incontinent men (95% CI = 2.7–3.8). In contrast, the adjusted risk of mortality was only slightly greater for women (RR = 1.1; 95% CI = 0.99–1.3) and men (RR = 1.2; 95% CI = 1.1–1.4).
Conclusions: urinary incontinence increases the risk of hospitalization and substantially increases the risk of admission to a nursing home, independently of age, gender and the presence of other disease conditions, but has little effect on total mortality.

Keywords: *incontinence of urine, institutionalization, mortality*

Introduction

Urinary incontinence is a common condition in elderly men and women. Population-based estimates of the prevalence of urinary incontinence among older women range from 34 to 45% for incontinence defined as one or more episodes in the past year [1–4] and from 3 to 7% for incontinence defined as once or more episodes per day [1–3, 5]. The prevalence of incontinence in men has been less well studied, but appears to be roughly one-half of that in women [2, 3, 5]. The direct medical cost of urinary incontinence in the US has been estimated at over 10 billion dollars each year [6]. The indirect costs, due to increased risk of hospitalization or nursing home admission, are unknown.

Urinary incontinence has been associated with several medical conditions, including neurological disease [7], depression [5], cardiovascular disease [7] and cerebrovascular disease [8]. However, these associations have been based on cross-sectional data which cannot establish the temporal relationship between urinary incontinence and the associated condition. In addition, previous studies have generally relied on patient self-report of medical conditions, rather than review of medical records.

Urinary incontinence has also been associated with multiple hospital admissions and is believed to be an important cause of admission to long-term care facilities [8, 9]. While the prevalence of urinary incontinence is higher in long-term care facilities [10] and among individuals with multiple hospitalizations

[8], urinary incontinence has not been evaluated as a risk factor for hospitalization or nursing home admission independently of other co-morbid conditions.

The current study examined the relation between several medical conditions, documented by medical record review and the subsequent diagnosis of urinary incontinence over a 9-year period in two cohorts of older adults. In addition, the study assessed urinary incontinence as an independent risk factor for hospitalization, nursing home admission and total mortality.

Methods

Study population

The study population consisted of two cohorts, each composed of approximately 3000 randomly selected members of Kaiser Foundation Health Plan of Northern California (KFHP), a large health maintenance organization enrolling approximately 25% of the general population in the San Francisco Bay and Sacramento Metropolitan areas. As a traditional health maintenance organization, KFHP provides virtually all care for its members within its own facilities and thus has medical records for over 90% of all office visits and hospitalizations by its members. All subjects had been KFHP members for at least 5 years and over 80% had been members for more than 10 years. The first cohort was composed of 1453 women and 1420 men aged 65 or older in 1971. The second cohort was composed of 1551 women and 1562 men aged 65 and older in 1980, of whom 282 (9.1%) had also been part of the 1971 cohort. Both cohorts were randomly selected from membership rolls stratified by age (65-69 years, 70-79 years and 80+ years) and gender to provide approximately equal numbers in each age-gender group. The sampling fractions for each of the three age groups were 5, 10 and 20%, respectively. Previous comparisons have shown that members of KFHP are generally representative of the population in the same geographical area with respect to race and income (except at the very high and very low ends of the income spectrum) [11-13] and include a broad distribution of educational levels (11% less than high school, 20% high-school graduates, 35% some college and 32% college graduates) [13].

Data collection

Subjects were followed for 9 years after the index year by reviewing and abstracting inpatient and outpatient medical records and by reviewing computerized hospitalization data. The prevalence of each medical condition at baseline was established by reviewing medical records and hospitalization data for 4 years prior to the index year. A pilot study found that 97% of prevalent chronic conditions were mentioned within 4 years, even if the diagnosis had been made earlier. Mortality was ascertained using the California Automated Mortality Linkage Information System [14] for the 12-year period following the index year. Sixty-eight subjects from both cohorts who died in the first 3 years of the second cohort were counted in both cohorts and represented 2.2% of all deaths. Subjects who died or who disenrolled from KFHP during the 9-year period were assigned a follow-up time equal to the difference between the index date and the date of dropout. There were no differences in dropout rates between the two cohorts.

