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ORIGINAL ARTICLE

Aging and utilization of hospital services in Hong Kong: retrospective cohort study

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Abstract

Objectives We tested the hypotheses firstly that people dying in older age groups do not use hospital services more than those dying in younger age groups in the previous 3 years before death; secondly, that there may be compression of morbidity demonstrated by a decline in the use of hospital services among people in the last 3 years before death in the older age groups.

Methods We extracted mortality data from all hospitals of the Hospital Authority and analyzed the data using negative binomial regression with duration of hospital stay before death as the outcome variables; age, gender, year of death (period), and birth cohort were predictor variables.

Results People dying in older age groups do not use in patient hospital services more than younger age groups in the 3 years before death. However, they do use more AED services. No compression in morbidity was demonstrated.

Conclusions Data obtained from this retrospective study may be used to project future usage for each type of service as a result of changing age structure of the population.

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Keywords Duration of hospital stay · Mortality · Compression of morbidity · Last years of life · Aging

Introduction

Aging populations worldwide raise concerns regarding increasing health care expenditure, because the prevalence of chronic diseases and disability increases with age. Such concerns have been raised with regard to the population of Hong Kong (Woo et al. 1996, 1997; Yip and Law 2002), such that the government is placing increasing emphasis on prevention of diseases and disabilities or healthy aging (Elderly Commission, HKSAR China 2001). Studies in Europe and North America examining the use of hospital days in the years before death (Himsworth and Goldacre 1999; Busse et al. 2002; Dixon et al. 2004) or trends in medicare payments or health care costs in the last year of life (Van Vliet and Lamers 1998) show that proximity to death, rather than age, is the main cost driver (Himsworth and Goldacre 1999; Busse et al. 2002; Dixon et al. 2004). The implication is that the projections using age-specific costs will exaggerate the impact of aging.

According to many large studies conducted in Europe and North America, health care services before death may also be used as an approximate indicator of compression of morbidity because most of the health care services would be used during the last few years of life, irrespective of age at death. Improving health as a result of health promotion, interventional programs has been proposed as a determining factor for a declining trend in health care costs in the last year of life (Himsworth and Goldacre 1999; Busse et al. 2002; Dixon et al. 2004; Van Vliet and Lamers 1998; Fries 2003; Liao et al. 2000). Most of these studies examine the use of acute medical services, but the cost of community care (social, nursing services) may follow a different pattern and should be taken into account in the overall assessment in projecting the health services needs of aging populations (McGrail et al. 2000).

Hong Kong has a rapidly aging population, with life expectancy increasing from 67.8 in 1971 to 78.6 in 2002 for men and from 75.3 to 84.5 for women. Currently no such analysis of Hong Kong data has been carried out. Examining the use of services in the last years of life enables comparison with other studies, and provides data for more accurate prediction of future needs (McGrail et al. 2000; Cohen 1994).

Methods

According to the studies conducted in Europe and North America, hospital services were used the most during the last 1–3 years of life, irrespective of the age at death. Hence for comparison, we studied all deaths that occurred in Hong Kong from 1999 to 2005. The start date of 1999 was chosen because the computerized hospital records (CMS) system only became available 3 years earlier in 1996. The decedents, who died in Hospital Authority (HA) hospitals, were the study population because 93–94% of deaths occurred in the public health care service system in Hong Kong. Deaths occurring in all HA hospitals were analyzed. A list of all deaths which occurred in all HA hospitals from 1st January 1999 to 31st December 2005 was extracted from the Hospital Authority database. The primary cause of death was recorded using the ICD code v.10. The medical record number (same as ID Number) was used to match the hospital service used within HA system during the last 3 years of life. The name and address were omitted to protect the decedents' personal privacy. More than 94% of hospital admissions in Hong Kong were to HA hospitals and therefore, the hospital services used outside the HA would not influence the estimation significantly. Secondly, the information about gender, the date of birth, date of death, each date of admission and discharge, reason/diagnosis for admission, and causes of death were traced for 3 years before death from the CMS database. Similarly, the number of episodes of HA outpatient episodes were documented during this period. Thirdly, to document any changes in health services provisions, available information regarding the number of public hospital beds, long-term residential care places, and community service provisions were noted during the study period.

