Brief Report

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Tracking hospital costs in the last year of life — The Shanghai experience

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Summary **One aim of the current study was to track end-of-life care using individual data in Shanghai, China to profile hospital costs for decedents and those for the entire population. A second aim of this study was to clarify the effect of proximity to death. Data from the Information Center of the Shanghai Municipal Commission of Health and Family Planning (SMCHFP) were examined. For decedents who died in medical facilities in 2015, inpatient care was tracked for 1 year before death. A total of 43,765 decedents were included in the study, accounting for 35% of total deaths in 2015 in Shanghai. Hospital costs were higher for people who died before the age of 45 (14,228.62 USD) than for those aged 90 or older (8,696.34 USD). The ratio of costs for decedents to the entire population declined significantly with age. Women received less care than men in the last year of life (t = -15.1244, $p < 0.05$). Average tertiary hospital costs per decedent declined significantly with age, whereas average secondary hospital costs increased slightly with age. Among the top 14 causes of death classified using the ICD-10, rectal cancer incurred the greatest costs (13,973 USD per decedent). Over 43% of hospital costs were incurred during the month before death. Declining costs in the last year of life with age as well as with distance to death demonstrate the existence of a proximity to death phenomenon in health care expenses. Disease-specific studies should be conducted and attention should be paid to gender equity when examining end-of-life medical costs in the future.**

Keywords: Aging, proximity to death, health care expenditures

1. Introduction

China is aging rapidly; the proportion of people aged 60 or older has increased from 7.0% in 2000 to 16.1% in 2015 (*1*). According to a population survey in Shanghai, people aged 60 or older accounted for 19.5% of the entire resident population in 2015 while people aged 65 or older accounted for 12.3%. These demographic changes have resulted in increasing demands for health care at the end of life, but to date there is little information about the healthcare expenditures at the end of life, and this is particularly true in developing countries.

Results of international studies have indicated that healthcare expenditures are affected by a proximity to death (PTD) phenomenon. Patients often receive excessive care at the end of life, resulting in mounting medical expenses (*2-5*). PTD can skew the effects of population aging on medical expenses due to the high mortality rate and greater end-of-life medical demands of the elderly (*6*). The PTD phenomenon varies among different age groups, costs, and categories of disease. Polder *et al*. (*4*) and Shugarman *et al*. (*7*) concluded that in the Netherlands and the United States, the average medical expenses in the last year of life were greater for people dying at younger ages (< 70) than older decedents. Gozalo *et al*. (*8*) found that hospice care can substitute for acute medical care at the end of life. An increase in hospice care was related to a 2.4 percentage-

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point reduction in the rate of hospital transfers and a 7.1 percentage-point reduction in care in an intensive care unit (ICU). Older elderly receive more nursing care and palliative care at the end of life but account for fewer ambulatory and hospital costs (*7*), indicating a continuing shift from acute medical care to long-term care late in life. A comparable conclusion was reached by Spillman and Lubitz (*9*). Wong *et al*. (*10*) found that people dying from cancer incur the most costs in the last year of life, while people dying from myocardial infarction incur the least costs. Another study found that payments for care to dying patients accounted for 27.2% to 30.6% of all Medicare payments (*11*).

Better knowledge of the characteristics of healthcare expenditures at the end of life and the combined effect of population aging and proximity to death is crucial to better policymaking. Shanghai is one region of China that faces the early challenges of aging, and Shanghai has accumulated a wealth of experience in health care management and health system reform. Since previous studies were mostly conducted in developed countries, the aims of the current study were to track end-of-life medical care using individual level data in Shanghai, China to profile hospital costs for decedents and those for the entire population; to describe age patterns and differences between causes of death for men and women; and to clarify the effect of PTD.