Detailed chart abstraction was performed by trained research personnel using a structured abstraction form. Information was abstracted for 32 medical conditions and included the date of onset and the date of diagnosis. In addition to data abstracted from the subjects charts, hospitalizations and nursing home admissions were available from the KFHP database. The chart abstraction form did not distinguish between urinary and faecal incontinence. To assess the degree to which 'incontinence' referred to urinary incontinence, a random sample of 49 charts from subjects with a diagnosis of incontinence was reviewed. Forty-six (94%) of the 49 subjects had a diagnosis of urinary incontinence recorded in their chart. Of these 46, 40 (87%) had a diagnosis of only urinary incontinence and six (13%) diagnoses of both urinary and faecal incontinence. Only three (6%) of the 49 subjects had a diagnosis of faecal incontinence without a diagnosis of urinary incontinence.

Data analysis

The prevalence of incontinence and other diagnoses was calculated as the percent of all observations in each cohort at baseline who had had the condition within the previous 4 years. Incidence rates for each diagnosis were calculated as the number of newly recognized events in the 9-year follow-up period, excluding prevalent cases from the analyses, over the total follow-up time in person-years per 1000. Follow-up time for incidence rates was calculated as the time from baseline to the first event, dropout, death or end of study period, whichever occurred first. Similar procedures were used for calculating rates of hospitalization, nursing home admissions and mortality by incontinence status.

The association between disease condition and incident incontinence was examined using a proportional hazards model [15] with incontinence as the dependent variable. The association between incident or prevalent incontinence and the outcomes of hospitalization, nursing home admission and mortality were examined using a proportional hazards model. Time from incident incontinence to the outcome of interest (hospitalization, nursing home admission or death) was used as a measure of survival time in those

Table 1. Patient demographic characteristics in the two cohorts

	Cohort 1 (n = 2873)		Cohort 2 (n = 3113)	
	n	%	n	%
Women	1453	50.8	1551	49.8
Men	1420	49.2	1562	50.2
Age distribution (years)				
65-74	993	34.5	1064	34.2
75-79	978	34.0	991	31.8
80+	902	31.4	1058	34.0

with incident incontinence. Time from baseline to the outcome of interest was used as a measure of survival time in those with prevalent incontinence.

All models were gender-specific and included adjustment for cohort and for age (as a continuous variable). Additional adjustment was made for co-morbid conditions if including them in the model significantly changed the estimated association between incontinence and the variable of interest.

Results

The demographic characteristics for each cohort are presented in Table 1. The age and gender distribution reflects the gender- and age-stratified sampling used to create the cohorts.

As shown in Table 2, the prevalence and incidence of most of the 11 common disease conditions of interest are similar (within 20%) between the two cohorts. The exceptions are: hypertension and cerebral vascular disease (strokes and transient ischaemic attacks), which were more prevalent in the second cohort; gout, which was more prevalent and had a higher incidence in the second cohort; and incontinence, which had a higher prevalence in the second cohort. Subsequent analyses combine both cohorts, with adjustment for cohort in all models.

Table 3 provides a more detailed look at the baseline prevalence and incidence rate of incontinence by age and gender. As expected, both incidence and prevalence increase with age for both men and women and both are greater in women than men, with the exception of incident incontinence among subjects aged 80 and older.

The associations between incident incontinence and previously diagnosed medical conditions of interest are presented in Table 4. The first four conditions (Parkinsonism, dementia, cerebral vascular disease, depression and congestive heart failure) were selected because of previously reported cross-sectional associations with urinary incontinence. The remaining two conditions, osteoarthritis and gout, were selected because they are common conditions which would be expected to have little association with urinary incontinence. The risk ratios for incontinence are significantly elevated for subjects with a medical record diagnosis of Parkinson's disease, dementia, cerebral vascular disease and congestive heart failure, in both men and women. Neither gout not osteoarthritis were associated with an increased risk of incontinence in men, but osteoarthritis was associated with a slightly increased risk in women.