Statistical analysis

The number of admissions and duration of hospital stay during the last months, last 24 months, and the last 36 months of life were calculated for each death. For multivariate analyses, we used negative binomial regression models with duration of hospital stay in the 12, 24, and 36 months before death as the outcome variables, and age, gender, year of death (period), and birth cohort as predictor variables. Negative binomial regression is an alternative to Poisson regression for modeling count data which has been shown to perform well in the presence of over-dispersion, i.e., variance larger than the mean (Byers et al. 2003). Since the data is over-dispersed, negative binomial regression rather than Poisson regression was used. In order to test whether usage of hospital services before death is influenced by age at death, we fitted age–period models (Clayton and Schifflers 1987a) with duration of hospital stay in the last 12, 24, and 36 months of life as the outcome variables. Age was grouped as 0–4, 5–15, 16–24, 25–44, 45–64, 65–74, 75–84, 85+, and period as 1999–2000, 2001–2002, and 2003–2005. The age grouping was chosen for ease of comparison with a previous study (Dixon et al. 2004). The effects of age and period were modeled using indicators variables with the age group 65–74, and period 1999–2000 serving as the reference categories. Controlling for age while looking at period effects, and vice versa, was necessary since the age structure of Hong Kong's population is changing rapidly. Since the data showed significant differences between males and females in terms of age and period effects, models were fitted separately by gender.

Because the changes in duration of hospital stay over time could be due to period effects, e.g., changes in medical practices, or cohort effects, i.e. changes in the characteristics of the patients through successive birth cohorts, age–cohort, age–period, and age–period–cohort models were fitted to the data for decedents aged 60–95 for the data from 2000 to 2005. Following the recommendation of Clayton (Clayton and Schifflers 1987b) for models involving cohort effects we used equal size (3 year) groupings for age (60–62,…, 93–95), birth cohort (1905–1907,…, 1944–1946), and year of death (2000–2002, 2003–2005). We used only 6 years of data to allow 3-year groupings. For age, period, and cohort effects, one category for each was chosen as the reference group and indicator variables were created for each of the other groups. The full age–period–cohort model is well known to have methodological problems (Clayton and Schifflers 1987b), in that the individual parameters are non-identifiable since age = period − cohort. However, comparison of the goodness-of-fit statistics between the age–period and age–period–cohort models allowed us to assess whether cohort effects make any significant contribution to model after inclusion of age and period effects. In addition, although it was not possible to directly compare age–period and age–cohort models using formal statistical methods, a much better goodness-of-fit result for one over the other could be interpreted as evidence that either period or cohort effects are primarily responsible for any observed trends over time (Clayton and Schifflers 1987a). Thus, if there was evidence of change over time in duration of hospital stay before death we may be able to ascertain whether it was primarily due to cohort or period effects. Gender was also controlled for in these models, and if there was evidence of strong differences between genders in terms of the effects of age, period, and cohort on the outcome variable we used separate models for males and females.

Results

For the period 3 years before death, the longest duration of stay occurred in the 5–15 years age group with the shortest duration in the 25–44 years age group (Fig. 1a, b). Duration rose slightly from age 44 onwards reaching a plateau at the 75–84 years age group. The pattern was the same for 2 years before death. Differences in duration of stay for 1 year before death for different age groups were less marked; the highest occurring in the 5–15 years age group followed by the 0–4 years age group. There was little difference in duration of stay between age groups from age 45 years upwards. The highest number of admissions for all three periods before death occurred in the 5–15 and 85+ years age groups, followed by the 45–84 years age group, and differences became less marked for the 1 year before death. The highest number for all three periods occurred in the middle age groups (45–64 years), with declining frequency with increasing age. There was a clear cut gradient with age, the number rising with increasing age groups for all three periods, the differences between age groups narrowing with increasing proximity to death, as for the other indicators of service utilization. With respect to the number of attendance at specialist outpatient departments, the highest average for all three periods occurred in the 45–64 age group, with declining frequency with increasing age thereafter. In contrast, the number of attendances at Accident and Emergency Departments (AED) rose with age for all three periods, being highest for the 85+ age group, but the differences between age groups narrowed with increasing proximity to death. There was no gender difference in the pattern of utilization by age group for any of the above services.

Adding terms representing cohort effects into the age only model did improve the fit of the model, however, the age–period models fit better than the age–cohort models in all cases. Also adding terms representing cohort effects to

