

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

End-of-life cost and its determinants for patients with malignant neoplasms in urban China: A population-based retrospective study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-026309
Article Type:	Research
Date Submitted by the Author:	29-Aug-2018
Complete List of Authors:	Li, Zhong; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management Pan, Zijin; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management ZHANG, LIANG; Huazhong University of Science and Technology Tongji Medical College He, Ruibo; Huazhong University of Science and Technology Tongji Medical College, Jiang, Shan; Nanjing Medical University, School of Health Policy and Management Xu, Chengzhong; Yichang Center for Disease Control and Prevention Lu, Fangfang ; Yichang Center for Disease Control and Prevention Zhang, Pei; Yichang Center for Disease Control and Prevention, Yichang Li, Boyang; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management
Keywords:	cancer patients, end-of-life, utilisation, expenditure, retrospective study, urban China

SCHOLARONE™
Manuscripts

1
2
3 **1 End-of-life cost and its determinants for patients with malignant neoplasms in**
4 **2 urban China: A population-based retrospective study**

5
6
7 3 Zhong Li ^{1#}, Zijin Pan ^{1#}, Liang Zhang¹, Ruibo He¹, Shan Jiang², Chengzhong Xu³,
8
9 4 Fangfang Lu³, Pei Zhang³, Boyang Li^{1*}

10
11 5 1. School of Medicine and Health Management, Huazhong University of Science and
12
13 6 Technology, Wuhan, Hubei, 430030, China; 2. School of Health Policy and
14
15 7 Management, Nanjing Medical University; 3. Yichang Center for Disease Control and
16
17 8 Prevention, Yichang, Hubei, 443000, China

18 9 # Zhong Li and Zijin Pan contributed equally.

19
20 10 * Corresponding author: Boyang Li, E-mail: jimmylee1900@foxmail.com

21
22 11 Address for correspondence: No.13 Hangkong Road, Qiaokou District, School of
23
24 12 Medicine and Health Management, Tongji Medical College, Huazhong University of
25
26 13 Science and Technology, Wuhan, Hubei, 430030, China

27 14 **Abstract**

28
29 15 **Objective** This study aimed to define end-of-life (EOL) healthcare utilisation and its
30
31 16 cost and determinants for patients with malignant neoplasms (PMNs) and to
32
33 17 proactively provide reference for related strategies in mainland China.

34 18 **Design** A population-based retrospective study.

35
36 19 **Setting and Participants** Data of 894 patients with PMNs were collected in the urban
37
38 20 Yichang, China from 1 July 2015 to 30 June 2017.

39
40 21 **Outcome measures** Emergency department (ED) visits, hospitalisation, intensive
41
42 22 care unit (ICU) admission and total costs were used as the main outcomes.

43
44 23 **Results** 66.78% of 894 patients were male, and the average age was 60.4 years.
45
46 24 Among these patients, 37.58% died at home with an average of 4.86 outpatient
47
48 25 services, 2.23 inpatient services and 1.44 ED visits. Additionally, 8.2% of these
49
50 26 patients who died at home once visited of ICU. During the EOL periods, the costs in
51
52 27 last 6 months, last 3 months, last 1 month and last 1 week were \$18235, \$13043,
53
54 28 \$6349 and \$2085, respectively. The cost increased dramatically as death approached.
55
56 29 The estimation results of generalised linear regression model showed that aggressive
57
58 30 care substantially affects expenditure. Patients with Urban Employee Basic Medical

1
2
3 1 Insurance spent more than those with Urban Resident-based Basic Medical Insurance
4 and New Rural Cooperative Medical Scheme. Place of death and survival time are
5
6 2 also the risk factors for the increased EOL cost.
7

8
9 4 **Conclusion** The findings suggested that the health expenditure for PMNs is
10 associated with aggressive care, insurance type and survival time. Timing palliative
11
12 5 care is urgently needed to deal with the irrational healthcare utilisation and reduce the
13
14 6 cost.
15

16 8 **Trial registration** This study was approved by the ethics committee of Tongji
17
18 9 Medical College, Huazhong University of Science and Technology (IORG no.
19
20 10 2018S291). All the data used in this study were de-identified.

21 11 **Keywords**

22
23 12 cancer patients, end-of-life, utilisation, expenditure, retrospective study, urban China
24

25 13 **Strengths and limitations**

26
27 14 This population-based study was the first to systematically estimate the EOL health
28
29 15 expenditure for patients with cancer in mainland China. Estimating the palliative care
30
31 16 demand and guiding its system-building are important.

32
33 17 This study introduced EOL healthcare and cost in China and quantified the
34
35 18 relationship between them.

36
37 19 This study will guide health policy regarding the delivery of high-quality,
38
39 20 cost-effective cancer care system.

40
41 21 Given the anonymity of the data, we cannot obtain the health records from primary
42
43 22 care facilities. Thus, the EOL healthcare cost might have been underestimated.

44
45 23 The unique socioeconomic status of the selected cohort population may reduce the
46
47 24 generalisability of our findings. Further studies on the provincial or national level are
48
49 25 essential to provide systematic evidence for policy makers.
50
51
52
53
54
55
56
57
58
59
60

1 Introduction

2 Cancer is the leading cause of mortality and accounts for 14.1 million new cancer
3 cases and 8.2 million deaths worldwide, thereby resulting in 32.6 million individuals
4 living with cancer in 2012 [1]. Cancer greatly affects low- and middle-income
5 countries and is expected to account for 70% of the newly reported cancer by 2030 [2].
6 Given the considerable share of the total health expenditure on cancer (approximately
7 6% in European countries [3], 9.2% in Taiwan) [4 5]) and the staging 5/80 cancer
8 disequilibrium between developed and developing countries[2], evaluating end-of-life
9 (EOL) cost and identifying its key determinants have been a worldwide concern [6].
10 Several systematic reviews pointed out that EOL in-home care can improve patient
11 satisfaction, thereby reducing hospital care utilisation and death [7 8]. These reviews
12 also indicated that aggressive procedures do not improve the quality of life [9 10].
13 However, the health expenditure and utilisation show large geographic variations
14 among patients in the USA with high medical care intensity at the EOL, thereby
15 producing poor outcomes and confusing the patients' preference [11-13]. EOL
16 hospitalisation relatively lacks value worldwide with unsustainable expenditure [14
17 15], and palliative care is relatively underutilised though is proven to save cost [16].
18 These phenomena thereby aggravate the inequality among patients with different
19 economic levels or health insurance types and decrease the overall efficacy [17-19].
20 According to the Fifth Chinese National Health Services Survey in 2013, the
21 incidences of malignant neoplasms in China reached 0.35% and 0.23% in the urban
22 and rural areas, respectively, which are higher than those in 2008 [20]. The most
23 common cancer types in China are lung cancer and stomach, liver and oesophageal
24 cancer, accounting for 22% and 27%, respectively, of global new cancer cases and
25 deaths [21]. Although the age-standardised 5-year relative survival has increased from
26 30.9% (2003–2005) to 40.5% (2012–2015), the geographical differences in cancer
27 survival still remain [22]. The Program of Cancer Prevention and Control in China
28 (2004–2010) reported that the decreased mortality rates and substantial geographic
29 variation in the survival rate have become a burden to the health system, especially
30 the high out-of-pocket (OOP) expenditure [21 23]. The Economist Intelligence Unit

1 pointed that China ranked 71st among 80 countries in a survey on the quality of death
2 [24]. A cross-sectional study in China found that OOP expenditures account for 57.5%
3 of the annual household income [25]; this percentage is higher than the household
4 income (23.7%) in the USA [26]. Given the limitation of medical insurance coverage
5 and reimbursement rate, patients with malignant neoplasms (PMNs) and their families
6 face extremely high health expenditure [27 28]. Hospital type, education, insurance
7 type and household income can also predict the expenditure of cancer care [25].
8 Research on the EOL healthcare cost in mainland China received considerable interest
9 in terms of policy; studies pointed out that some treatments for PMNs in the tertiary
10 hospital are unnecessary, especially during the patients' last days [21 29 30]. However,
11 cross-sectional studies mainly focus on the total healthcare cost limited to
12 single-institutional level, thus underestimating the actual expenditure [31].
13 Population-based study examining the EOL healthcare expenditure and its
14 determinants has not been explored, especially in terms of the real-world data of the
15 regional health system in urban China. According to the International Statistical
16 Classification of Diseases and Related Health Problems 10th Revision (ICD-10), the
17 WHO version for 2016 [32], the present study selected patients diagnosed with
18 C00-C97 in urban Yichang, China.

19 **Methods**

20 **Data collection**

21 Residents who died from malignant neoplasms from 1 July 2015 and 30 June 2017 in
22 urban Yichang, China were continuously enrolled in this study. The demographic
23 information of cancer decedents was collected from the National Population Death
24 Registration and Management System established in 2013. Data on the place of death,
25 cancer type and date of death were obtained from the National Decedent Registration
26 Database. All healthcare utilisation and cost data were provided by the Yichang
27 Health Management Centre affiliated to the Yichang Centre for Diseases Control and
28 Prevention integrating hospital information system, health insurance database and
29 population information database with the identification card number. This study was
30 approved by the ethics committee of Tongji Medical College, Huazhong University of

1
2
3 1 Science and Technology (IORG no: 2018S291).

4 2 **Variables**

5
6
7 3 Patients were divided into three groups, such as those younger than 65 years, 65–80
8
9 4 years old and those 80 years or older when diagnosed [21]. Gender and survival time
10
11 5 were also divided into four types [33], namely, education, marriage status, cancer type
12
13 6 and medical insurance type. The place of death was routinely coded as a binary
14
15 7 independent variable. The recommended benchmark measures for terminal cancer
16
17 8 care were used to identify the aggressive and palliative procedures [34-38]. The
18
19 9 primary outcome was healthcare utilisation, including hospitalisation services,
20
21 10 outpatient services, emergency department (ED) visits and intensive care unit (ICU)
22
23 11 admission. The secondary outcome was total expenditure. To compare the results, we
24
25 12 converted the cost data to the international purchasing power parities by using rate for
26
27 13 Chinese Yuan to US dollars (¥2.03=\$1) in health from the International Comparison
28
29 14 Program 2011[39].

30 15 **Patient and public involvement**

31
32 16 This study aimed to define end-of-life (EOL) healthcare utilisation and its cost and
33
34 17 determinants for decedents with PMNs based on a population-based retrospective
35
36 18 study. All the data were provided by the Yichang Health Management Centre
37
38 19 affiliated to the Yichang Centre for Diseases Control and Prevention and de-identified
39
40 20 before statistical analysis. Therefore, decedents were not involved in the recruitment
41
42 21 or implementation of this study. The results will not be disseminated to the decedents.

43 22 **Statistical analysis**

44
45 23 Descriptive analysis was used to describe the detailed information about the enrolled
46
47 24 population. Generalised linear model was used to evaluate the mechanism of the
48
49 25 effect of independent variables on the EOL cost because the EOL data were severely
50
51 26 positive skewed [40 41]. For the regression model, the EOL cost was the outcome
52
53 27 variables, and the independent variables are as follows: (1) age (<65, 65–80 and 80
54
55 28 years and above), (2) gender (male/female), (3) education level, (4) marital status, (6)
56
57 29 first cancer type, (7) medical insurance type, (9) number of ED visit, (10) number of
58
59 30 ICU admission and (11) survival time. All the above-mentioned data were calculated

with Stata 14.0. Differences at $P < 0.05$ were considered statistically significant.

Results

Table 1. Basic characteristics of the enrolled patients

Demographic characteristics	patients (N=894)	%
Age (year), Median (range)	69 (25,102)	
<65	315	35.23
65-80	440	49.22
>80	139	15.55
Gender		
Male	597	66.78
Female	297	33.22
Marital status		
Unmarried	9	1.01
Married	742	83.00
Widow	126	14.09
Divorced	17	1.90
Insurance type		
Urban Employee Basic Medical Insurance (UEBMI)	518	57.94
Urban Resident-based Basic Medical Insurance (URBMI)	181	20.25
New Rural Cooperative Medical Scheme (NRCMS)	195	21.81
Education		
Junior school or below	675	75.5
Senior school	141	15.77
college or above	78	8.72
Place of death (POD)		
Health institution	558	62.42
Home	336	37.58
Survival time from cancer diagnosis		
< 3 months	261	29.19
3-6 months	233	26.06
7-12 months	216	24.16
> 12 months	184	20.58

Characteristics of the patients and ICD-10 code

As shown in Table 1, 894 patients were identified. The median age of enrolled patients was 69 (range, 25–102) years, 35.23% of which were younger than 65 years, and 15.55% were older than 80 years. Over half (66.78%) of these of the patients were male, and 83% of these male patients were married. A total of 57.94% of the patients were enrolled in the Urban Resident-based Basic Medical Insurance (URBMI). Over 75% of the patients finished junior school or below, and 44.74%

1 survived for at least 6 months. A total of 62.42% of the patients died at hospitals. As
 2 shown in Table 2, The most common cancer types were lung cancer (34.68%), liver
 3 cancer (13.98%) and colorectal cancer (9.51%).