The association between prevalent or incident incontinence and hospitalization and admission to a skilled nursing facility is shown in Table 5. The following co-morbid conditions were entered, stepwise into the model: dementia, Parkinson's disease, cerebral vascular disease, depression, congestive heart failure, ischaemic heart disease, chronic lung disease,

Table 2. Disease prevalence and incidence/1000 person-years for cohorts 1 (n = 2873) and 2 (n = 3113)

	Baseline prevalence				Incidence			
	Cohort 1		Cohort 2		Cohort 1		Cohort 2	
	n	%	n	%	CE	Rate per 1000/P-Y	CE	Rate per 1000/P-Y
Incontinence	160	5.6	206	6.6	332	12.2	508	17.5
Parkinsonism	61	2.1	60	1.9	64	3.4	65	3.1
Dementia	177	6.1	190	6.1	382	21.4	450	23.3
Cerebral vascular disease	276	9.4	379	12.1	240	13.9	247	15.3
Depression	238	8.1	254	8.1	270	15.8	280	18.0
Congestive heart failure	232	8.1	285	9.2	290	10.1	320	10.3
Osteoarthritis	1183	40.4	1351	43.1	433	45.2	520	54.7
Gout	97	4.1	136	6.4	56	3.0	88	4.5
Hypertension	892	30.5	1297	41.4	254	20.4	259	22.6
Diabetes	314	10.7	274	8.7	57	3.3	96	5.0
Acute myocardial infarction	326	11.1	352	11.2	95	5.5	126	6.7

CE, cumulative events; P-Y, person-years.

Table 3. Prevalence at baseline and incidence of incontinence by age in both cohorts combined ($n = 5986$)

	Prevalence		Incidence	
	n	%	Cumulative events	Rate/1000 P-Y
Women	207	6.9	428	23.0
Men	159	5.3	412	23.8
Women by age (years)				
65-74	43	4.2	54	7.7
75-79	72	7.3	92	20.2
80+	92	9.4[a]	282	30.9[a]
Men by age (years)				
65-74	29	2.8	37	7.0
75-79	55	5.6	73	17.8
80+	75	7.6[a]	302	37.2[a]

P-Y, person-years.
[a]$P < 0.001$ for increase by age.

musculo-skeletal disease, diabetes, cancer, chronic renal disease, peripheral vascular disease and hypertension. Only those conditions that significantly affected the estimated association between incontinence and the risk of either hospitalization or nursing home admission were retained in the model. After adjustment for age and cohort and the co-morbid conditions listed in Table 5, women with incontinence were 30% more likely to be hospitalized and twice as likely to be admitted to a nursing home as women without incontinence. Men with incontinence were 47% more likely to be hospitalized and over three times more likely to admitted to a nursing home.

The risk of mortality associated with medically recognized incontinence was evaluated using the same approach. The results, reported in Table 6, show that the crude association between incontinence and mortality was substantially less after adjustment for co-morbid conditions. After adjustment, there remained a non-significant increased risk for women and a small but still significant increased risk (20%) for men.

Table 4. Relative risk of incident incontinence by selected pre-existing medical conditions for women and men

	Risk ratio[a]	95% Confidence interval
Women		
Parkinson's disease	2.6	1.5-4.2
Dementia	3.0	2.4-3.7
Cerebral vascular disease	1.9	1.5-2.4
Depression	1.6	1.2-2.0
Congestive heart failure	1.6	1.2-2.1
Osteoarthritis	1.4	1.1-1.7
Gout	1.0	0.6-1.6
Men		
Parkinson's disease	2.9	2.0-4.2
Dementia	3.6	2.9-4.5
Cerebral vascular disease	1.6	1.2-2.1
Depression	2.0	1.6-2.7
Congestive heart failure	1.3	1.0-1.7
Osteoarthritis	1.0	0.8-1.2
Gout	1.1	0.8-1.5

[a]Adjusted for age and cohort.