2. Subjects and Methods

An administrative database from the Information Center of the Shanghai Municipal Commission of Health and Family Planning was used to track the end-of-life inpatient care received by decedents in Shanghai. The database covers all outpatients and inpatients in every type of medical facility in Shanghai in 2015. For decedents who died in medical facilities between January 1 to December 31, 2015, inpatient care received in different medical facilities was tracked for 1 year before death. Hence, decedents with a single hospital stay longer than 1 year were excluded from this study. Medical records were linked at individual level using age, gender, and an identification number. The front page of each medical record was reviewed to obtain information regarding age, gender, type of basic medical insurance scheme, diagnosis, date of admission and discharge, and costs for each category of medical care. The latest record of admission was used to ascertain the cause of death, and the date of discharge served as the date of death. Individuals without basic medical insurance were excluded since most were patients from other provinces. Hence, subjects represent the resident population of Shanghai.

Hospital costs were calculated by gender, age, cause of death, and the level of medical facility. The hospital costs in the 12 months prior to death were calculated for decedents in 2015. Health care expenditures by the entire population in 2015 were calculated as well. Some of those individuals also died in 2015 but in places other than medical facilities for whom we were not able to identify as decedents, which may narrow the gap between decedents and the entire population. Decedents and the entire population were compared only in terms of expenditures in 2015. All Chinese currency figures in this study were adjusted to comparable amounts in USD using the average exchange rate in 2015 (6.2284 RMB = 1 USD).

A *t*-test was used to compare continuous data while a chi-square test was used to compare categorical data. Pearson's correlation coefficient (*r*) was used to analyze the relationship between different variables. Prescriptive and statistical analysis were performed using STATA 13.0, and a significance level of 0.05 was set for hypothesis testing.

3. Results and Discussion

3.1. *Basic characteristics*

A total number of 43,812 decedents were identified though the database. Forty-seven decedents were hospitalized for longer than 1 year in a single stay and were excluded as subjects. As a result, 43,765 decedents who died in medical facilities were included in this study. These individuals accounted for approximately 35% of the total deaths in 2015 in Shanghai. Table 1 shows some basic characteristics of the patients who died in medical facilities in 2015, and 81.77% of those patients were elderly people age 65 or older. Males accounted

Table 1. Basic characteristics of subjects (*n* = 43,765)

Indicators	Values
Age (Mean ± SD)	76.95 ± 12.85
Gender (*n* (%))	
Male	24,312 (55.56)
Female	19,453 (44.44)
Insurance scheme (n (%))*	
UEBMI	35,800 (81.80)
URBMI	4,811 (10.99)
NCMS	1,145 (2.62)
Other type	2,009 (4.59)
Cause of death (*n* (%))	
Cancer	15,115 (34.54)
Circulatory disease	11,464 (26.19)
Respiratory disease	9,825 (22.45)
Other cause	7,361 (16.82)
Level of the medical facility (number of admissions (%))	
Tertiary hospital	46,120 (31.67)
Secondary hospital	89,037 (61.15)
Primary care facility	10,457 (7.18)

*The 3 basic medical insurance schemes in Shanghai include Urban Employee Basic Medical Insurance (UEBMI), Urban Resident Basic Medical Insurance (URBMI), and the New Rural Cooperative Medical Insurance System (NCMS), which cover over 95% of the residents of Shanghai.

Table 2. Average annual hospital costs per person, in USD

Age group (year)	In the last year of life			Regardless of proximity to death		
	Female	Male	Both	Female	Male	Both
< 1	3,150.63	3,848.27	3,499.45	1,011.09	1,336.91	1,179.47
1~4	14,429.82	30,427.14	25,094.70	128.84	170.83	151.16
5~9	3,322.60	30,384.53	16,853.56	89.50	120.63	106.11
10~14	9,632.01	23,167.09	16,399.54	78.80	116.23	98.64
15~19	11,714.65	17,546.21	14,769.27	77.64	88.61	83.60
20~24	21,214.21	7,480.24	14,347.23	84.37	55.70	68.98
25~29	18,380.35	23,404.55	20,740.21	147.49	72.54	108.77
30~34	11,533.36	15,106.30	13,221.36	153.01	83.88	117.48
35~39	16,060.05	16,310.53	16,184.57	133.82	99.95	116.04
40~44	11,625.88	10,803.46	11,109.14	154.28	140.39	146.89
45~49	11,154.63	11,520.36	11,383.00	232.53	227.36	229.79
50~54	10,900.00	11,289.01	11,161.00	281.53	297.57	290.04
55~59	12,649.24	11,299.42	11,727.94	322.34	403.06	363.48
60~64	11,079.94	11,010.75	11,032.37	397.82	533.91	465.72
65~69	10,494.43	10,842.19	10,730.47	529.61	700.95	616.98
70~74	9,822.30	9,997.73	9,935.38	676.15	925.11	800.79
75~79	8,628.57	9,127.05	8,916.77	889.10	1,142.69	1,008.11
80~84	7,834.50	8,812.16	8,352.74	1,131.81	1,442.54	1,264.63
85~89	7,417.46	10,360.24	8,818.95	1,468.18	2,255.46	1,771.05
≥ 90	6,356.31	11,819.05	8,696.34	1,509.07	3,022.85	2,007.90