4 **Healthcare utilisation and cost**

5 As shown Table 3, the average number of outpatients and hospitalisation services
 6 were 4.86 and 2.23 times per capita, respectively. The ED visits and ICU were 1.44
 7 and 0.06 times per capita, respectively. A total of 5.9% (53/894) of the patients were
 8 admitted once into the ICU, and 49.7% (444/894) visited ED only once. The average
 9 expenditures per capita during the last 1 week, 1 month, 3 months and 6 months were
 10 \$2085, \$6349, \$13043 and \$18235, respectively. The costs in the last 1 week, 1 month
 11 and 3 were 11.4%, 34.8% and 71.5% of the last 6 months.

12 **Table 2. The ICD-10 codes of first cancer type when diagnosed**

13 First cancer type	codes	patients (N=894)	%
Lung	C34.x	310	34.68
Stomach	C16.x	60	6.71
Colorectum	C18.x, C19.x, C20.x	85	9.51
Liver	C22.x	125	13.98
Pancreas	C25.xl	39	4.36
Biliary tract	C23.x, C24.x	19	2.13
Blood	C81.x-C86.x, C91.x-C95.x	0	0
Prostate	C61.x	15	1.68
Breast	C50.x	28	3.13
Others	C00.x-C15.x, C17.x, C21.x, C26.x, C30.x-C33.x, C37.x-C41.x, C43.x-C49.x, C51.x-C58.x, C60.x, C62.x, C80.x, C88.x, C90.x, C96.x, C97.x	213	23.83

13 **Table 3. Healthcare services utilization and cost***

14 Variable	mean	Std. error	median	range
15 Outpatient services	4.86	7.67	2	59
hospitalization services	2.23	2.16	2	39
Emergency department visit	1.44	2.91	1	13
Intensive care unit admission	0.06	0.25	0	2
Cost during the last 1 week	2085	6829	1195	66437
Cost during the last 1 month	6349	18469	6640	195182
Cost during the last 3 months	13043	37434	13901	431158
Cost during the last 6 months	18234	34583	19276	723144

14 * the International Purchasing Power Parities using rate for Chinese Yuan to US dollars (¥2.03=\$1)
 15 in health from International Comparison Program (ICP) 2011.

1 **Determinants of EOL healthcare cost**

2 As shown in Table 4, all the results revealed proportionate increase/decrease in the
3 health expenditures among different groups. In the four generalised linear models, the
4 patients with different genders, marital statuses and education levels showed
5 statistically insignificant differences in the four kinds of cost. High EOL healthcare
6 expenditure was associated with the age of first diagnosis, insurance type, place of
7 death, survival of time after diagnosis and aggressive care services. In terms of the
8 cost in last 6 months, old patients (>80) spent 27.2% ($P=0.010$), which is less than of
9 young patients (<65, 65–80) at 25.5% ($P=0.011$). The difference ($OR=0.638$, $P=0.039$)
10 between old patients (>80) and relatively younger patients (65–80) increased the cost
11 during in the last 1 week. Patients with the Urban Employee Basic Medical Insurance
12 (UEBMI) spent higher than those with Urban Resident-based Basic Medical
13 Insurance (URBMI) and the New Rural Cooperative Medical Scheme (NRCMS)
14 groups did in the last 6 months ($OR=1.691$, $P<0.001$; $OR=1.471$, $P=0.006$), 3 months
15 ($OR=1.960$, $P<0.001$; $OR=1.474$, $P=0.011$) and 1 month ($OR=1.840$, $P=0.001$;
16 $OR=1.474$, $P=0.011$). Patients with NRCMS spent 33.2% ($P=0.019$) and 66%
17 ($P=0.033$) higher than the URBMI group did in the last 6 months and 1 week,
18 respectively. The difference between the UEBMI and NRCMS groups was
19 statistically insignificant ($P=0.151$). Patients who died in the hospitals spent 1.364-
20 ($P=0.002$), 1.878- ($P<0.001$), 3.227- ($P<0.001$) and 5.362-fold higher ($P<0.001$) than
21 those died at home during the four EOL periods. The healthcare expenditures during
22 the last 6 months of the patients who survived for 3–6, 7–12 and >12 months were
23 30.4% ($P=0.010$), 43.8% ($P=0.001$) 39.2% ($P=0.018$) higher than those of the
24 reference group, respectively (<3 months). For the healthcare expenditure during the
25 last 3 months, the expenditures of the patients who survived for 7–12 and >12 months
26 were lower than those of the reference group (<3 months). Differences between the
27 four groups were also observed on the healthcare expenditure during last 1 month and
28 1 week. For the survival time, the mean costs estimated during the last 1 week of the
29 groups who survived for 3–6 ($OR=1.776$, $P=0.017$) and 7–12 months ($OR=1.557$,
30 $P=0.342$) were higher than those of the group with longest survival time (>12

1 months).

2 **Discussion**

3 In this study, patients with end-stage cancer have high rates of hospitalisation and an
4 average admission of 2.23 times in the last 6 months of life. A total of 5.9% of the
5 patients with cancer had used ICU services during the EOL period. A comparative
6 study in 7 developed countries showed that 40.3% of patients were admitted in the
7 ICU in USA and approximately 18% in the 6 other countries [59]. The mean cost is
8 \$18234 per capita which is lower than those of developed countries, such as Canada
9 (US \$21840), Norway (US \$19783), the US (US \$18500) [42], South Korea, Japan
10 and Taiwan (annual cost of \$68,773 in 2010) [43]. The cost increased dramatically as
11 death approached. Considering the irrational utilisation and the EOL expenditures
12 trajectory, the risk factors of the high EOL cost must be investigated.

13 High EOL healthcare expenditure was associated with young age due to high hospital
14 care intensity. This result is consistent with those of previous studies [44-46].
15 Different studies indicated that gender [46 47] and marital status [48] were not
16 facilitative determinants of the increased EOL healthcare cost. Striking disparities
17 were also observed among the different medical insurances; this finding is consistent
18 with the study of Zeng H et al. [49]. Patients enrolled in NRCMS spent more than
19 those enrolled in URBMI during the last weeks. This phenomenon may be related to
20 the traditional Chinese concept on death and suggests irrational utilisation and
21 low-value service provision [50]. However, this finding is inconsistent with the
22 patient's preference to receive relatively passive care in Taiwan [20]. Cost also
23 depends on the place of death, and it increased rapidly as death approached. The
24 percentage (62.42%) of patients who died in hospitals in China was higher than those
25 in the USA (29.5%) and Canada (52%) [42]. However, 74% of non-hospice
26 beneficiaries died in hospitals or skilled nursing facilities as compared with the 14%
27 who died receiving hospice care in the USA [51]. When the effect of survival time on
28 cost was examined, patients that survived for <3 months spent more than the other
29 groups did. This result is different from the findings of Obermeyer Z, et al. [52],
30 thereby suggesting that the patients with poor cancer prognosis in the present study

1 may have high rates of aggressive care at the EOL period. However, the ED visit in
2 China is not a risk factor for the increase in cost, which may be due to the current
3 operation process wherein patients are usually hospitalised once admitted during ED
4 visits [53].

5 The above-mentioned results indicated that numerous health resources in China are
6 irrationally used similar to in other countries [54]. The overuse of aggressive care
7 during the EOL period can be harmful from the patient's perspective [18], and the
8 patients receiving hospice care experience an improved quality of death [12]. Hence,
9 the healthcare need of patients should be satisfied. The timely initiation of hospice or
10 home care may reduce the low-value cancer healthcare services in China because
11 EOL hospice or home care can reduce the hospital care and cost [55], and individuals
12 in EOL period in home or hospice programs have twice as high possibility to have a
13 home death than those with usual care [52].

14 **Conclusion**

15 According to real-world data, this study provides comprehensive evidence on the
16 healthcare utilisation and expenditure for PMNs during the EOL period in China. This
17 study revealed the potential irrational utilisation of the medical resources and the
18 urgency to improve hospice care system in China. Overall, this study may aid in
19 formulating specific measures to optimise cancer care delivery system, especially at
20 the germination stage of hospice care system. Future studies should focus on the
21 evaluation of the current system on the provincial or national level.

22 **Abbreviation**

23 EOL, End-of-life;

24 OOP, Out-of-pocket;

25 PMNs, patients with malignant neoplasms;

26 ICD-10, International Statistical Classification of Diseases and Related Health
27 Problems 10th Revision;

28 UEBMI, Urban Employee Basic Medical Insurance;

29 URBMI, Urban Resident-based Basic Medical Insurance;

30 NRCMS, New Rural Cooperative Medical Scheme;

1
2
3 1 CI, Confidence interval

4
5 2 AIC, Akaike Information Criterion

6
7 3 OR, Odds ratio

8
9 4 **Competing interests**

10 5 The authors declare that they have no competing interests.

11
12 6 **Authors' contributions**

13
14 7 Zhong Li, Zijin Pan, Pei Zhang, Liang Zhang and Boyang Li designed this study;

15
16 8 Zhong Li, Zijin Pan, Chengzhong Xu, Fangfang Lu collected and analyzed the data;

17
18 9 Zhong Li drafted the manuscript; Ruibo He, Shan Jiang, Boyang Li and Liang Zhang

19
20 10 modified the manuscript. All authors read and approved the final manuscript.

21
22 11 **Authors' information**

23
24 12 **Fundings**

25
26 13 This project was funded by National Natural Science Foundation of China (71734003,

27
28 14 71673099, 71804053).

29
30 15 **Acknowledgements**

31
32 16 We thank all the staff involved in the establishment of the Yichang Health

33
34 17 Management Data Analysis Center, including experts from Yichang Centre for

35
36 18 Disease Control and Prevention.

37
38 19 **Data sharing statement**

39
40 20 All the research data is available upon reasonable request.

41
42 21 **Reference**

43
44 22 1. Torre L A, Bray F, Siegel R L, et al. Global cancer statistics, 2012[J]. CA: a cancer
45
46 23 journal for clinicians, 2015, 65(2): 87-108.

47
48 24 2. Farmer P, Frenk J, Knaul FM, et al. Expansion of cancer care and control in
49
50 25 countries of low and middle income: a call to action. Lancet 2010,376(9747):1186.

51
52 26 3. Jönsson B, Hofmarcher T, Lindgren P, et al. The cost and burden of cancer in the
53
54 27 European Union 1995-2014. European Journal of Cancer 2016,66:162.

55
56 28 4. Røe O D. The high cost of new cancer therapies—a challenge of inequality for all
57
58 29 countries[J]. JAMA oncology, 2017, 3(9): 1169-1170.

59
60 30 5. Ramsey S. What do we want from our investment in cancer research? Health

- 1 Affairs 2005, 24 Suppl 2(6):W5R101-4.
- 2 6. Sullivan R. Delivering affordable cancer care in high-income countries. *Lancet*
- 3 *Oncology* 2011,12(10):933-80.
- 4 7. Bainbridge D, Seow H, Jonathan Sussman MD MSc. Common Components of
- 5 Efficacious In-Home End-of-Life Care Programs: A Review of Systematic Reviews[J].
- 6 *Journal of the American Geriatrics Society*, 2016, 64(3):632-639.
- 7 8. Lockett T, Davidson PM, Lam L, et al. Do community specialist palliative care
- 8 services that provide home nursing increase rates of home death for people with
- 9 life-limiting illnesses? A systematic review and meta-analysis of comparative studies.
- 10 *Journal of Pain & Symptom Management* 2013,45(2):279-97.
- 11 9. Wennberg JE, Bronner K, Skinner JS, et al. Inpatient care intensity and patients'
- 12 ratings of their hospital experiences. *Health Affairs* 2009, 28(1):103-12.
- 13 10. Chitnis XA, Georghiou T, Steventon A, et al. Effect of a home-based end-of-life
- 14 nursing service on hospital use at the end of life and place of death: a study using
- 15 administrative data and matched controls. *BMJ Support Palliative Care*
- 16 2013,3(4):422-30.
- 17 11. the Dartmouth Atlas of health care. Inpatient days per decedent during the last six
- 18 months of life by gender and level of care intensity.2015.
- 19 Available from: <http://www.dartmouthatlas.org/data/topic/topic.aspx?cat=18>
- 20 12. Pizzo P, Walker D, Bomba P. *Dying in America: Improving quality and honoring*
- 21 *individual preferences near the end of life*. Washington, DC: Insitute of Medicine.
- 22 2015.
- 23 13. Divi V, Tao L, Whittemore A, et al. Geographic variation in Medicare treatment
- 24 costs and outcomes for advanced head and neck cancer. *Oral Oncology*
- 25 2016,61:83-88.
- 26 14. Pivodic L, Van dBL, Pardon K, et al. Burden on family carers and care-related
- 27 financial strain at the end of life: a cross-national population-based study. *European*
- 28 *Journal of Public Health* 2014,24(5):819-26.
- 29 15. Earle CC, Landrum MB, Souza JM, et al. Aggressiveness of cancer care near the
- 30 end of life: is it a quality-of-care issue? *Journal of Clinical Oncology Official Journal*