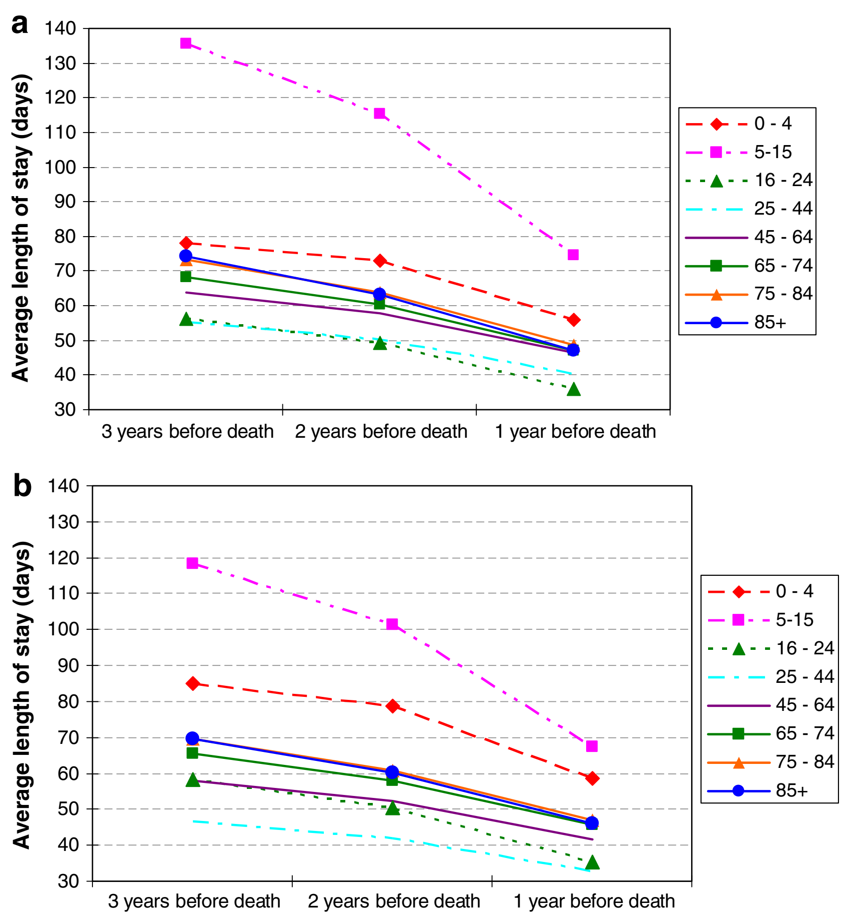

Fig. 1 **a** Average inpatient length of stay—by age group (female only). **b** Average inpatient length of stay—by age group (male only)

the age–period models did not significantly improve model fit indicating that there was a lack of evidence for an additional cohort effect once period was controlled for (Table 1). The findings suggest that while use of hospital services within 3 years before death showed a slight decline, the explanation is likely to be due to causes other than compression of morbidity.

In terms of period effects in the 1 year before death models, there is evidence of a slight rise in admission rates in 2001–2002 relative to the reference period (1999–2000) for both genders followed by a return to reference period levels in 2003–2005 for males and a drop to a rate very slightly lower than the reference period rate for females (Table 2). The period pattern for the 2-year models is similar to that for the 1 year models except the rate for males in 2003–2005 that is slightly higher than the reference period, while the rate for females in 2003–2005 is no longer significantly lower than for the reference period.

Changes in health and social services provision 1996–2005

Table 3 lists the changes in number of beds provided by the HA, the number of infirmary beds in HA, the number of community nursing service home visits, the number of people living in long-term residential care; and the number of people enrolled in various types of community centers run by various non-government organizations subvented by the Social Welfare Department. Community palliative care teams were not available. There was a steady increase in the quantity of all types of services, in parallel with increases in the total population size and percentage of people aged 65+ years (10.2% in 1996 to 12.3% in 2005). During this period the ratio of hospital discharges between the Hospital Authority and private sector hospitals remained unchanged (Hospital Authority Statistical Report 2005–2006). Increases in various community services were more marked than the increase in the number of beds. Newer models of integrated social services were also developed that targeted community-living people with various types of functional dependencies, such as district elderly community centers, day care centers, home support teams, and carer support centers.

Discussion

Previous findings in other countries with different health care systems show that proximity to death, rather than old age, is the main cost driver for the use of inpatient services (Himsworth and Goldacre 1999; Busse et al. 2002; Dixon et al. 2004; McGrail et al. 2000; Zweiffel et al. 1999;

Table 1 Negative binomial APC regression model (age, period) for length of stay 3 years prior to death