Note: Costs have been converted into USD using the average exchange rate in 2015 (the same applies to the table below). Costs for both genders mean the average costs for both genders in each age group. Costs regardless of proximity death refer to the average costs for the entire population of Shanghai in 2015.

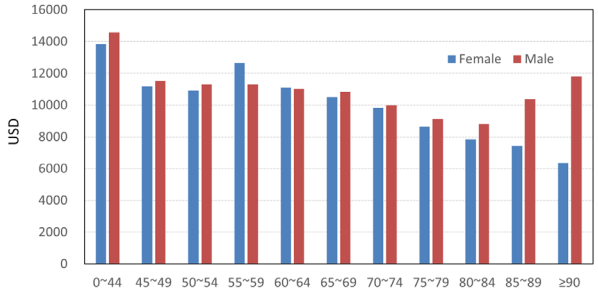


Figure 1. Average hospital costs (in USD) per decedent in the last year of life by age and sex in 2015.

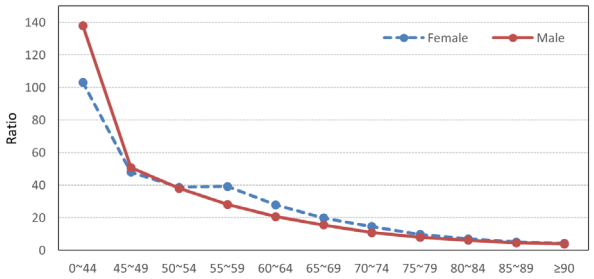


Figure 2. Ratio of average hospital costs for decedents in the last year of life to average costs for the entire population, by age and sex, in 2015.

for 55.56%. The most frequent cause of death was cancer, which accounted for 34.54% of deaths among decedents, followed by circulatory diseases (26.19%) and respiratory diseases (22.45%). Most inpatient care received during the last year of life was provided at secondary (61.15%) and tertiary hospitals (31.67%), and only 7.18% was provided at primary care facilities.

3.2. *Age and gender*

The per person-year hospital costs in 2015 by sex, age, and PTD are shown in Table 2. Costs for the entire population (regardless of PTD) varied more than 18-fold from 106.11 USD for individuals aged 5-9 to 2,007.90 USD for individuals over the age of 90.

Hospital costs in the last year of life were inversely related to age (Figure 1). Costs were 14,228.62 USD for individuals aged 0-44 compared to 8,696.34 USD for individuals aged 90 or older (r = -0.0894, $p < 0.05$). This inverse relationship was more evident among women (r = -0.1746, $p < 0.05$), while for men the average hospital costs rebounded after the age of 85. This can be partly explained by the different age patterns for men and women to seek health care at different levels of facilities.

Hospital costs in the last year of life decline with increasing age at death (Figure 1). Our figures demonstrated that in Shanghai, people who died at age 95 or older accounted for about 80% of inpatient expenditures compared to decedents aged 65-70. This decrease is relatively smaller than that found in other studies and might be affected by filial piety in Chinese culture. Polder *et al*. (*4*) and Serup-Hansen *et al*. (*12*) estimated a larger decrease in the Netherlands and in Denmark, while the figure for Germany was about 43-47% (*13*). For the United States, the figure was about 40% (*14*) or 52% (*15*).