Discussion

This study offers several advantages over previous studies in this area. Cohort data from a large, representative population were used to examine, prospectively, the association between urinary incontinence, other incident disease, hospitalization, nursing home admissions and mortality. Diagnoses were determined by medical record review, hospitalizations, nursing home admission and mortality from computerized data bases. The risks of hospitalization, nursing home admission and mortality associated with incontinence were analysed separately for men and women and adjusted for co-morbid conditions, as well as age and cohort.

Women were more likely to be incontinent at baseline than men, a finding consistent with previous studies of incontinence prevalence [2, 3, 5, 7, 16, 17]. The ratio of the prevalence of incontinence in women to men was 1.5 for the 65-74-year-old group and decreased with age. Most previous studies have reported ratios around 2 for adults over 60 years of age, although in older age groups (e.g. 85 years old and older) and with more severe incontinence, ratios below 1.5 have been reported [7, 17]. The incidence of incontinence in the current study increased with age

Table 5. Association between incontinence and risk of hospitalization and admission to a skilled nursing facility in women and men

	Hospitalizations			Admissions to skilled nursing facility		
	No./1000 P-Y	Adjusted RR (95% CI) Age/cohort	Disease	No. /1000 P-Y	Adjusted RR (95% CI) Age/cohort	Disease
Women						
Incontinent	282	1.4 (1.3-1.6)	1.3[a] (1.2-1.5)	73	2.5 (2.1-2.9)	2.0[c] (1.7-2.4)
Continent	198			31		
Men						
Incontinent	437	1.6 (1.5-1.8)	1.5[b] (1.3-1.6)	98	3.7 (3.2-4.4)	3.2[d] (2.7-3.8)
Continent	272			24		

P-Y, person-years.
[a]Adjusted for age, cohort, dementia, cerebral vascular disease, depression, congestive heart failure, ischaemic heart disease, musculo-skeletal disease, cancer, renal disease and hypertension.
[b]Adjusted for age, cohort, cerebral vascular disease, congestive heart failure, ischaemic heart disease, pulmonary disease and diabetes.
[c]Adjusted for age, cohort, cerebral vascular disease, dementia, depression, ischaemic heart disease, renal disease and hypertension.
[d]Adjusted for age, cohort, cerebral vascular disease, dementia, congestive heart failure, renal disease and diabetes.

and was similar in women and men. In contrast, Herzog *et al.* reported approximately twice the incidence of incontinence in women as in men aged 60 years and older [18]. However, when one looks at the rate of new, severe incontinence among those previously reporting no or mild incontinence in this study, the rates for women and men are virtually the same (6% *versus* 6.1% in first year, 4.5% *versus* 5.5% in second year) [18]. The higher incidence among men in the oldest age group of the current study (37%) may be related to the higher prevalence of prostate disease in this group. The increase in incidence of incontinence between the two cohorts may represent an increased sensitivity by providers to diagnosing and documenting urinary incontinence for the later cohort.

Table 6. Association between incontinence and risk of death in women and men

	Deaths/ 1000 P-Y	Adjusted RR (95% CI) Age/cohort	Disease
Women			
Incontinent	59	1.2 (1.1-1.4)	1.1[a] (0.99-1.3)
Continent	40		
Men			
Incontinent	112	1.5 (1.3-1.7)	1.2[b] (1.1-1.4)
Continent	62		

P-Y, person-years.
[a]Adjusted for age, cohort, dementia, ischaemic heart disease, lung disease, musculo-skeletal disease, diabetes, cancer, renal disease and depression.
[b]Adjusted for age, cohort, dementia, cerebral vascular disease, congestive heart failure, ischaemic heart disease, pulmonary disease, musculo-skeletal disease, diabetes, cancer and peripheral vascular disease.