- 1 of the American Society of Clinical Oncology 2008,26(23):3860.
- 2 16. Langton JM, Blanch B, Drew AK, et al. Retrospective studies of end-of-life
3 resource utilization and costs in cancer care using health administrative data: a
4 systematic review. Palliative Medicine 2014,28(10):1167-96.
- 5 17. AEB, McClellan MB, Kagay CR, et al. Trends in Inpatient Treatment Intensity
6 among Medicare Beneficiaries at the End of Life. Health Services Research
7 2004,39(2):363-75.
- 8 18. Teno JM, Curtis JR. Family Perspectives on Aggressive Cancer Care Near the End
9 of Life. JAMA 2016,315(3):284.
- 10 19. Listed N. A controlled trial to improve care for seriously ill hospitalized patients.
11 The study to understand prognoses and preferences for outcomes and risks of
12 treatments (SUPPORT). The SUPPORT Principal Investigators. JAMA
13 1900,274(20):1591-8.
- 14 20. National Center for Health Statistics and Information. The Fifth National Health
15 Service Survey and Analysis Report.2013.
- 16 21. Chen W, Zheng R, Baade PD, et al. Cancer statistics in China, 2015. CA Cancer
17 Journal for Clinicians 2016,66(2):115.
- 18 22. Zeng H, Chen W, Zheng R, et al. Changing cancer survival in China during 2003–
19 15: a pooled analysis of 17 population-based cancer registries. The Lancet Global
20 Health 2018, 6(5):e555-e67.
- 21 23. World Bank Group, World Health Organization, Ministry of Finance, National
22 Health and Family Planning Commission, Ministry of Human Resources and Social
23 Security. Health China: Deepening health reform in China building high-quality and
24 value-based service quality. Available from:
25 [https://openknowledge.worldbank.org/bitstream/handle/10986/24720/
26 HealthReformInChina.pdf](https://openknowledge.worldbank.org/bitstream/handle/10986/24720/HealthReformInChina.pdf). Accessed 29 Apr 2018.
- 27 24. Unit EI. the 2015 Quality of death index: Ranking palliative care across the world
28 . 2015 Available from:
29 [https://www.eiuperspectives.economist.com/sites/default/files/2015%20EIU%20Quality%20of%
30 20Death%20Index%20Oct%2029%20FINAL.pdf](https://www.eiuperspectives.economist.com/sites/default/files/2015%20EIU%20Quality%20of%20Death%20Index%20Oct%2029%20FINAL.pdf)

- 1
2
3 25. Huang H-Y, Shi J-F, Guo L-W, et al. Expenditure and financial burden for
4 common cancers in China: a hospital-based multicentre cross-sectional study. *The*
5 *Lancet* 2016, 388:S10.
6
7
8 26. Narang AK, Nicholas LH. Out-of-Pocket Spending and Financial Burden Among
9 Medicare Beneficiaries With Cancer. *JAMA Oncology* 2016,3(6):757.
10
11 27. Yang T, Chu J, Zhou C, et al. Catastrophic health expenditure: a comparative
12 analysis of empty-nest and non-empty-nest households with seniors in Shandong,
13 China. *BMJ Open* 2016, 6(7):e010992.
14
15 28. Wang Z, Li X, Chen M. Catastrophic health expenditures and its inequality in
16 elderly households with chronic disease patients in China. *International Journal for*
17 *Equity in Health* 2015,14(1):8.
18
19 29. Haiying An, Jinghua Sun, Jiqi Zhao, Research on the palliative care nursing for
20 the patients with end-stage cancer. *Practice and Research on Nursing*. 2008,
21 5(18):65-66.[in Chinese]
22
23 30. Ethical reflection of the health resource allocation for the palliative care
24 services——an study on the medical cost of 215 patients with the end-stage cancer.
25 *Chinese Journal of Medical Ethics*, 1995(4):26-27. [in Chinese]
26
27 31. Jufang Shi, Chunlei Shi, Xinpei Yue, et al. Economic burden of cancer in China
28 during 1996-2014 : a systematic review. *Chinese Journal of Oncology*,
29 2016;38(12):929-41.
30
31 32. WHO. the International Statistical Classification of Diseases and Related Health
32 Problems 10th Revision (ICD-10).
33
34 33. Florence KLTPD, Sujha SPD, M.P.H SASMD, et al. End-of-Life Medical Costs of
35 Medicaid Cancer Patients. *Health Services Research* 2015, 50(3):690–709.
36
37 34. Earle CC, Neville BA, Landrum MB, et al. Trends in the aggressiveness of cancer
38 care near the end of life. *Journal of Clinical Oncology Official Journal of the*
39 *American Society of Clinical Oncology* 2004, 22(2):315-21.
40
41 35. Earle CC, Neville BA, Landrum MB, et al. Evaluating claims-based indicators of
42 the intensity of end-of-life cancer care. *International Journal for Quality in Health*
43 *Care Journal of the International Society for Quality in Health Care* 2005,17(6):505-9.
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3 1 36. Setoguchi S, Earle CC, Glynn R, et al. Comparison of Prospective and
4 2 Retrospective Indicators of the Quality of End-of-Life Cancer Care. *Journal of*
5 3 *Clinical Oncology Official Journal of the American Society of Clinical Oncology*
6 4 2008,26(35):5671-8.
7 5 37. Grunfeld E, Urquhart R, Mykhalovskiy E, et al. Toward population-based
8 6 indicators of quality end-of-life care. *Cancer* 2008,112(10):2301-08.
9 7 38. Grunfeld E, Lethbridge L, Dewar R, et al. Towards using administrative databases
10 8 to measure population-based indicators of quality of end-of-life care: testing the
11 9 methodology. *Palliative Medicine* 2006,20(8):769-77.
12 10 39. World Bank Group, ICP 2011: International Comparison Program. -
13 11 Available from:
14 12 http://siteresources.worldbank.org/ICPEXT/Resources/ICP_2011.html
15 13 40. Barber J, Thompson S. Multiple regression of cost data: use of generalised linear
16 14 models. *J Health Serv Res Policy* 2004,9(4):197-204.
17 15 41. Diehr P, Yanez D, Ash A, et al. Methods for analyzing health care utilization and
18 16 costs. *Annual Review of Public Health* 1999,20(1):125.
19 17 42. Bekelman JE, Halpern SD, Blankart CR, et al. Comparison of Site of Death,
20 18 Health Care Utilization, and Hospital Expenditures for Patients Dying With Cancer in
21 19 7 Developed Countries. *JAMA* 2016,315(3):272.
22 20 43. Hung Y N, Liu T W, Wen F H, et al. Escalating Health Care Expenditures in
23 21 Cancer Decedents' Last Year of Life: A Decade of Evidence from a Retrospective
24 22 Population-Based Cohort Study in Taiwan[J]. *Oncologist*, 2017, 22(4):460.
25 23 44. Polder JJ, Barendregt JJ, Van OH. Health care costs in the last year of life--the
26 24 Dutch experience. *Social Science & Medicine* 2006,63(7):1720.
27 25 45. Gielen B, Remacle A, Mertens R. Patterns of health care use and expenditure
28 26 during the last 6 months of life in Belgium: differences between age categories in
29 27 cancer and non-cancer patients. *Health Policy* 2010,97(1):53-61.
30 28 46. Langton JM, Reeve R, Srasuebku P, et al. Health service use and costs in the last
31 29 6 months of life in elderly decedents with a history of cancer: a comprehensive
32 30 analysis from a health payer perspective. *British Journal of Cancer*

- 1 2016,114(11):1293-302.
- 2 47. Yabroff KR, Lamont EB, Mariotto A, et al. Cost of care for elderly cancer patients
3 in the United States. *Journal of the National Cancer Institute* 2008,100(9):630-41.
- 4 48. Cabreraalonso J, Long MJ, Bangalore V, et al. Marital status and health care
5 expenditures among the elderly in a managed care organization. *Health Care Manager*
6 2003,22(3):249.
- 7 49. Zeng H, Zheng R, Guo Y, et al. Cancer survival in China, 2003-2005: A
8 population-based study. *International Journal of Cancer* 2015,136(8):1921-30.
- 9 50. Zuckerman RB, Stearns SC, Sheingold SH. Hospice Use, Hospitalization, and
10 Medicare Spending at the End of Life. *J Gerontol B Psychol Sci Soc Sci*
11 2016;71(3):gbv109.
- 12 51. Z O, M M, S A, et al. Association between the Medicare hospice benefit and
13 health care utilization and costs for patients with poor-prognosis cancer. *JAMA* 2014,
14 312(18):1888-96.
- 15 52. Obermeyer Z, Makar M, Abujaber S, et al. Association Between the Medicare
16 Hospice Benefit and Health Care Utilization and Costs for Patients With
17 Poor-Prognosis Cancer. *Journal of the American Medical Association*
18 2014,312(18):1888.
- 19 53. Hou XY, Chu K. Emergency department in hospitals, a window of the world: A
20 preliminary comparison between Australia and China. *World Journal of Emergency*
21 *Medicine* 2010,1(3):180.
- 22 54. Davies NJ, Batehup L. Towards a personalised approach to aftercare: a review of
23 cancer follow-up in the UK. *Journal of Cancer Survivorship* 2011,5(2):142-51.
- 24 55. Carlson MD, Herrin J, Du Q, et al. Impact of hospice disenrollment on health care
25 use and medicare expenditures for patients with cancer. *Journal of Clinical Oncology*
26 *Official Journal of the American Society of Clinical Oncology* 2010,28(28):4371.

Table 4. Results of the generalized linear models

Variables	Group	OR (a)	P	95% CI	OR (b)	P	95% CI	OR (c)	P	95% CI	OR (d)	P	95% CI
Gender(e)	Female	0.941	0.461	0.774-1.106	0.929	0.494	0.751-1.148	0.869	0.243	0.687-1.100	0.915	0.555	0.680-1.230
Age(f)	65-80	0.967	0.701	0.811-1.152	1.017	0.887	0.805-1.284	1.118	0.387	0.868-1.439	1.280	0.142	0.921-1.778
	>80	0.728	0.010	0.572-0.926	0.789	0.148	0.573-1.087	0.883	0.491	0.621-1.257	0.816	0.393	0.511-1.302
Insurance	NRCMS	1.332	0.019	1.048-1.693	1.333	0.081	0.966-1.839	1.248	0.225	0.872-1.786	1.662	0.033	1.041-2.654
Type(g)	UEBMI	1.691	<0.001	1.316-2.172	1.960	<0.001	1.401-2.742	1.840	0.001	1.269-2.668	2.211	0.001	1.360-3.596
Marriage	Married	1.343	0.43	0.645-2.795	1.275	0.627	0.478-3.401	1.197	0.742	0.411-3.487	1.341	0.676	0.339-5.313
Status(h)	Widow	1.182	0.667	0.551-2.539	1.029	0.956	0.371-2.852	1.318	0.625	0.435-3.997	1.293	0.725	0.308-5.417
	Divorced	1.225	0.658	0.498-3.017	0.961	0.949	0.290-3.190	1.350	0.652	0.366-4.975	1.591	0.592	0.291-8.687
Education(i)	Senior	1.092	0.414	0.885-1.347	1.050	0.734	0.792-1.392	1.039	0.802	0.768-1.407	0.914	0.667	0.607-1.376
	= > College	0.903	0.467	0.687-1.188	1.037	0.846	0.717-1.501	1.275	0.230	0.858-1.894	1.272	0.353	0.765-2.114
POD(j)	Hospital	1.364	0.002	1.121-1.660	1.878	<0.001	1.438-2.453	3.227	<0.001	2.412-4.317	5.362	<0.001	3.664-7.847
Survival time(k)	3-6 months	1.304	0.01	1.065-1.595	0.802	0.118	0.609-1.057	0.590	<0.001	0.438-0.793	0.587	0.008	0.397-0.870
	7-12 months	1.438	0.001	1.150-1.795	0.625	0.003	0.458-0.851	0.584	0.002	0.419-0.815	0.515	0.003	0.331-0.801
	> 12 months	1.392	0.018	1.058-1.831	0.541	0.002	0.369-0.794	0.448	<0.001	0.300-0.670	0.331	<0.001	0.194-0.562
Outpatients		1.006	0.281	0.995-1.017	1.001	0.938	0.984-1.018	0.992	0.420	0.974-1.011	1.003	0.791	0.979-1.029
EMR		0.998	0.752	0.969-1.023	0.983	0.356	0.947-1.020	0.982	0.399	0.942-1.024	0.974	0.317	0.924-1.026
hospitalization		1.421	<0.001	1.347-1.500	1.398	<0.001	1.294-1.512	1.373	<0.001	1.262-1.495	1.373	<0.001	1.235-1.526
ICU		2.544	<0.001	1.865-3.470	3.169	<0.001	2.081-4.827	3.305	<0.001	2.128-5.133	3.411	<0.001	1.910-6.089
AIC	22.88				21.84			20.25			17.69		

(a) identified during the last 6 months; (b)identified during the last 3 months; (c)identified during the last 1 months; (d)identified during the last 1 week.