	Male				Female			
	N	Rate ratio	95% CI for rate ratio	*p* Value	*N*	Rate ratio	95% CI for rate ratio	*p* Value
Age group								
60–62	4,348	0.85	0.81–0.88	<0.001	1,648	0.85	0.80–0.90	<0.001
63–65	5,882	0.91	0.87–0.94	<0.001	2,430	0.86	0.82–0.91	<0.001
66–68	7,590	0.90	0.87–0.93	<0.001	3,690	0.84	0.80–0.87	<0.001
69–71	9,813	0.92	0.89–0.95	<0.001	4,878	0.88	0.84–0.91	<0.001
72–74	11,318	0.96	0.93–0.99	0.007	6,475	0.91	0.88–0.94	<0.001
75–77	11,814	0.97	0.94–1.00	0.022	7,586	0.92	0.89–0.96	<0.001
78–80	11,645	0.99	0.97–1.03	0.717	8,987	0.96	0.93–0.99	0.009
81–83	10,429	1.00			9,720	0.96	0.93–0.99	0.022
84–86	8,249	1.00	0.97–1.03	0.860	9,547	1.00	0.97–1.03	0.929
87–89	6,068	1.00	0.96–1.04	0.978	8,737	1.00		
90–92	3,552	1.02	0.98–1.07	0.326	6,806	0.94	0.91–0.98	0.001
93–95	1,626	0.97	0.91–1.03	0.289	4,343	0.93	0.89–0.97	0.001
Year of death								
2000–2002	43,838	1.12	1.10–1.13	<0.001	35,351	1.17	1.15–1.19	<0.001
2003–2005	48,496	1.00			39,496	1.00		
	Estimate		95% CI		Estimate		95% CI	
Intercept	4.20				4.27			
Dispersion	1.30		1.29–1.31		1.29		1.27–1.30	

Table 2 Negative binomial APC regression model (age, period) for number of inpatient admission 1 year prior to death

	Male ($n = 134{,}099$)				Female ($n = 105{,}231$)			
	N	Rate ratio	95% CI for rate ratio	*p* Value	*N*	Rate ratio	95% CI for rate ratio	*p* Value
Age group								
0–4	717	0.47	0.44–0.51	<0.001	586	0.46	0.42–0.49	<0.001
5–15	375	0.79	0.72–0.86	<0.001	268	0.92	0.83–1.02	0.110
16–24	1,011	0.53	0.50–0.57	<0.001	523	0.60	0.56–0.65	<0.001
25–44	7,185	0.68	0.66–0.69	<0.001	4,293	0.87	0.84–0.89	<0.001
45–64	26,955	0.96	0.95–0.97	<0.001	11,930	1.02	1.00–1.04	0.037
65–74	36,170	1.00			18,924	1.00		
75–84	42,281	0.99	0.98–1.01	0.380	34,334	0.97	0.95–0.98	<0.001
85+	19,405	0.99	0.97–1.00	0.134	34,373	0.96	0.95–0.98	<0.001
Year of death								
1999–2000	36,418	1.00			28,451	1.00		
2001–2002	37,182	1.05	1.03–1.06	<0.001	28,498	1.05	1.04–1.07	<0.001
2003–2005	60,499	1.00	0.99–1.01	0.927	48,282	0.99	0.98–1.00	0.038
	Estimate		95% CI		Estimate		95% CI	
Intercept	1.37				1.38			
Dispersion	0.48		0.47–0.48		0.42		0.42–0.43	

Table 3 Changes in health and social services provisions 1996–2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of HA beds	25,177	25,947	26,790	27,544	28,517	28,877	29,022	29,188	28,476	28,176
Number of infirmary beds	–	1,069	1,433	1,710	1,950	1,960	2,128	2,208	2,195	2,151
Number of people in										
Long-term residential care places	40,116	42,083	50,666	54,915	60,930	63,900	68,418	70,381	71,641	71,659
Subvented	16,475	16,979	20,012	21,882	23,710	25,854	26,278	26,763	26,985	25,705
Non-subvented	23,641	25,104	30,654	33,033	37,220	38,046	42,140	43,618	44,656	45,954
Number of people enrolled in[a]										
Multi service center	–	–	–	–	26,637	52,106	54,159	54,885	–	–
District elderly community center	–	–	–	–	–	–	24	2,695	60,110	60,811
Social center	–	–	–	–	76,855	127,087	132,093	136,498	41,108	42,974
Neighborhood center	–	–	–	–	–	–	–	–	77,326	77,915
Day care center	–	–	–	–	947	1,529	1,620	1,782	1,979	2,072
Support team	–	–	–	–	–	46,823	44,981	47,036	58,951	59,211
Carer support center	–	–	–	–	–	3,079	3,546	3,742	–	–
CNS home visits (number to the nearest thousand)	375	435	480	590	630	680	750	710	775	795

[a] Data not available for 1996–1999

Vetter 2005). A previous study in Hong Kong to examine whether smokers used hospital services more before death compared with non-smokers also found that proximity to death rather than smoking habit was the main determinant (McGhee et al. 2008).