The current study found that Parkinsonism and cerebral vascular disease (stroke or transient ischaemic attack) were each associated with an increased risk of subsequent incontinence in men and women after adjustment for age and cohort. Neurological disease (not otherwise specified) has been associated with urinary incontinence in a study of men and women aged 85 and older [7]. An association between incontinence and cerebrovascular disease has been reported in women but not in men in one study [8]. However, stroke was not associated with incontinence for either men or women in another study [19]. The association between dementia and incontinence, found in the current study, has been previously reported in cross-sectional studies [20], including at least one that was population-based [17]. The association between depression and incontinence in the current study is consistent with a previous population-based study which found depression to be more common among subjects with incontinence [5]. The current study also found an increased risk of incontinence following the diagnosis of congestive heart failure. Another population-based study reported a significant association between urinary incontinence and cardiovascular disease in women only [7], but did not examine congestive heart failure separately.

These previous studies were all cross-sectional and relied on patient self-reporting. The associations reported in the current prospective study suggest that incontinence follows the medically documented diagnosis of each of these conditions. However, while the prospective nature of the data helps to identify the temporal relation between diagnosis of incontinence and diagnosis of other conditions, it cannot establish the temporal relationship between the onset of symptoms, since both urinary incontinence and the

conditions with which it was associated may have substantial lag periods between onset of symptoms and diagnosis. It is possible that the onset of a new disease condition might worsen pre-existing incontinence and lead to its diagnosis or might lead to a diagnosis of pre-existing incontinence due to increased medical attention. Even when incontinence clearly follows the development of a medical condition, the relationship may not be causal, but may reflect a common relationship with a third factor. For example, impaired mobility has been suggested as an important mediating factor in dementia and other neurological diseases [21]. Such a mechanism might explain the modest association found between arthritis and incontinence among women in the current study and previously reported in a cross-sectional population study [19]. For congestive heart failure, the association with incontinence could be mediated through treatment with a diuretic.

Unlike the other conditions investigated in this study, depression could as easily be a consequence of incontinence as a cause. Since both depression and incontinence can have a substantial lag time from symptoms to diagnosis, it is possible that the association observed is in part due to undiagnosed incontinence preceding depression. To explore this possibility, the data were analysed to determine the association between prevalent incontinence and the subsequent risk of depression. For women, there was no increased risk of subsequent depression among those with previously diagnosed incontinence after adjustment for age and cohort (risk ratio = 0.9, 95% CI = 0.6–1.6), while in men the age and cohort-adjusted risk of depression was greater among those with incontinence (risk ratio = 2.4, 95% CI = 1.6–3.7), suggesting that the relationship may be bi-directional in men.

The association between incontinence and admission to a nursing home supports the commonly held belief that urinary incontinence is an important risk factor for nursing home admission [9]. At least one previous study showed incontinence, particularly in the presence of aggressive behaviour, to be a significant predictor of nursing home admission among demented outpatients [22]. The association between incontinence and risks of hospitalization and nursing home admission in the current study persisted even after adjustment for age, gender and multiple co-morbid conditions. It is possible that one or more additional factors, not in the data set and therefore not controlled for, could be associated with both incontinence and nursing home admission, but the persistence of the association after adjustment for multiple disease conditions makes this explanation unlikely.

Previous studies have suggested that incontinence, especially of new onset, may be an independent risk factor for increased mortality among hospitalized patients with pneumonia [23] and patients admitted to a nursing home [24]. The results from population-based studies of the association between urinary incontinence and mortality have not been consistent. One study of 559 older adults, including those in institutions, reported that the 3-year mortality for incontinent subjects was over twice that of continent subjects [17]. However, when survival was plotted by age, the difference was much less. A recent study by Herzog *et al.* of nearly 2000 community-residing older adults found no association between incontinence and risk of death after adjusting for age, education, number of medical conditions and self-assessed health status [25]. The current results of a small increased risk of mortality among incontinent men only tends to support the study by Herzog *et al.* It is possible that the small association remaining after adjustment in the current study reflects an association between incontinence and other health conditions not measured (and therefore not adjusted for in the data). These results suggest that in contrast to the associations between incontinence and hospitalizations and nursing home admission, where the presence of incontinence can plausibly play a direct role in the decision to institutionalize, the association between incontinence and mortality is probably mediated primarily through co-morbid disease conditions.