The ratio of costs for decedents and the entire population declines with increase in age. Figure 2

Table 3. Hospital costs in the last year of life by gender and cause of death*

Items	Average costs per decedent (USD			Total costs	
	Female	Male	Both	USD 1mln	%
Rectal cancer	13,127	14,421	13,973	8.97	1.69
Colon cancer	12,876	14,577	13,795	16.50	3.11
Stomach cancer	12,585	13,930	13,418	22.58	4.26
Respiratory failure	11,787	13,826	12,934	13.63	2.57
COPD	10,821	13,757	12,785	31.83	6.01
Sequelae of cerebrovascular disease	12,091	13,372	12,692	13.45	2.54
Other respiratory disorders	10,437	14,355	12,500	40.72	7.68
Pancreatic cancer	11,711	12,949	12,384	13.77	2.60
Chronic ischemic heart disease	10,476	14,640	12,275	40.24	7.59
Lung cancer	11,010	12,511	12,092	44.26	8.35
Pneumonia	9,206	13,670	11,675	23.22	4.38
Liver cancer	9,348	10,841	10,435	14.39	2.71
Stroke	7,982	9,100	8,562	30.57	5.77
Myocardial infarction	7,566	8,741	8,230	5.51	1.04
Other cause	11,273	13,782	12,584	210.47	39.70
Total	10,777	13,181	12,113	530.11	100.00

*Average costs per decedent in USD. Total costs for all decedents in 2015 (million USD, share in %)

shows that the ratio of costs declines for both males and females, with a ratio of almost 120 for people under the age of 45 to a ratio of less than 5 for people aged 85 or older. Women aged 50-79 had a relatively high ratio of costs in comparison to men. This was caused by lower costs for the entire female population instead of higher costs for female decedents. An average cost ratio of 32.9 was found between decedents and the whole population with a broad range from 4.3 to 119.5. This ratio is higher than that reported by Polder *et al*. (*4*), who reported an overall ratio of 13.5 (from 30 to less than 5), and that reported by Serup-Hansen *et al*. (*12*), who estimated ratios of 9.4 and 13.3 for Danish men and women, respectively. The ratio for the elderly population (from 17.4 to 4.3 for those aged 65 or older) was comparable to that reported by McGrail *et al*. (*2*), who reported a ratio ranging from 16.6 to 2.5 for the Canadian population aged 65 or older.

Economists have long regarded health as one form of human capital (*16-18*). According to Theodore W. Schultz, investment in health enhances the quality of human resource, which is one of the main drivers of economic growth (*19*). In Michael Grossman's model of the demand for health, health can be viewed as a durable capital stock that produces an output of healthy time, and investment in health is assumed to increase productivity and to yield greater economic benefits (*20*). The inverse relationship between end-of-life hospital costs and age at death could partly be explained by the combination of these two theories. The younger population is believed to have a longer life expectancy and greater productivity, hence investment in the health of young people is expected to yield greater economic benefits, especially at the end of life.

3.3. *Cause of death*

The top 14 causes of death were classified based on the ICD-10 to determine the relationship between the type of disease and end-of-life hospital costs. Of all decedents, 61.77% died from one of those 14 diseases. The most prevalent cause of death was lung cancer, accounting for 8.35% of total hospital costs.

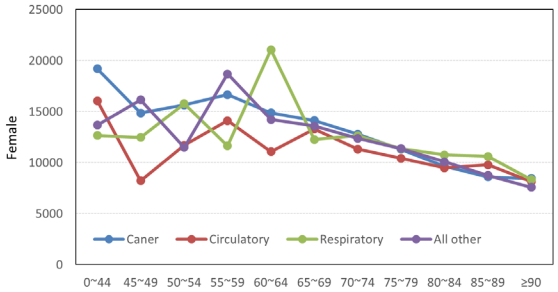
A stroke or heart attack incurred relatively low costs, with an average of 8,562 and 8,230 USD, respectively, per decedent. This was partly due to the high fatality of these diseases. The average costs of rectal cancer appeared to be the highest (13,973 USD per decedent), though the overall burden did not seem to be severe (costs for rectal cancer accounted for 1.69% of total costs). Costs of the top 14 causes of death varied significantly ($F = 19.47$, $p < 0.05$), indicating that costs vary more widely among people dying from different diseases than among people dying of a certain disease (Table 3). Hence, more disease-specific studies of end-of-life medical costs should be conducted to further understand the effects of population aging and epidemiological changes on health care expenditures.