Reference Catogeries: (e)Male; (f)<65; (g) URBMI; (h)Unmarried; (i)Junior or below; (j)Home; (k)< 3 months

AIC, Akaike Information Criterion;OR, odds ratio, CI, Confidential Interval.

BMJ Open

End-of-life cost and its determinants for cancer patients in urban China: A population-based retrospective study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-026309.R1
Article Type:	Research
Date Submitted by the Author:	08-Jan-2019
Complete List of Authors:	Li, Zhong; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management Pan, Zijing; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management ZHANG, LIANG; Huazhong University of Science and Technology Tongji Medical College He, Ruibo; Huazhong University of Science and Technology Tongji Medical College, Jiang, Shan; Nanjing Medical University, School of Health Policy and Management Xu, Chengzhong; Yichang Center for Disease Control and Prevention Lu, Fangfang ; Yichang Center for Disease Control and Prevention Zhang, Pei; Yichang Center for Disease Control and Prevention, Yichang Li, Boyang; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health services research
Keywords:	cancer patients, end-of-life, utilisation, expenditure, retrospective study, urban China

SCHOLARONE™
Manuscripts

1
2
3
4 **End-of-life cost and its determinants for cancer patients in urban China: A**
5 **population-based retrospective study**
6

7 Zhong Li ^{1#}, Zijing Pan ^{1#}, Liang Zhang¹, Ruibo He¹, Shan Jiang², Chengzhong Xu³,
8 Fangfang Lu³, Pei Zhang³, Boyang Li^{1*}
9

10
11 1. School of Medicine and Health Management, Huazhong University of Science and
12 Technology, Wuhan, Hubei, 430030, China; 2. School of Health Policy and
13 Management, Nanjing Medical University; 3. Yichang Center for Disease Control and
14 Prevention, Yichang, Hubei, 443000, China
15
16

17
18 # Zhong Li and Zijin Pan contributed equally.
19

20
21 * Corresponding author: Boyang Li, E-mail: jimmylee1900@foxmail.com
22

23 Address for correspondence: No.13 Hangkong Road, Qiaokou District, School of
24 Medicine and Health Management, Tongji Medical College, Huazhong University of
25 Science and Technology, Wuhan, Hubei, 430030, China
26
27

28
29 **Abstract**
30

31 **Objective** This study aimed to define the end-of-life (EOL) healthcare utilisation and
32 its cost and determinants for cancer patients and to proactively inform related strategies
33 in mainland China.
34
35

36
37 **Design** A population-based retrospective study.
38

39 **Setting and Participants** Data from 894 cancer patients were collected in urban
40 Yichang, China from 1 July 2015 to 30 June 2017.
41

42
43 **Outcome measures** Emergency department (ED) visits, outpatient and inpatient
44 hospitalisation services, intensive care unit (ICU) admission and total costs were used
45 as the main outcomes.
46
47

48
49 **Results** In this study, 66.78% of the 894 patients were male, and the average age was
50 60.4 years. Among these patients, 37.58% died at home, and patients had an average of
51 4.86 outpatient services, 2.23 inpatient hospitalisation services and 1.44 ED visits.
52 Additionally, 5.9% of these patients visited the ICU at least once. During the EOL
53 periods, the costs in the last 6 months, last 3 months, last 1 month and last 1 week were
54 \$18234, \$13043, \$6349 and \$2085, respectively. The cost increased dramatically as
55 death approached. The estimation results of generalised linear regression models
56
57
58
59
60

1
2
3 showed that aggressive care substantially affected expenditure. Patients with Urban
4 Employee Basic Medical Insurance spent more than those with Urban Resident-based
5 Basic Medical Insurance or the New Rural Cooperative Medical Scheme. The place of
6 death and survival time are also risk factors for increased EOL cost.
7
8
9

10
11 **Conclusion** The findings suggested that the EOL cost for cancer patients is associated
12 with aggressive care, insurance type and survival time. Timing palliative care is
13 urgently needed to address irrational healthcare utilisation and to reduce costs.
14
15
16

17 **Trial registration** This study was approved by the Ethics Committee of the Tongji
18 Medical College, Huazhong University of Science and Technology (IORG No:
19 IORG0003571). All the data used in this study were de-identified.
20
21
22

23 **Keywords**

24 Cancer patients, end-of-life, utilisation, expenditure, retrospective study, urban China.
25
26

27 **Strengths and limitations**

28 This population-based study was the first to systematically estimate the EOL health
29 expenditure for cancer patients in mainland China. It is important to estimate the
30 palliative care demand and guide its system building.
31
32
33

34 This study introduced EOL healthcare utilisation and cost in China and quantified the
35 relationship between them.
36
37

38 This study will guide health policy regarding the delivery of high-quality, cost-effective
39 cancer care systems.
40
41

42 Given the anonymity of the data, we cannot obtain the health records from primary care
43 facilities and healthcare utilisation outside Yichang. Thus, the EOL healthcare cost
44 might have been underestimated.
45
46
47

48 The unique socioeconomic status of the selected population may reduce the
49 generalisability of our findings. Further studies on the provincial or national levels are
50 essential to provide systematic evidence.
51
52
53
54
55
56
57
58
59
60

Introduction

Cancer is the leading cause of mortality and accounts for 14.1 million new cancer cases and 8.2 million deaths worldwide, thereby resulting in 32.6 million individuals living with cancer in 2012 [1]. Cancer greatly affects low- and middle-income countries and is expected to account for 70% of the newly reported cancer cases worldwide by 2030 [2]. Given the considerable share of the total health expenditure on cancer (approximately 6% in European countries [3], 9.2% in Taiwan [4 5]) and the great gap in the cancer healthcare delivery system between developed and developing countries [2], evaluating the end-of-life (EOL) cost and identifying its key determinants have been a worldwide concern [6].

Several systematic reviews have noted that in-home EOL care can improve patient satisfaction, thereby reducing inpatient hospitalisation utilisation and hospital death [7 8]. These reviews also indicated that aggressive procedures do not improve the quality of life [9 10]. However, health expenditure and utilisation show large geographic variations among patients in the USA with high medical care intensity during the EOL period, thereby producing poor outcomes and confusing the patients' preference [11-13]. EOL hospitalisation relatively lacks value worldwide with its unsustainable expenditure [14 15], whereas palliative care is relatively underutilised, though it is proven to save costs [16]. These phenomena thereby aggravate inequality among patients with different socioeconomic statuses and decrease overall efficacy [17-19].

According to the Fifth Chinese National Health Services Survey in 2013, the incidences of malignant neoplasms in China reached 0.35% and 0.23% in the urban and rural areas, respectively, which are higher than those in 2008 [20]. The most common cancer types in China are lung and stomach cancers, accounting for 22% of new global cancer cases and deaths, and liver and oesophageal cancers, accounting for 27% of new global cancer cases and deaths [21]. Although the age-standardised 5-year relative survival rate has increased from 30.9% (2003–2005) to 40.5% (2012–2015), geographical differences in cancer survival still remain [22]. The Program of Cancer Prevention and Control in China (2004–2010) reported that the decreased mortality rates and the substantial geographic variation in the survival rates have become a burden to the health system,

1
2
3
4 especially with the high out-of-pocket (OOP) expenditure [21 23]. The Economist
5 Intelligence Unit noted that China ranked 71st among 80 countries in a survey on the
6 quality of death [24]. A cross-sectional study in China found that OOP expenditures for
7 cancer patients accounted for 57.5% of the annual household income [25]. This
8 percentage is higher than the household income (23.7%) in the USA [26]. Given the
9 limitations of medical insurance coverage and reimbursement rate, cancer patients and
10 their families face extremely high health expenditures [27 28]. Hospital type, education,
11 insurance type and household income can also predict the expenditure of cancer care
12 [25]. Research on the EOL healthcare cost in mainland China has received considerable
13 interest in terms of policy. Studies have noted that some treatments for cancer patients
14 in tertiary hospitals are unnecessary, especially during the patients' last days [21 29 30].
15 However, cross-sectional studies mainly focus on the total healthcare cost limited to
16 the single-institutional level, thus underestimating the actual expenditure [31]. A
17 population-based study examining EOL healthcare expenditure and its determinants
18 hasnot been explored, especially in terms of the real-world data of the regional health
19 system in China. Therefore, in this study, we aimed 1) to define the EOL healthcare
20 utilisation and its cost among cancer patients, 2) to investigate the determinants of EOL
21 healthcare cost, and 3) to inform related policy making and implementation in China.

38 **Methods**

39 **Data collection**

40
41 According to the International Statistical Classification of Diseases and Related Health
42 Problems 10th Revision (ICD-10), and the WHO version for 2016 [32], the present
43 study selected patients diagnosed with C00-C97 in urban Yichang, China. Residents
44 who died from cancer from 1 July 2015 and 30 June 2017 in were continuously enrolled
45 in this study. The demographic information of cancer patients, data on the place of death,
46 cancer type was collected from the National Population Death Registration and
47 Management System established in 2013. All healthcare utilisation and cost data were
48 provided by the Yichang Health Management Centre affiliated with the Yichang Centre
49 for Disease Control and Prevention integrating hospital information system, health
50 insurance database and population information database with the identification card
51
52
53
54
55
56
57
58
59
60

number. This study was approved by the Ethics Committee of Tongji Medical College, Huazhong University of Science and Technology (IORG No: IORG0003571).

Variables

Patients were divided into three groups: those younger than 65 years, those 65–80 years old and those 80 years or older when diagnosed [21]. Survival was divided into four types [33], namely, education, marital status, cancer type and medical insurance type. The place of death was routinely coded as a binary independent variable. The recommended benchmark measures for terminal cancer care were used to identify the aggressive and palliative procedures [34–38]. The primary outcome was healthcare utilisation, including outpatient and inpatient hospitalisation services, emergency department (ED) visits and intensive care unit (ICU) admission. The secondary outcome was total expenditure. To compare the results, we converted the cost data to the international purchasing power parities by using the rate for Chinese Yuan to US dollars (¥2.03=\$1) in health from the International Comparison Program 2011[39].

Patient and public involvement

All the data were provided by the Yichang Health Management Centre affiliated with the Yichang Centre for Disease Control and Prevention and de-identified before statistical analysis. Therefore, identifiable cancer patients were not involved in the recruitment or implementation of this study.

Statistical analysis

Descriptive analysis was used to describe the detailed information about the enrolled population. Generalised linear models were used to evaluate the mechanism of the effect of independent variables on the EOL cost because the EOL data were severely positively skewed [40–41]. Four regression models were conducted for patients with different lengths of survival, the EOL costs were the outcome variables, and the independent variables were as follows: (1) age (<65, 65–80, and 80 years and above), (2) gender (male/female), (3) education level, (4) marital status, (6) first cancer type, (7) medical insurance type, (8) number of outpatient services, (9) number of ED visits, (8) number of inpatient hospitalisation services, (11) number of ICU admissions and (12) survival. All the above mentioned data were calculated with Stata 14.0. Differences

at $P < 0.05$ were considered statistically significant.

Results

Characteristics of the patients and ICD-10 code

As shown in Table 1, 894 patients were included in this study. The median age of enrolled patients was 69 (range, 25–102) years, 35.23% of which were younger than 65 years, and 15.55% were older than 80 years. Over half (66.78%) of these patients were male, and 83% of the 894 patients were married. A total of 57.94%, 20.25%, and 21.81% of the patients were enrolled in the Urban Employee Basic Medical Insurance (UEBMI), Urban Resident-based Basic Medical Insurance (URBMI) and the New Rural Cooperative Medical Scheme (NRCMS), respectively. Over 75% of the patients finished junior school or below, and 44.74% survived for at least 6 months. A total of 62.42% of the patients died in hospitals. As shown in Table 2, the most common cancer types were lung cancer (34.68%), liver cancer (13.98%) and colorectal cancer (9.51%).

Healthcare utilisation and cost

As shown in Table 3, the average number of outpatient and inpatient hospitalisation services were 4.86 and 2.23 times per capita, respectively. The ED visits and ICU visits were 1.44 and 0.06 times per capita, respectively. A total of 5.9% (53/894) of the patients were admitted once into the ICU, and 49.7% (444/894) visited the ED only once. The average expenditures per capita during the last 1 week, 1 month, 3 months and 6 months were \$2085, \$6349, \$13043 and \$18235, respectively. The population-level costs in the last 1 week, 1 month and 3 months were, on average, 11.4%, 34.8% and 71.5%, respectively, of the last 6 months.