The current study has several limitations. Approximately 6% of the subjects with incontinence had faecal incontinence only. However, this small proportion would not be likely to have a large effect on the study's findings. The study also relied on incontinence noted in the patient's medical record. Studies have shown that only about one-third of all people with urinary incontinence seek medical attention [1, 4] and those with more severe incontinence are more likely to seek help. Most studies use one or more definitions of urinary incontinence based on an average or on the most recent number of episodes over a past period of time (from 1 day to 12 months). However, using a definition of 'medically noted' urinary incontinence has the advantage of representing what providers 'see' in their practice. The prevalence of urinary incontinence found in this study—about 7% for women and 5% for men—is similar to the prevalence for incontinence occurring several times per week or more reported in previous studies [2, 3, 5, 7, 16, 17]. Defining incident urinary incontinence is by nature difficult, as onset is often gradual and remission common [2]. For this reason, few studies even attempt to address incident incontinence [2]. The current study used a precise definition of urinary incontinence—its first mention in the medical record—recognizing that this lags behind the actual onset. It is also possible that the diagnosis of particular conditions would have triggered an inquiry into the presence of incontinence, creating a false association between the condition and incontinence.

A final limitation is that no direct measure of functional status was available in the current study

and in fact would not be feasible for a study of this size and for this length of follow-up. The large amount of data on co-morbid conditions was used as a proxy for functional status. In addition, functional status, as measured by such commonly used scales as the Instrumental Activities of Daily Living [26], Activities of Daily Living [27] or the Barthel index [28] is partially determined by continence status. The later two scales include incontinence in the measure and the first includes activities that may be indirectly related to incontinence (e.g. shopping, housekeeping). It is nonetheless possible that functional limitations other than those caused by urinary incontinence or measured co-morbid conditions could explain some or all of the association between incontinence and hospitalization and nursing home admission reported in this study.

The current study confirmed and extended previous findings of an association between urinary incontinence and several other disease conditions and suggested that incontinence is associated with a significantly increased risk of hospital and nursing home admissions independently of age, gender and multiple co-morbid conditions. Further studies are needed to establish the independent contribution of urinary incontinence to the risk of institutionalization and to determine whether interventions to reduce urinary incontinence are also effective in reducing the risk of institutionalization.

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Key points

- The risk of newly diagnosed urinary incontinence was increased following diagnosis of Parkinson's disease, dementia, stroke, depression and congestive heart failure.
- The adjusted risk of hospitalization was 30% higher among incontinent women and 50% higher among incontinent men.
- The adjusted risk of nursing home admissions was two times greater in incontinent women and over three times greater in incontinent men.
- The adjusted mortality rate did not differ significantly by continence status for either women or men.

References

1. Yarnell JWG, Voyle GJ, Richards CJ, Stephenson TP. The prevalence and severity of urinary incontinence in women. J Epidemiol Comm Health 1981; 35: 71-4.

2. Herzog AR, Fultz NH. Prevalence and incidence of urinary incontinence in community dwelling populations. J Am Geriatr Soc 1990; 38: 273-81.

3. Diokno AC, Brock DM, Brown MB, Herzog AR. Prevalence of urinary incontinence and other urological symptoms in the non-institutionalized elderly. J Urol 1986; 136: 1022-30.

4. Holst K, Wilson PD. The prevalence of female urinary incontinence and reasons for not seeking treatment. N Z Med J 1988; 101: 756-8.