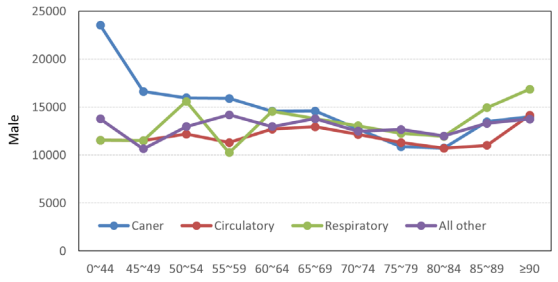
For people dying from different disease groups, the declining age pattern of end-of-life hospital costs was less prominent for men than for women, especially after 69 years old. The average hospital costs for men who died from a certain cause slightly rebounded after the age of 84, which was consistent with the age patterns of total inpatient expenditures. Hospital costs for people dying from cancer declined sharply at younger ages (< 45), especially for men. Circulatory diseases incurred lower costs and costs varied less among different age groups (Figure 3). In each category of disease, men had higher average costs than women ($p < 0.05$). In general, the deceased cancer patients generated higher hospital costs than patients dying from other major disease ($F = 50.42$, $p < 0.05$).

3.4. *Facilities*

Average tertiary hospital costs per decedent declined significantly with age (r = -0.0678, $p < 0.05$), whereas average secondary hospital costs increased slightly with age (r = 0.0128, $p < 0.05$), exceeding the costs incurred at tertiary hospitals for individuals after age 79. Figure 4 shows some notable differences in the age patterns of decedents and the entire population seen at secondary and tertiary hospitals. The age pattern of tertiary hospitalization costs is contrary for decedents and the entire population, in spite of the particularly high costs for decedents, while for secondary hospitals the age pattern for decedents and the entire population is almost the same. Such a difference reflects, to a certain extent, the different characteristics of care provided at secondary and tertiary hospitals in Shanghai due to variations in the severity of disease. More advanced medical technologies and care are provided at tertiary hospitals while secondary hospitals mainly provide rehabilitation, nursing, and other less-intensive care.

Older terminal patients received a greater proportion of inpatient care at the primary care level, indicating that elderly patients are more likely to go to community health centers for care at the end of their lives. However, according to Shanghai Statistical Yearbook 2016, the limited number of beds at the community care level in Shanghai (17,099 beds, accounting for 14% of the total) may mean that the healthcare needs of terminal patients are not being met. According to Hartman *et al*. (*21*), an increase in nursing home care has resulted in a decrease in the ratio of costs for people aged 85 or older and the working-age population. In Shanghai, the average hospital costs per decedent in primary care facilities were 30% of the costs in tertiary hospitals (Figure 5). Allocating additional resources to primary care and encouraging patients to be seen





Average costs per decedent (USD) (*$p < 0.05$)

	Cancer	Circulatory	Respiratory	Other cause
Gender				
Female	12400.00	9645.32	10426.90	10366.25
Male	13647.51*	11825.86*	13912.96*	12960.31*

Figure 3. Average hospital costs (in USD) in the last year of life for people who died in 2015, by age and cause of death.