Determinants of EOL healthcare cost

As shown in Table 4, all the results revealed proportionate changes in health expenditures among the different groups. In the four generalised linear models, the gender, marital status and education levels of the patients showed statistically insignificant differences in the costs in the four different EOL periods. High EOL healthcare expenditure was associated with the age of first diagnosis, insurance type, place of death, survival after diagnosis and aggressive care services.

For age, we can see that patients aged between 65–80 years spent 66.8% and 34.7%

1
2
3
4 more than the oldest groups (OR=1.322, P=0.033, 95% CI=1.022-1.710) and younger
5 patients (OR=1.347, P=0.036, 95% CI=1.02-1.779) on the cost during the last 6 months
6 and 3 months, respectively. Patients with UEBMI spent more than those with URBMI,
7 and the NRCMS in the last 6 months (OR=1.79, P<0.001, 95% CI=1.313-2.44;
8 OR=1.480, P=0.002, 95% CI=1.160-1.887), 3 months (OR=2.172, P<0.001, 95%
9 CI=1.464-3.222; OR=1.668, P=0.002, 95% CI=1.206-2.305) and 1 month (OR=2.132,
10 P<0.001, 95% CI=1.46-3.113; OR= 1.581, P=0.004, 95% CI=1.161-2.152). Patients
11 with the NRCMS spent between 98.2% (OR=1.982, P=0.005, 95% CI=1.228-3.2) and
12 153.2% (OR=2.532, P<0.001, 95% CI=1.548-4.139) higher than the URBMI group
13 during the last week. Patients who died in the hospitals spent 1.488- (P=0.002, 95% CI:
14 1.187-1.864), 2.323- (P<0.001, 95% CI: 1.712-3.151), 3.481- (P<0.001, 95% CI:
15 2.585-4.688) and 3.246-fold higher (P<0.001, 95% CI: 2.427-4.341) than those who
16 died at home during the four EOL periods.
17
18
19
20
21
22
23
24
25
26
27
28

29 For the survival time, the difference between the patients who survived for 7-12 months
30 and those who survived for longer than 12 months was not statistically significant
31 (OR=1.026, P=0.787, 95% CI=0.854-1.231). The cost during the last 3 months for
32 patients who survived longer than 12 months was 31.7% (OR=0.682, P=0.032, 95%
33 CI=0.482-0.968) less than that of the reference group (<3-6 months). Differences
34 between the four groups were also observed on the cost during the last 1 week. The
35 mean costs estimated during the last 1 week of the groups who survived for 3–6 months
36 (OR=0.624, P=0.023, 95% CI=0.416-0.937), 7–12 months (OR=0.54, P=0.007, 95%
37 CI=0.346-0.845) and longer than 12 months (OR=0.346, P<0.001, 95% CI=0.199-
38 0.599) were less than patients who survived less than 3 months. Moreover, patients with
39 7-12 months (OR=0.554, P=0.017, 95% CI=0.341-0.900) and longer survival spent less
40 than patients surviving between 3-6 months (OR=1.602, P=0.023, 95% CI=1.067-
41 2.405). Patients with more than 12 months of survival also spent (OR=0.640, P=0.048,
42 95% CI=0.411-0.997) less than those who survived 7-12 months. For the inpatient
43 hospitalisation and ICU services, once the inpatient hospitalisation and ICU services
44 increased by one time, the cost with the four periods increased 30.5% (P<0.001, 95%
45 CI=1.25-1.362) and 83.5% (P<0.001, 95% CI=1.292-2.606), 35.3% (P<0.001, 95%
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 CI=1.187-1.864) and 113.7% (P<0.001, 95% CI=1.253-1.461), 35.7% (P<0.001, 95%
5 CI=1.248-1.477) and 202.5% (P<0.001, 95% CI=1.994-5.152), 35.3% (P<0.001, 95%
6 CI=1.245-1.471) and 222.9% (P<0.001, 95% CI=2.07-5.038), respectively.
7
8

9 **Discussion**

10
11 Many studies have noted that aggressive treatment during the EOL of a patient can lead
12 to higher costs [17-18]. In this study, patients with end-stage cancer had high rates of
13 hospitalisation and an average admission of 2.23 times in the last 6 months of life. A
14 total of 5.9% of the cancer patients had used ICU services during the EOL period. A
15 comparative study in 7 developed countries showed that 40.3% of patients were
16 admitted to the ICU in the USA and approximately 18% of patients were admitted to
17 the ICU in the 6 other countries [42]. The mean cost in China is \$18234 per capita,
18 which is lower than those of developed countries, such as Canada (US \$21840), Norway
19 (US \$19783), the US (US \$18500) [42], South Korea, Japan and Taiwan (annual cost
20 of \$68,773 in 2010) [43]. The cost increased dramatically as death approached, similar
21 to the results that SEER-Medicare costs revealed [44]. We also found that cost
22 increased rapidly in the last one month, indicating excessive treatment and unnecessary
23 medical expenses. Considering the current status of EOL healthcare utilisation and the
24 expenditures trajectory, the risk factors of the high EOL cost must be investigated.
25
26
27
28
29
30
31
32
33
34
35
36
37
38

39 In this study, several determinants were identified that were associated with the higher
40 EOL cost. First, high EOL healthcare expenditure was associated with young age due
41 to high hospital care intensity. This result is consistent with those of previous studies
42 [44-46]. Many studies indicated that gender [46 47] and marital status [48] were not
43 facilitative determinants of the increased EOL healthcare cost. Second, striking
44 disparities were also observed among the different medical insurances, which is
45 consistent with the study of Zeng H et al. [49]. Patients enrolled in NRCMS spent more
46 than those enrolled in URBMI during the last week. This phenomenon may be related
47 to the traditional Chinese concept of death and suggests irrational utilisation and low-
48 value service provision [50]. However, this finding is inconsistent with the conclusion
49 that patients prefer to receive relatively passive care in Taiwan [43]. Third, cost also
50 depends on the place of death, and it increased rapidly as death approached. The
51
52
53
54
55
56
57
58
59
60

percentage (62.42%) of patients who died in hospitals in China was higher than patients in the USA (29.5%) and Canada (52%) [42]. However, in the USA, 74% of non-hospice beneficiaries died in hospitals or skilled nursing facilities compared with the 14% who died receiving hospice care [51]. Fourth, the effect of survival on EOL cost differed among patients with different survival periods, suggesting that the patients with poor cancer prognosis in the present study may have high rates of aggressive care at the EOL period. Moreover, inpatient hospitalisation and ICU services were risk factors for high EOL cost. An ED visit in China is not a risk factor for the increase in cost, which may be due to the current operation process wherein patients are usually hospitalised once admitted during ED visits [52]. One study by Obermeyer Z et al. [53] revealed that Medicare fee-for-service beneficiaries with poor-prognosis cancer, which were enrolled in the hospice care programme, used less hospitalisation, intensive care unit admissions, and invasive procedures with a lower total cost than the non-hospice group. Hence, there is great potential for the development of hospice care programmes in China.

The abovementioned results indicated that numerous health resources in China might be irrationally used, similar to other countries [54]. Studies have noted that patients receiving hospice care or early palliative care intervention could experience better palliation of pain and symptom management [55] and improved the likelihood of the place of death they preferred [12, 52]. The overuse of aggressive care during the EOL period can be harmful from the perspective of the patient, including care-related financial strain [14] and the inability to palliate the bereavement of the families [18, 56]. Given the potential benefits of hospice care and early palliative care intervention, the healthcare need of patients should be satisfied. The timely initiation of hospice or home care may reduce the low-value cancer healthcare services in China.

Conclusion

According to real-world data, this study provides comprehensive evidence on healthcare utilisation and expenditure for cancer patients during the EOL period in China. This study revealed the potential irrational utilisation of medical resources and the urgency to improve hospice care systems in China. Overall, this study may aid in

1
2
3
4 formulating specific measures to optimise the current cancer care delivery system,
5 especially at the developing stages of the hospice care system. Future studies should
6 focus on the evaluation of the current system on the provincial or national levels.
7
8

9 **Abbreviation**

10
11 EOL, End-of-life;

12
13 OOP, Out-of-pocket;

14
15 ICD-10, International Statistical Classification of Diseases and Related Health
16 Problems 10th Revision;

17
18 UEBMI, Urban Employee Basic Medical Insurance;

19
20 URBMI, Urban Resident-based Basic Medical Insurance;

21
22 NRCMS, New Rural Cooperative Medical Scheme;

23
24 CI, Confidence interval;

25
26 AIC, Akaike Information Criterion.

27
28 OR, Odds ratio

29 **Competing interests**

30
31 The authors declare that they have no competing interests.

32 **Authors' contributions**

33
34 Zhong Li, Zijin Pan, Pei Zhang, Liang Zhang and Boyang Li designed this study; Zhong
35 Li, Zijin Pan, Chengzhong Xu, Fangfang Lu collected and analyzed the data; Zhong Li
36 drafted the manuscript; Ruibo He, Shan Jiang, Boyang Li and Liang Zhang modified
37 the manuscript. All authors read and approved the final manuscript.
38
39
40
41
42
43

44 **Fundings**

45
46 This project was funded by National Natural Science Foundation of China (71734003,
47 71673099, 71804053).
48
49

50 **Acknowledgements**

51
52 We thank all the staff involved in the establishment of the Yichang Health Management
53 Data Analysis Center, including experts from Yichang Centre for Disease Control and
54 Prevention.
55
56

57 **Data sharing statement**

58
59 All the research data is available upon reasonable request.
60

Reference

1. Torre L A, Bray F, Siegel R L, et al. Global cancer statistics, 2012[J]. *CA: a cancer journal for clinicians*, 2015, 65(2): 87-108.
2. Farmer P, Frenk J, Knaul FM, et al. Expansion of cancer care and control in countries of low and middle income: a call to action. *Lancet* 2010,376(9747):1186.
3. Jönsson B, Hofmarcher T, Lindgren P, et al. The cost and burden of cancer in the European Union 1995-2014. *European Journal of Cancer* 2016,66:162.
4. Røe O D. The high cost of new cancer therapies—a challenge of inequality for all countries[J]. *JAMA oncology*, 2017, 3(9): 1169-1170.
5. Ramsey S. What do we want from our investment in cancer research? *Health Affairs* 2005, 24 Suppl 2(6):W5R101-4.
6. Sullivan R. Delivering affordable cancer care in high-income countries. *Lancet Oncology* 2011,12(10):933-80.
7. Bainbridge D, Seow H, Jonathan Sussman MD MSc. Common Components of Efficacious In-Home End-of-Life Care Programs: A Review of Systematic Reviews[J]. *Journal of the American Geriatrics Society*, 2016, 64(3):632-639.
8. Luckett T, Davidson PM, Lam L, et al. Do community specialist palliative care services that provide home nursing increase rates of home death for people with life-limiting illnesses? A systematic review and meta-analysis of comparative studies. *Journal of Pain & Symptom Management* 2013,45(2):279-97.
9. Wennberg JE, Bronner K, Skinner JS, et al. Inpatient care intensity and patients' ratings of their hospital experiences. *Health Affairs* 2009, 28(1):103-12.
10. Chitnis XA, Georghiou T, Steventon A, et al. Effect of a home-based end-of-life nursing service on hospital use at the end of life and place of death: a study using administrative data and matched controls. *BMJ Support Palliative Care* 2013,3(4):422-30.
11. the Dartmouth Atlas of health care. Inpatient days per decedent during the last six months of life by gender and level of care intensity.2015.
Available from: <http://www.dartmouthatlas.org/data/topic/topic.aspx?cat=18>
12. Pizzo P, Walker D, Bomba P. Dying in America: Improving quality and honoring

- individual preferences near the end of life. Washington, DC: Insitute of Medicine. 2015.
13. Divi V, Tao L, Whittemore A, et al. Geographic variation in Medicare treatment costs and outcomes for advanced head and neck cancer. *Oral Oncology* 2016,61:83-88.
14. Pivodic L, Van dBL, Pardon K, et al. Burden on family carers and care-related financial strain at the end of life: a cross-national population-based study. *European Journal of Public Health* 2014,24(5):819-26.
15. Earle CC, Landrum MB, Souza JM, et al. Aggressiveness of cancer care near the end of life: is it a quality-of-care issue? *Journal of Clinical Oncology Official Journal of the American Society of Clinical Oncology* 2008,26(23):3860.
16. Langton JM, Blanch B, Drew AK, et al. Retrospective studies of end-of-life resource utilization and costs in cancer care using health administrative data: a systematic review. *Palliative Medicine* 2014,28(10):1167-96.
17. AEB, Mcclellan MB, Kagay CR, et al. Trends in Inpatient Treatment Intensity among Medicare Beneficiaries at the End of Life. *Health Services Research* 2004,39(2):363-75.
18. Teno JM, Curtis JR. Family Perspectives on Aggressive Cancer Care Near the End of Life. *JAMA* 2016,315(3):284.
19. Zhong Li, Shan Jiang, Ruibo He, et al. Trajectories of Hospitalization Cost Among Patients of End-Stage Lung Cancer: A Retrospective Study in China *International Journal of Environmental Research and Public Health* 2018, 15(12), 2877.
20. National Center for Health Statistics and Information. *The Fifth National Health Service Survey and Analysis Report*.2013.
21. Chen W, Zheng R, Baade PD, et al. Cancer statistics in China, 2015. *CA Cancer Journal for Clinicians* 2016,66(2):115.
22. Zeng H, Chen W, Zheng R, et al. Changing cancer survival in China during 2003–15: a pooled analysis of 17 population-based cancer registries. *The Lancet Global Health* 2018, 6(5):e555-e67.
23. World Bank Group, World Health Organization, Ministry of Finance, National Health and Family Planning Commission, Ministry of Human Resources and Social Security. *Health China: Deepening health reform in China building high-quality and*

1
2
3
4 value-based service quality. Available from:

5 [https:// openknowledge.worldbank.org/bitstream/handle/10986/24720/](https://openknowledge.worldbank.org/bitstream/handle/10986/24720/)

6
7 HealthReformInChina.pdf. Accessed 29 Apr 2018.