However, in contrast to previous studies in other countries, the collection of data in the last years of life would cover the majority of deaths, unlike other countries where more deaths may take place at home, in intermediate hospitals (UK), or in long-term residential care, with a well-developed primary care system. For example, up to 20% of deaths in the UK have no record of hospital admissions (Himsworth and Goldacre 1999). In contrast, 93–94% of Hong Kong deaths occur in HA hospitals. The majority of long-term care institutions for the elderly (old age hostels, old age homes, care, and attention homes) are not under the Hospital Ordinance, and therefore any death occurring in these homes have to be reported to the police. As a result, in order to avoid police visits, the threshold for sending residents to hospital is very low, particularly for the frail elderly. This makes the Hospital Authority Database particularly suited to address the issue of use of hospital services in the last years of life, having advantages over previous studies in the UK which only examined acute hospital data (Himsworth and Goldacre 1999; Busse et al. 2002; Dixon et al. 2004).

The implication for Hong Kong is that the increasing numbers of elderly people occupying hospital beds is a result of proximity to death rather than age per se. The number of admissions also followed the same pattern as for duration of stay. Possible explanations for the greater use of hospital services in women include obstetric and gynecological causes, and greater frailty in the older age groups. People in the middle age group were the highest users of specialist outpatient clinics (SOPC), followed by the 65–74 years group. In contrast, the 85+ age group were the second lowest users after the 0–4 age group. The lower use of SOPC services by the 85+ group compared with the middle age or the 65–74 years age group could reflect a survivor effect, or the fact that they may be followed up in the general outpatient or family medicine clinics. Attendance at these clinics was not examined. Another possibility is that those who need medical care may have been very frail and residing in residential care homes for the elderly, which are supported by visiting medical officers or community geriatric outreach teams.

Although this pattern of usage of AED followed that for the number of admissions, the extent of AED usage by the 85+ age group far exceeded that for the lower age groups. The magnitude of difference was greater than that for the number of admissions where the usage peaked from age 45 upwards. This suggests that AED may be used as a primary care service by the very old age group, being easily accessible and available 24 h. Affordability would not have been a barrier even though during this period attendance fees were introduced, because fees were waived for those who could not afford to pay and were receiving comprehensive social security allowance. The findings suggest that a more responsive and affordable primary care system particularly for the old–old age group could reduce inappropriate use of AED.

Comments on age–period effect and age–period–cohort effect

In general one would expect that changes in duration of stay due to administrative changes over time would be manifested as a period effect in the regression models as they should affect all age groups about equally at the time of the change. In contrast, compression of morbidity due to successive generations being healthier at a given age and thus using less medical services at that age should manifest itself mostly as a cohort effect in the models. The sorts of changes that result in healthier populations including better nutrition in childhood and adulthood, healthier lifestyles, better sanitation, and less physically stressful occupations would tend to effect the cohort throughout their lifetime. During this period the number of beds increased as did various community service provision indicators. There were new initiatives in developing community services to cater for medical needs together with social needs, which may have resulted in shorter duration of stay. At the same time the increasing number of places in long-term residential care may also have contributed to this period effect. Finally, there had been a constant pressure on each service unit to reduce duration of stay in order to cope with increasing numbers of people waiting for admission (both clinical admissions for investigations for specialties, e.g., cardiac procedures, various endoscopies, sleep studies, etc., as well as emergency admissions), such that duration of stay formed one of the performance measures for clinical units. There was a constant review process to provide service in a more efficient way, with re-organization, and development of new models of care that may also have contributed to the trend toward reduction in length of stay. Compression of morbidity was not a likely factor contributing to this trend, since no cohort effect was demonstrated. It is possible that the trend in reduction in duration of stay together with the trend in increasing number of admissions may reflect the revolving door phenomenon (Yu et al. 2007).

There are limitations to this study. We were unable to capture all the mortality data, because a small proportion used the private sector and the pattern would be different. Nevertheless, the ratio of hospital discharges from HA hospitals to private hospitals remained fairly constant during this period, according to the Hospital Authority Annual Statistical Reports, so that the period effect for duration of stay was unlikely because of increasing usage of the private sector. Attendance at general outpatient clinics (GOPC) was not examined, as during this period, the administration of GOPC was transferred from the Department of Health to the Hospital Authority, and computerization was only implemented at a later stage. We did not include use of long-term residential care as one of the indicators of health service usage, although long-term care would be a significant health care cost component. The number of years for which data was available for analysis of cohort effect may have been too short for any significant effect to be detected. Studies in which compression of morbidity were demonstrated included cohorts that cover a ten or more year difference (Hessler et al. 2003).

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