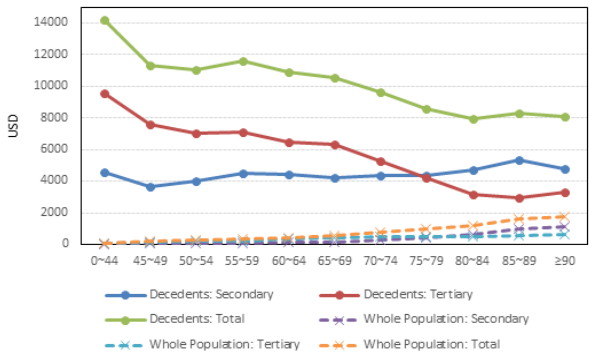
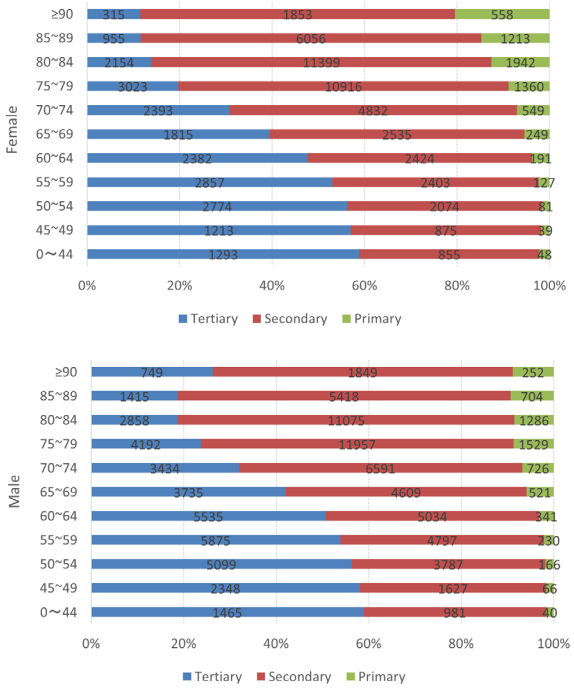


Figure 4. Average hospital costs (in USD) for decedents in their last year of life and the entire population in 2015, by age and level of hospital. Secondary hospitals: mainly provide rehabilitation, nursing, and other less-intensive care, versus Tertiary hospitals: mainly provide more intensive care.



Level	Number of patients (%)	Average costs per patient (USD)
Tertiary	16,439 (28.49)	13754.55*
Secondary	35,192 (60.98)	10178.71*
Primary	6,080 (10.54)	4009.10

(*$p < 0.05$)

Figure 5. Admissions to different levels of medical facilities in the last year of life for people who died in 2015, by age and level of facility.

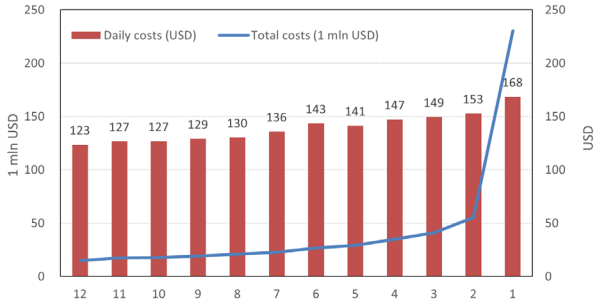


Figure 6. Hospital costs (in million USD) and daily costs (in USD) over the last 12 months of life.

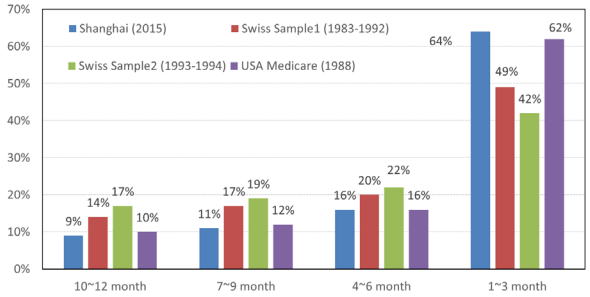


Figure 7. Hospital costs over the last four quarters of life for people aged 65 or older.

at primary care facilities are key ways to use funds more efficiently, even though the end-of-life care is still predominantly provided by hospitals. Healthcare resources at the level of primary care, and particularly nursing and hospice resources, need to be enhanced in Shanghai so that healthcare needs at the end of life can be met and healthcare costs can be curtailed.