8
9 24. Unit EI. the 2015 Quality of death index: Ranking palliative care across the world
10 . 2015 Available from:

11
12 [https://www.eiuperspectives.economist.com/sites/default/files/2015%20EIU%20Quality%20of%
13
14
15
16
17
18
19
20
21
22](https://www.eiuperspectives.economist.com/sites/default/files/2015%20EIU%20Quality%20of%20Death%20Index%20Oct%2029%20FINAL.pdf)

23 25. Huang H-Y, Shi J-F, Guo L-W, et al. Expenditure and financial burden for common
24 cancers in China: a hospital-based multicentre cross-sectional study. *The Lancet* 2016,
25 388:S10.

26 26. Narang AK, Nicholas LH. Out-of-Pocket Spending and Financial Burden Among
27 Medicare Beneficiaries With Cancer. *JAMA Oncology* 2016,3(6):757.

28 27. Yang T, Chu J, Zhou C, et al. Catastrophic health expenditure: a comparative
29 analysis of empty-nest and non-empty-nest households with seniors in Shandong,
30 China. *BMJ Open* 2016, 6(7):e010992.

31 28. Wang Z, Li X, Chen M. Catastrophic health expenditures and its inequality in
32 elderly households with chronic disease patients in China. *International Journal for
33
34
35
36
37
38* Equity in Health 2015,14(1):8.

39 29. Haiying An, Jinghua Sun, Jiqi Zhao, Research on the palliative care nursing for the
40 patients with end-stage cancer. *Practice and Research on Nursing*. 2008, 5(18):65-66.
41 [in Chinese]

42 30. Ethical reflection of the health resource allocation for the palliative care services—
43 —an study on the medical cost of 215 patients with the end-stage cancer. *Chinese
44
45
46
47
48* Journal of Medical Ethics, 1995(4):26-27. [in Chinese]

49 31. Jufang Shi, Chunlei Shi, Xinpei Yue, et al. Economic burden of cancer in China
50 during 1996-2014 : a systematic review. *Chinese Journal of Oncology*,
51 2016;38(12):929-41.

52 32. WHO. the International Statistical Classification of Diseases and Related Health
53 Problems 10th Revision (ICD-10).

54 33. Florence KLTPD, Sujha SPD, M.P.H SASMD, et al. End-of-Life Medical Costs of
55
56
57
58
59
60

- 1
2
3
4 Medicaid Cancer Patients. *Health Services Research* 2015, 50(3):690–709.
- 5
6 34. Earle CC, Neville BA, Landrum MB, et al. Trends in the aggressiveness of cancer
7 care near the end of life. *Journal of Clinical Oncology Official Journal of the American*
8 *Society of Clinical Oncology* 2004, 22(2):315-21.
- 9
10
11 35. Earle CC, Neville BA, Landrum MB, et al. Evaluating claims-based indicators of
12 the intensity of end-of-life cancer care. *International Journal for Quality in Health Care*
13 *Journal of the International Society for Quality in Health Care* 2005,17(6):505-9.
- 14
15
16 36. Setoguchi S, Earle CC, Glynn R, et al. Comparison of Prospective and
17 Retrospective Indicators of the Quality of End-of-Life Cancer Care. *Journal of Clinical*
18 *Oncology Official Journal of the American Society of Clinical Oncology*
19 2008,26(35):5671-8.
- 20
21
22 37. Grunfeld E, Urquhart R, Mykhalovskiy E, et al. Toward population-based indicators
23 of quality end-of-life care. *Cancer* 2008,112(10):2301–08.
- 24
25
26 38. Grunfeld E, Lethbridge L, Dewar R, et al. Towards using administrative databases
27 to measure population-based indicators of quality of end-of-life care: testing the
28 methodology. *Palliative Medicine* 2006,20(8):769-77.
- 29
30
31 39. World Bank Group, ICP 2011: International Comparison Program. -
32 Available from:
33 http://siteresources.worldbank.org/ICPEXT/Resources/ICP_2011.html
- 34
35
36 40. Barber J, Thompson S. Multiple regression of cost data: use of generalised linear
37 models. *J Health Serv Res Policy* 2004,9(4):197-204.
- 38
39
40 41. Diehr P, Yanez D, Ash A, et al. Methods for analyzing health care utilization and
41 costs. *Annual Review of Public Health* 1999,20(1):125.
- 42
43
44 42. Bekelman JE, Halpern SD, Blankart CR, et al. Comparison of Site of Death, Health
45 Care Utilization, and Hospital Expenditures for Patients Dying With Cancer in 7
46 Developed Countries. *JAMA* 2016,315(3):272.
- 47
48
49 43. Hung Y N, Liu T W, Wen F H, et al. Escalating Health Care Expenditures in Cancer
50 Decedents' Last Year of Life: A Decade of Evidence from a Retrospective Population-
51 Based Cohort Study in Taiwan. *Oncologist*, 2017, 22(4):460.
- 52
53
54 44. Bremner K E, Krahn M D, Warren J L, et al. An international comparison of costs
55
56
57
58
59
60

of end-of-life care for advanced lung cancer patients using health administrative data. *Palliative medicine*, 2015, 29(10): 918-928.

45. Gielen B, Remacle A, Mertens R. Patterns of health care use and expenditure during the last 6 months of life in Belgium: differences between age categories in cancer and non-cancer patients. *Health Policy* 2010,97(1):53-61.

46. Langton JM, Reeve R, Srasuebkul P, et al. Health service use and costs in the last 6 months of life in elderly decedents with a history of cancer: a comprehensive analysis from a health payer perspective. *British Journal of Cancer* 2016,114(11):1293-302.

47. Yabroff KR, Lamont EB, Mariotto A, et al. Cost of care for elderly cancer patients in the United States. *Journal of the National Cancer Institute* 2008,100(9):630-41.

48. Cabreraalonso J, Long MJ, Bangalore V, et al. Marital status and health care expenditures among the elderly in a managed care organization. *Health Care Manager* 2003,22(3):249.

49. Zeng H, Zheng R, Guo Y, et al. Cancer survival in China, 2003-2005: A population-based study. *International Journal of Cancer* 2015,136(8):1921-30.

50. Zuckerman RB, Stearns SC, Sheingold SH. Hospice Use, Hospitalization, and Medicare Spending at the End of Life. *J Gerontol B Psychol Sci Soc Sci* 2016;71(3):gbv109.

51. Z O, M M, S A, et al. Association between the Medicare hospice benefit and health care utilization and costs for patients with poor-prognosis cancer. *JAMA* 2014, 312(18):1888-96.

52. Hou XY, Chu K. Emergency department in hospitals, a window of the world: A preliminary comparison between Australia and China. *World Journal of Emergency Medicine* 2010,1(3):180.

53. Obermeyer Z, Makar M, Abujaber S, et al. Association Between the Medicare Hospice Benefit and Health Care Utilization and Costs for Patients With Poor-Prognosis Cancer. *Journal of the American Medical Association* 2014,312(18):1888.

54. Davies NJ, Batehup L. Towards a personalised approach to aftercare: a review of cancer follow-up in the UK. *Journal of Cancer Survivorship* 2011,5(2):142-51.

55. Temel J S, Greer J A, Muzikansky A, et al. Early palliative care for patients with

1
2
3
4 metastatic non–small-cell lung cancer. New England Journal of Medicine, 2010, 363(8):
5 733-742.

6
7 56. Carlson MD, Herrin J, Du Q, et al. Impact of hospice disenrollment on health care
8 use and medicare expenditures for patients with cancer. Journal of Clinical Oncology
9 Official Journal of the American Society of Clinical Oncology 2010,28(28):4371.
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

Table 1. Basic characteristics of the enrolled patients

Demographic characteristics	patients (N=894)	%
Age (year), Median (range)	69 (25,102)	
<65	315	35.23
65-80	440	49.22
>80	139	15.55
Gender		
Male	597	66.78
Female	297	33.22
Marital status		
Unmarried	9	1.01
Married	742	83.00
Widow	126	14.09
Divorced	17	1.90
Insurance type		
Urban Employee Basic Medical Insurance (UEBMI)	518	57.94
Urban Resident-based Basic Medical Insurance (URBMI)	181	20.25
New Rural Cooperative Medical Scheme (NRCMS)	195	21.81
Education		
≤ Junior school	675	75.5
Senior school	141	15.77
≥ College	78	8.72
Place of death (POD)		
Health institution	558	62.42
Home	336	37.58
Survival time from cancer diagnosis #		
< 3 months	260	29.25
3-6 months	231	26.0
7-12 months	219	24.6
> 12 months	179	20.14

Survival time of five patients was not obtained.

Table 2. The ICD-10 codes of first cancer type when diagnosed

First cancer type	codes	patients (N=894)	%
Lung	C34.x	310	34.68
Stomach	C16.x	60	6.71
Colorectum	C18.x, C19.x, C20.x	85	9.51
Liver	C22.x	125	13.98
Pancreas	C25.x	39	4.36
Biliary tract	C23.x, C24.x	19	2.13
Blood	C81.x-C86.x, C91.x-C95.x	0	0
Prostate	C61.x	15	1.68
Breast	C50.x	28	3.13
Others	C00.x-C15.x, C17.x, C21.x, C26.x, C30.x- C33.x, C37.x-C41.x, C43.x-C49.x, C51.x-C58.x, C60.x, C62.x, C80.x, C88.x, C90.x, C96.x, C97.x	213	23.83

Table 3. Healthcare services utilization and cost of the enrolled patients*

Variable	mean	Std. error	median	range
Outpatient services	4.86	7.67	2	59
Inpatient hospitalization services	2.23	2.16	2	39
Emergency department visit	1.44	2.91	1	13
Intensive care unit admission	0.06	0.25	0	2
Cost during the last 1 week	2085	6829	1195	66437
Cost during the last 1 month	6349	18469	6640	195182
Cost during the last 3 months	13043	37434	13901	431158
Cost during the last 6 months	18234	34583	19276	723144

* The International Purchasing Power Parities using rate for Chinese Yuan to US dollars (¥2.03=\$1) in health from International Comparison Program (ICP) 2011.