5. Vetter NJ, Jones DA, Victor CR. Urinary incontinence in the elderly at home. Lancet 1981; ii: 1275-7.

6. Hu TW. Impact of urinary incontinence on health-care costs. J Am Geriatric Soc 1990; 38: 292-5.

7. Hellstrom L, Ekelund P, Milsom I, Messtrom D. The prevalence of urinary incontinence and use of incontinence aids in 85-year-old men and women. Age Ageing 1990; 19: 383-9.

8. Yarnell JWG, St Leger AS. The prevalence, severity and factors associated with urinary incontinence in a random sample of the elderly. Age Ageing 1979; 8: 81-5.

9. Ouslander J. Urinary incontinence in the elderly. West J Med 1981; 135: 482-91.

10. Ouslander JG, Kane RL, Abrass IB. Urinary incontinence in elderly nursing home patients. JAMA 1982; 248: 1194-8.

11. Kreiger N. Data Resources of the Kaiser Permanente Medical Care Program in Northern California. Oakland: Division of Research, Kaiser Foundation Research Institute, 1990.

12. Kreiger N. Overcoming the absence of socioeconomic data in medical records: validation and application of a census-based methodology. Am J Public Health 1992; 82: 703-10.

13. Department of Research. Member Health Survey. Oakland: Division of Research, Kaiser Permanente, 1992.

14. Arellano MG, Petersen GR, Petitti DB, Smith RE. The California Automated Mortality Linkage System (CAMLIS). Am J Public Health 1984; 74: 1324-30.

15. Selvin S. A model for survival data: proportional hazards. In: Selvin S. Statistical Analysis of Epidemiologic Data. New York: Oxford University Press, 1991; 310-38.

16. Thomas TM, Plymat KR, Blannin J, Meade TW. Prevalence of urinary incontinence. Br Med J 1980; 281: 1243-5.

17. Campbell JA, Reinken J, McCosh L. Incontinence in the elderly: prevalence and prognosis. Age Ageing 1985; 14: 65-70.

18. Herzog AR, Diokno AC, Brown MB, Normolle DP, Brock BM. Two-year incidence, remission and change patterns of urinary incontinence in noninstitutionalized older adults. J Gerontol 1990; 45: M67-74.

19. Diokno AC, Brock BM, Herzog AR, Bromberg J. Medical correlates of urinary incontinence in the elderly. Urology 1990; 36: 129-38.

20. Skelly J, Flint AJ. Urinary incontinence associated with dementia. J Am Geriatr Soc 1995; 43: 286-94.

21. DuBeau CE, Resnick NM. Urinary incontinence and dementia: the perils of guilt by association. J Am Geriatr Soc 1995; 43: 310-1.

22. O'Donnell BF, Drachman DA, Barnes HJ, Peterson KE, Swearer JM, Lew RA. Incontinence and troublesome behaviors predict institutionalization in dementia. J Geriatr Psychiatr Neurol 1992; 5: 45–52.

23. Verkatsen P, Gladman J, Macfarlane JT, Barer D, Kinnear W, Finch RG. A hospital study of community acquired pneumonia in the elderly. Thorax 1990; 45: 254–8.

24. Lewis MA, Kane RL, Cretin S, Clark V. The immediate and subsequent outcomes of nursing home care. Am J Public Health 1985; 75: 758–62.

25. Herzog AR, Diokno AC, Brown MB, Fultz NH, Goldstein NE. Urinary incontinence as a risk factor for mortality. J Am Geriatr Soc 1994; 42: 264–8.

26. Lawton MP, Body EM. Assessment of older people: self maintaining and instrumental activities of daily living. Gerontologist 1969; 9: 179–86.

27. Katz S, Downs TD, Cash HR, Grotz RC. Progress in development of the index of ADL. Gerontologist 1970; 10: 20–30.

28. Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. Maryland State Med Assoc 1965; 61–5.

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