The current study indicated that there were significant sex differences (t = -15.1244, $p < 0.05$) in hospital costs in the last year of life (higher in men). This finding differs from results of other studies (*5*). This is partly due to the absence of sudden death, reflecting a higher incidence rate among males (*e.g.* death from road accidents or occupational injuries). Another possible explanation is the difference in medical facilities where individuals are seen, and especially the older elderly. Admissions to tertiary hospitals declined with age. Except that among men aged 85, the proportion of admissions to tertiary hospitals started to increase, from 18.77% for individuals aged 85-89 to 26.28% for individuals aged 90 or older (Figure 5). The average hospital costs per patient in tertiary hospitals are higher than those of lower level medical facilities ($p < 0.05$), so the difference in health-seeking behavior in later life might cause a difference in health care expenditures by men and women. The reasons for these differences in health-seeking behavior by men and women need to be further explored. The influence of social attitudes, in combination with the human capital theory, could explain gender differences in end-of-life medical costs. When men suffer from a severe disease, they are more likely to receive intensive and extensive medical care. Hence, more attention needs to be paid to gender equity in the provision of health care.

3.5. *PTD*

In the current study, over 43% of hospital costs for decedents in the last year of life were incurred during the month before death, and that proportion declined significantly with the distance to death, dropping to 2.78% in the 12th month before death. Lubitz and Rily (*11*) reported comparable results; in both 1976 and 1988, about 40% of the Medicare costs in the last year of life were incurred in the last 30 days. Upon reflection, the current study indicated that the average daily hospital costs increased gradually with PTD by 36.59% from 123 USD 12 months before death to 168 USD 1 month prior to death (Figure 6). Felder *et al.* (*22*) found that in OECD countries, medical expenses were mainly spent on diseases at the end of life. Their finding that medical expenses increased abruptly in the last month of life indicated that PTD is a major factor influencing medical expenditures. Seshamani and Gray (*23*) found that the impact of aging on health care expenditures might be affected by PTD due to the concentration of morbidities and costs in the last year of life. Another study noted higher general practitioner costs closer to death, while finding that costs were not significantly impacted by age (*24*). Most studies have concluded that age has less of an impact than PTD (*2,23,25,26*), while one study that controlled for PTD found that population aging was an important factor influencing the increase in medical expenses (*27*).

Figure 7 shows health care expenditures for people aged 65 or older during the last year of life according to different studies. In the current study, hospital costs incurred in the last quarter of life accounted for 64% of the cumulative hospital costs in the last year of life. In the United States, about 60% of all Medicare payments were incurred in the last quarter of life, and this share has remained unchanged since 1976 (*11*). In two Swiss samples, the proportion of health care expenditures (based on payments to sick funds) in the last quarter of life amounted to 49% and 42% (*6*). Medical expenditures in the last 4 quarters of life in Shanghai have a distribution like that of the Medicare figures. The surge in costs near death in the Swiss samples is less marked than in the corresponding data from Shanghai and the US, which may be attributable to the high rate of government subsidization of institutional care in Switzerland. Health care received increases closer to death, so the increase in medical expenses could have been mitigated.

Theoretically, due to the co-existence of a PTD phenomenon and prolonged life expectancy, the decline in age-specific mortality rates over time postpones

death to later ages, pushing back death-related costs. The occurrence of a PTD phenomenon further reveals how aging causes an increase in healthcare spending. The rise in healthcare expenditures is not merely the result of age and health status but is also influenced by other key factors such as end-of-life care and changes in patterns of seeking healthcare. The combined effect of age and population size (caused by longer life expectancy) has resulted in a larger number of people with vast medical needs, challenging the sustainability of the healthcare and financing system.

One limitation of the current study is that subjects were only decedents who died in medical facilities while a large proportion of individuals (over 60%) died at home or somewhere else. This may decrease the generalizability of the current findings.

In conclusion, hospital costs for the entire population appear to increase with age. However, declining costs in the last year of life with increasing age as well as with distance to death demonstrate the existence of a PTD phenomenon in health care expenses. The combined effects of population aging and greater costs closer to death pose a substantial challenge to future projections of health care expenditures. Disease-specific studies should be conducted and attention should be paid to gender equity when examining end-of-life medical costs in the future.

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