Table 4. Results of the four generalized linear models

Variables	Group	Model 1			Model 2			Model 3			Model 4		
		OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI
Gender(e)	Female	0.906	0.305	(0.751,1.094)	1.016	0.903	(0.789,1.308)	0.824	0.127	(0.643,1.056)	0.946	0.722	(0.694,1.288)
Age(f)	65-80 (2)	1.098	0.369	(0.895,1.347)	1.347	0.036	(1.02,1.779)	1.017	0.901	(0.779,1.329)	1.241	0.212	(0.885,1.74)
	>80 (3)	0.831	0.224	(0.616,1.12)	1.043	0.834	(0.702,1.551)	0.767	0.156	(0.531,1.107)	0.932	0.778	(0.568,1.527)
Insurance	NRCMS (2)	1.21	0.230	(0.886,1.652)	1.302	0.215	(0.858,1.977)	1.349	0.117	(0.928,1.961)	1.982	0.005	(1.228,3.2)
Type(g)	UEBMI (3)	1.79	<0.001	(1.313,2.44)	2.172	<0.001	(1.464,3.222)	2.132	<0.001	(1.46,3.113)	2.532	<0.001	(1.548,4.139)
Marriage status(h)	Married (1)	2.457	0.069	(0.933,6.468)	1.205	0.757	(0.371,3.919)	1.07	0.906	(0.349,3.276)	1.239	0.764	(0.305,5.031)
	Widow (2)	2.163	0.132	(0.792,5.905)	0.893	0.855	(0.264,3.017)	1.27	0.687	(0.397,4.064)	1.004	0.996	(0.231,4.355)
Education(i)	Divorced (3)	2.504	0.112	(0.808,7.763)	1.074	0.922	(0.257,4.489)	1.248	0.746	(0.327,4.772)	1.572	0.607	(0.28,8.824)
	Senior (2)	1.143	0.242	(0.913,1.431)	1.004	0.978	(0.73,1.382)	1.043	0.791	(0.767,1.418)	0.921	0.702	(0.605,1.403)
POD(j)	≥College (3)	0.996	0.981	(0.737,1.346)	1.227	0.358	(0.794,1.897)	1.255	0.277	(0.833,1.891)	1.244	0.406	(0.743,2.086)
	Hospital	1.488	0.001	(1.187,1.864)	2.323	<0.001	(1.712,3.151)	3.481	<0.001	(2.585,4.688)	5.371	<0.001	(3.653,7.897)
Survival(k)	3-6 months (2)							0.648	0.008	(0.47,0.893)	0.624	0.023	(0.416,0.937)
	7-12 months (3)				0.827	0.186	(0.623,1.096)	0.661	0.02	(0.466,0.937)	0.54	0.007	(0.346,0.845)
	> 12 months (4)	1.026	0.787	(0.854,1.231)	0.683	0.032	(0.482,0.968)	0.507	0.002	(0.333,0.771)	0.346	<0.001	(0.199,0.599)
OS		1.007	0.13	(0.998,1.016)	0.998	0.842	(0.981,1.015)	0.993	0.441	(0.974,1.011)	1.005	0.679	(0.98,1.031)
EMR		0.997	0.824	(0.975,1.02)	0.98	0.267	(0.945,1.016)	0.98	0.343	(0.941,1.022)	0.971	0.273	(0.922,1.023)
'H'IS		1.305	<0.001	(1.25,1.362)	1.353	0.001	(1.253,1.461)	1.357	<0.001	(1.248,1.477)	1.369	<0.001	(1.229,1.526)
ICU		1.835	0.001	(1.292,2.606)	2.378	<0.001	(1.438,3.932)	3.205	<0.001	(1.994,5.152)	3.456	<0.001	(3.456,6.299)
No		398			629			807			868		

Model 1: cost during the last 6 months; Model 2: cost during the last 3 months; Model 3: cost during the last 1 months; Model 4: cost during the last 1 week. # Reference: (e)Male; (f)<65; (g) URBMI; (h)Unmarried; (i) Junior or below; (j)Home; (k)< 3 months In Model 1 and 2, we took the patients survived 7-12 months and

1
2
3
4
5 3-6 months as reference, respectively. Results of additional models: Model 1: Agegroup: 2 vs.3 (OR=1.322, P=0.033, 95% CI=1.022-1.710); Insurnace type: 3 vs.2
6 (OR=1.480, P=0.002, 95% CI=1.160-1.887); Model 2: Insurnace type: 3 vs.2 (OR=1.668, P=0.002, 95% CI=1.206-2.305); Model 3: Insurnace type: 3 vs.2 (OR=
7 1.581 , P=0.004, 95% CI=1.161-2.152); Model 4: Survival: 4 vs.2 (OR=0.554, P=0.017, 95% CI=0.341-0.900); 5 vs.2 (OR=1.602, P=0.023, 95% CI=1.067-2.405);4
8 vs.3 (OR=0.640, P=0.048, 95% CI=0.411-0.997); OS, outpatient services; IHS, inpatient hospitalization services; No, number of observation; AIC, Akaike Information
9 Criterion; OR, odds ratio, CI, Confidential Interval.
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

For peer review only

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	4-5
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	Not required
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-5
Bias	9	Describe any efforts to address potential sources of bias	4-5
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	4-5
		(b) Describe any methods used to examine subgroups and interactions	4-5
		(c) Explain how missing data were addressed	4-5
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	4-5

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage	6 6
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	6 6-7 6
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6-7 6-7 6-7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	6-7 6-7 6-7
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6-7
Discussion			
Key results	18	Summarise key results with reference to study objectives	8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8-9, 1
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9, 1
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-9, 1

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

End-of-life cost and its determinants for cancer patients in urban China: A population-based retrospective study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-026309.R2
Article Type:	Research
Date Submitted by the Author:	22-Jan-2019
Complete List of Authors:	Li, Zhong; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management Pan, Zijing; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management ZHANG, LIANG; Huazhong University of Science and Technology Tongji Medical College He, Ruibo; Huazhong University of Science and Technology Tongji Medical College, Jiang, Shan; Nanjing Medical University, School of Health Policy and Management Xu, Chengzhong; Yichang Center for Disease Control and Prevention Lu, Fangfang ; Yichang Center for Disease Control and Prevention Zhang, Pei; Yichang Center for Disease Control and Prevention, Yichang Li, Boyang; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health services research
Keywords:	cancer patients, end-of-life, utilisation, expenditure, retrospective study, urban China

SCHOLARONE™
Manuscripts

1
2
3
4 **End-of-life cost and its determinants for cancer patients in urban China: A**
5 **population-based retrospective study**

6
7 Zhong Li ^{1#}, Zijing Pan ^{1#}, Liang Zhang¹, Ruibo He¹, Shan Jiang², Chengzhong Xu³,
8 Fangfang Lu³, Pei Zhang³, Boyang Li^{1*}

9
10
11 1. School of Medicine and Health Management, Huazhong University of Science and
12 Technology, Wuhan, Hubei, 430030, China; 2. School of Health Policy and
13 Management, Nanjing Medical University; 3. Yichang Center for Disease Control and
14 Prevention, Yichang, Hubei, 443000, China

15
16
17 # Zhong Li and Zijing Pan contributed equally.

18
19 * Corresponding author: Boyang Li, E-mail: jimmylee1900@foxmail.com

20
21
22 Address for correspondence: No.13 Hangkong Road, Qiaokou District, School of
23 Medicine and Health Management, Tongji Medical College, Huazhong University of
24 Science and Technology, Wuhan, Hubei, 430030, China

25
26
27 **Abstract**

28
29
30
31 **Objective** This study aimed to define the end-of-life (EOL) healthcare utilisation and
32 its cost and determinants for cancer patients and to proactively inform related strategies
33 in mainland China.

34
35
36 **Design** A population-based retrospective study.

37
38
39 **Setting and Participants** Data from 894 cancer patients were collected in urban
40 Yichang, China from 1 July 2015 to 30 June 2017.

41
42
43 **Outcome measures** Emergency department (ED) visits, outpatient and inpatient
44 hospitalisation services, intensive care unit (ICU) admission and total costs were used
45 as the main outcomes.

46
47
48
49 **Results** In this study, 66.8% of the 894 patients were male, and the average age was
50 60.4 years. Among these patients, 37.6% died at home, and patients had an average of
51 4.86 outpatient services, 2.23 inpatient hospitalisation services and 1.44 ED visits.
52 Additionally, 5.9% of these patients visited the ICU at least once. During the EOL
53 periods, the costs in the last 6 months, last 3 months, last 1 month and last 1 week were
54 \$18234, \$13043, \$6349 and \$2085, respectively. The cost increased dramatically as
55 death approached. The estimation results of generalised linear regression models
56
57
58
59
60

1
2
3
4 showed that aggressive care substantially affected expenditure. Patients with Urban
5 Employee Basic Medical Insurance spent more than those with Urban Resident-based
6 Basic Medical Insurance or the New Rural Cooperative Medical Scheme. The place of
7 death and survival time are also risk factors for increased EOL cost.
8
9

10
11 **Conclusion** The findings suggested that the EOL cost for cancer patients is associated
12 with aggressive care, insurance type and survival time. Timing palliative care is
13 urgently needed to address ineffective and irrational healthcare utilisation and to reduce
14 costs.
15
16
17

18
19 **Trial registration** This study was approved by the Ethics Committee of the Tongji
20 Medical College, Huazhong University of Science and Technology (IORG No:
21 IORG0003571). All the data used in this study were de-identified.
22
23
24

25 **Keywords**

26
27 Cancer patients, end-of-life, utilisation, expenditure, retrospective study, urban China.
28

29 **Strengths and limitations**

30
31 This population-based study was the first to systematically estimate the EOL health
32 expenditure for cancer patients in mainland China. It is important to estimate the
33 palliative care demand and guide its system building.
34
35

36
37 This study introduced EOL healthcare utilisation and cost in China and quantified the
38 relationship between them.
39

40
41 This study will guide health policy regarding the delivery of high-quality, cost-effective
42 cancer care systems.
43

44
45 Given the anonymity of the data, we cannot obtain the health records from primary care
46 facilities and healthcare utilisation outside Yichang. Thus, the EOL healthcare cost
47 might have been underestimated.
48

49
50 The unique socioeconomic status of the selected population may reduce the
51 generalisability of our findings. Further studies on the provincial or national levels are
52 essential to provide systematic evidence.
53
54
55
56
57
58
59
60

Introduction

Cancer is the leading cause of mortality and accounts for 14.1 million new cancer cases and 8.2 million deaths worldwide, 32.6 million individuals living with cancer in 2012 [1]. Cancer greatly affects low- and middle-income countries and is expected to account for 70% of the newly reported cancer cases worldwide by 2030 [2]. Given the considerable share of the total health expenditure on cancer (approximately 6.0 % in European countries [3], 9.2 % in Taiwan [4 5]) and the great gap in the cancer healthcare delivery system between developed and developing countries [2], evaluating the end-of-life (EOL) cost and identifying its key determinants have been a worldwide concern [6].

Several systematic reviews have noted that in-home EOL care can improve patient satisfaction, as well as reducing inpatient hospitalisation utilisation and hospital death [7 8]. These reviews also indicated that aggressive procedures do not improve the quality of life [9 10]. However, health expenditure and utilisation show large geographic variations among patients in the USA with high medical care intensity during the EOL period, thereby producing poor outcomes and confusing the patients' preference [11-13]. EOL hospitalisation relatively lacks value worldwide with its unsustainable expenditure [14 15], whereas palliative care is relatively underutilised, though it is proven to save costs [16]. These phenomena thereby aggravated inequality among patients with different socioeconomic statuses and decrease overall efficacy [17-19].

According to the Fifth Chinese National Health Services Survey in 2013, the incidences of malignant neoplasms in China reached 0.35% and 0.23% in the urban and rural areas, respectively, higher than those in 2008 [20]. The most common cancer types in China are lung and stomach cancers, accounting for 22% of new global cancer cases and deaths, and liver and oesophageal cancers, accounting for 27% of new global cancer cases and deaths [21]. Although the age-standardised 5-year relative survival rate has increased from 30.9% (2003–2005) to 40.5% (2012–2015), geographical differences in cancer survival still remain [22]. The Program of Cancer Prevention and Control in China (2004–2010) reported that the decreased mortality rates and the substantial

1
2
3
4 geographic variation in the survival rates have become a burden to the health system,
5 especially with the high out-of-pocket (OOP) expenditure [21–23]. The Economist
6 Intelligence Unit noted that China ranked 71st among 80 countries in a survey on the
7 quality of death [24]. A cross-sectional study in China found that OOP expenditures for
8 cancer patients accounted for 57.5% of the annual household income [25]. This
9 percentage is higher than that (23.7%) in the USA [26]. Given the limitations of medical
10 insurance coverage and reimbursement rate, cancer patients and their families face
11 extremely high health expenditures [27–28]. Hospital type, education, insurance type
12 and household income can also predict the expenditure of cancer care [25]. Research
13 on the EOL healthcare cost in mainland China has received considerable interest in
14 terms of policy. Studies have noted that some treatments for cancer patients in tertiary
15 hospitals are unnecessary, especially during the patients' last days [21–29–30]. However,
16 cross-sectional studies mainly focus on the total healthcare cost limited to the single-
17 institutional level, thus underestimating the actual expenditure [31]. A population-
18 based study examining EOL healthcare expenditure and its determinants is not explored,
19 especially in terms of the real-world data of the regional health system in China.
20 Therefore, in this study, we aimed 1) to define the EOL healthcare utilisation and its
21 cost among cancer patients, 2) to investigate the determinants of EOL healthcare cost,
22 and 3) to inform related policy making and implementation in China.

40 **Methods**

41 **Data collection**

42
43 Based on the International Statistical Classification of Diseases and Related Health
44 Problems 10th Revision (ICD-10), and the WHO version for 2016 [32], the present
45 study selected patients diagnosed with C00–C97 in urban Yichang, China. Residents
46 who died from cancer from 1 July 2015 and 30 June 2017 were continuously enrolled
47 in this study. The demographic information of cancer patients, data on the place of death,
48 cancer type was collected from the National Population Death Registration and
49 Management System established in 2013. All healthcare utilisation and cost data were
50 provided by the Yichang Health Management Centre affiliated with the Yichang Centre
51 for Disease Control and Prevention integrating hospital information system, health
52
53
54
55
56
57
58
59
60

1
2
3
4 insurance database and population information database with the identification card
5 number. This study was approved by the Ethics Committee of Tongji Medical College,
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

insurance database and population information database with the identification card number. This study was approved by the Ethics Committee of Tongji Medical College, Huazhong University of Science and Technology (IORG No: IORG0003571).

Variables

Patients were divided into three groups: those younger than 65 years, those 65–80 years old and those 80 years or older when diagnosed [21]. Survival was divided into four types [33], namely, education, marital status, cancer type and medical insurance type. The place of death was routinely coded as a binary variable. The recommended benchmark measures for terminal cancer care were used to identify the aggressive and palliative procedures [34-38]. The main outcome was healthcare utilisation, including outpatient and inpatient hospitalisation services, emergency department (ED) visits and intensive care unit (ICU) admission, and the EOL expenditures. To compare the results, we converted the cost data to the international purchasing power parities by using the rate for Chinese Yuan to US dollars (¥2.03=\$1) in health from the International Comparison Program 2011[39].

Patient and public involvement

All the data were provided by the Yichang Health Management Centre affiliated with the Yichang Centre for Disease Control and Prevention and de-identified before statistical analysis. Therefore, identifiable cancer patients were not involved in the recruitment or implementation of this study.

Statistical analysis

Descriptive analysis was used to describe the detailed information about the enrolled population. Generalised linear models were used to evaluate the mechanism of the effect of independent variables on the EOL cost because the EOL data were severely positively skewed [40 41]. Four regression models were conducted for patients with different lengths of survival, the EOL costs were the outcome variables, and the independent variables were as follows: (1) age (<65, 65–80, and \geq 80 years), (2) gender (male/female), (3) education level, (4) marital status, (6) first cancer type, (7) medical insurance type, (8) number of outpatient services, (9) number of ED visits, (8) number of inpatient hospitalisation services, (11) number of ICU admissions and (12)

1
2
3
4 survival. All the above mentioned data were calculated with Stata 14.0. Differences at
5 $P < 0.05$ were considered statistically significant.
6

7 **Results**

8 **Characteristics of the patients and ICD-10 code**

9
10 As shown in Table 1, 894 patients were included in this study. The median age of
11 enrolled patients was 69 (range, 25–102) years, 35.2% of which were younger than 65
12 years, and 15.6% were older than 80 years. Two-thirds (66.8%) of these patients were
13 male, and 83% of the 894 patients were married. A total of 57.9%, 20.3%, and 21.8%
14 of the patients were enrolled in the Urban Employee Basic Medical Insurance (UEBMI),
15 Urban Resident-based Basic Medical Insurance (URBMI) and the New Rural
16 Cooperative Medical Scheme (NRCMS), respectively. 75.5 % of the patients finished
17 junior school or below, and 44.7% survived for at least 6 months. A total of 62.4% of
18 the patients died in hospitals. As shown in Table 2, the most common cancer types were
19 lung cancer (34.7%), liver cancer (14.0 %) and colorectal cancer (9.5%).
20
21
22
23
24
25
26
27
28
29
30

31 **Healthcare utilisation and cost**

32 As shown in Table 3, the average number of outpatient and inpatient hospitalisation
33 services were 4.86 and 2.23 times per capita, respectively. The ED visits and ICU visits
34 were 1.44 and 0.06 times per capita, respectively. A total of 5.9% (53/894) of the
35 patients were admitted once into the ICU, and 49.7% (444/894) visited the ED only
36 once. The average expenditures per capita during the last 1 week, 1 month, 3 months
37 and 6 months were \$2085, \$6349, \$13043 and \$18235, respectively. The population-
38 level costs in the last 1 week, 1 month and 3 months were, on average, 11.4%, 34.8%
39 and 71.5%, respectively, of the last 6 months.
40
41
42
43
44
45
46
47

48 **Determinants of EOL healthcare cost**

49 As shown in Table 4, all the results revealed proportionate changes in health
50 expenditures among the different groups. In the four generalised linear models, the
51 gender, marital status and education levels of the patients showed statistically
52 insignificant differences in the costs during the four different EOL periods. High EOL
53 healthcare expenditure was associated with the age of first diagnosis, insurance type,
54 place of death, survival after diagnosis and aggressive care services.
55
56
57
58
59
60

1
2
3
4 For age, we can see that patients aged between 65-80 years spent 66.8% and 34.7%
5 more than the oldest groups (OR=1.322, P=0.033, 95% CI=1.022-1.710) and younger
6 patients (OR=1.347, P=0.036, 95% CI=1.02-1.779) on the cost during the last 6 months
7 and 3 months, respectively. Patients with UEBMI spent more than those with URBMI,
8 and the NRCMS in the last 6 months (OR=1.79, P<0.001, 95% CI=1.313-2.44;
9 OR=1.480, P=0.002, 95% CI=1.160-1.887), 3 months (OR=2.172, P<0.001, 95%
10 CI=1.464-3.222; OR=1.668, P=0.002, 95% CI=1.206-2.305) and 1 month (OR=2.132,
11 P<0.001, 95% CI=1.46-3.113; OR= 1.581, P=0.004, 95% CI=1.161-2.152). Patients
12 with the NRCMS spent between 98.2% (OR=1.982, P=0.005, 95% CI=1.228-3.2) and
13 153.2% (OR=2.532, P<0.001, 95% CI=1.548-4.139) higher than the URBMI group
14 during the last week. Patients who died in the hospitals spent 1.488- (*P*=0.002, 95% CI:
15 1.187-1.864), 2.323- (*P*<0.001, 95% CI=1.712-3.151), 3.481- (*P*<0.001, 95% CI=
16 2.585-4.688) and 3.246-fold higher (*P*<0.001, 95% CI=2.427-4.341) than those who
17 died at home during the four EOL periods.

18
19
20
21
22
23
24
25
26
27
28
29
30
31 For the survival time, the difference between the patients who survived for 7-12 months
32 and those who survived for longer than 12 months was not statistically significant
33 (OR=1.026, P=0.787, 95% CI=0.854-1.231). The cost during the last 3 months for
34 patients who survived longer than 12 months was 31.7% (OR=0.682, P=0.032, 95%
35 CI=0.482-0.968) less than that of the reference group (<3-6 months). Differences
36 between the four groups were also observed on the cost during the last 1 week. The
37 mean costs estimated during the last 1 week of the groups who survived for 3–6 months
38 (OR=0.624, P=0.023, 95% CI=0.416-0.937), 7–12 months (OR=0.54, P=0.007, 95%
39 CI=0.346-0.845) and longer than 12 months (OR=0.346, P<0.001, 95% CI=0.199-
40 0.599) were less than patients who survived less than 3 months. Moreover, patients with
41 7-12 months (OR=0.554, P=0.017, 95% CI=0.341-0.900) and longer survival spent less
42 than patients surviving between 3-6 months (OR=1.602, P=0.023, 95% CI=1.067-
43 2.405). Patients with more than 12 months of survival also spent (OR=0.640, P=0.048,
44 95% CI=0.411-0.997) less than those who survived 7-12 months. For the inpatient
45 hospitalisation and ICU services, once the inpatient hospitalisation and ICU services
46 increased by one time, the cost with the four periods increased 30.5% (P<0.001, 95%
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 CI=1.25-1.362) and 83.5% (P<0.001, 95% CI=1.292-2.606), 35.3% (P<0.001, 95%
5
6 CI=1.187-1.864) and 113.7% (P<0.001, 95% CI=1.253-1.461), 35.7% (P<0.001, 95%
7
8 CI=1.248-1.477) and 202.5% (P<0.001, 95% CI=1.994-5.152), 35.3% (P<0.001, 95%
9
10 CI=1.245-1.471) and 222.9% (P<0.001, 95% CI=2.07-5.038), respectively.

11 **Discussion**

12
13 Many studies have noted that aggressive treatment during the EOL of a patient can lead
14
15 to higher costs [17-18]. In this study, patients with end-stage cancer had high rates of
16
17 hospitalisation and an average admission of 2.23 times in the last 6 months of life. A
18
19 total of 5.9% of the cancer patients had used ICU services during the EOL period. A
20
21 comparative study in 7 developed countries showed that 40.3% of patients were
22
23 admitted to the ICU in the USA and approximately 18% of patients were admitted to
24
25 the ICU in the 6 other countries [42]. The mean cost is \$18234 per capita, which is
26
27 lower than those of developed countries, such as Canada (US \$21840), Norway (US
28
29 \$19783), the US (US \$18500) [42], South Korea, Japan and Taiwan (annual cost of
30
31 \$68,773 in 2010) [43]. The cost increased dramatically as death approached, similar to
32
33 the results that SEER-Medicare costs revealed [44]. We also found that cost increased
34
35 rapidly in the last one month, indicating excessive treatment and ineffective medical
36
37 expenses. Considering the current status of EOL healthcare utilisation and the
38
39 expenditures trajectory, the risk factors of the high EOL cost must be investigated.

40
41 In this study, several determinants were identified that were associated with the higher
42
43 EOL cost. First, high EOL healthcare expenditure was associated with young age due
44
45 to high hospital care intensity. This result is consistent with those of previous studies
46
47 [44-46]. Many studies indicated that gender [46 47] and marital status [48] were not
48
49 facilitative determinants of the increased EOL healthcare cost. Second, striking
50
51 disparities were also observed among the different medical insurances, which is
52
53 consistent with the study of Zeng H et al [49]. Patients enrolled in NRCMS spent more
54
55 than those enrolled in URBMI during the last week. This phenomenon may be related
56
57 to the traditional Chinese concept of death and suggests ineffective and irrational
58
59 utilisation and low-value service provision [50]. However, this finding is inconsistent
60
with the conclusion that patients prefer to receive relatively passive care in Taiwan [43].

1
2
3
4 Third, cost also depends on place of death, and cost increased rapidly as death
5 approached. The percentage (62.42%) of patients who died in hospitals in China was
6 higher than patients in the USA (29.5%) and Canada (52%) [42]. However, in the USA,
7 74% of non-hospice beneficiaries died in hospitals or skilled nursing facilities
8 compared with the 14% who died receiving hospice care [51]. Fourth, the effect of
9 survival on EOL cost differed among patients with different survival periods,
10 suggesting that the patients with poor cancer prognosis in the present study may have
11 high rates of aggressive care at the EOL period. Moreover, inpatient hospitalisation and
12 ICU services were risk factors for high EOL cost. An ED visit in China is not a risk
13 factor for the increase in cost, which may be due to the current operation process
14 wherein patients are usually hospitalised once admitted during ED visits [52]. One
15 study by Obermeyer Z et al. [53] revealed that Medicare fee-for-service beneficiaries
16 with poor-prognosis cancer, which were enrolled in the hospice care programme, used
17 less hospitalisation, intensive care unit admissions, and invasive procedures with a
18 lower total cost than the non-hospice group. Hence, there is great potential for the
19 development of hospice care programmes in China.

20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35 The abovementioned results indicated that numerous health resources in China might
36 be ineffectively used, similar to other countries [54]. Patients receiving hospice care or
37 early palliative care intervention could experience better management of pain and
38 symptom[55] and an improved likelihood of dying at home if that was preferred [12,
39 52]. Given the potential benefits of hospice care and early palliative care intervention,
40 the timely initiation of hospice or home care may reduce low value cancer healthcare
41 services in China. The overuse of aggressive care during the EOL period can be harmful
42 from the perspective of the patients, including additional care-related financial strain
43 [14], no reduction in the bereavement of their families [18, 56]. Given the potential
44 benefits of hospice care and early palliative care intervention, the healthcare need of
45 patients should be satisfied. The timely initiation of hospice or home care may reduce
46 the low-value cancer healthcare services in China.

57 58 **Conclusion**

59 According to real-world data, this study provides comprehensive evidence on
60

1
2
3
4 healthcare utilisation and expenditure for cancer patients during the EOL period in
5 China. This study revealed the potential ineffective and irrational utilisation of medical
6 resources and the urgency to improve hospice care systems in China. Overall, this study
7 may aid in formulating specific measures to optimise the current cancer care delivery
8 system, especially at the developing stages of the hospice care system. Future studies
9 should focus on the evaluation of the current system on the provincial or national levels.
10
11
12
13
14

15 **Abbreviation**

16 EOL, End-of-life;

17 OOP, Out-of-pocket;

18 ICD-10, International Statistical Classification of Diseases and Related Health
19 Problems 10th Revision;

20 UEBMI, Urban Employee Basic Medical Insurance;

21 URBMI, Urban Resident-based Basic Medical Insurance;

22 NRCMS, New Rural Cooperative Medical Scheme;

23 CI, Confidence interval;

24 AIC, Akaike Information Criterion.

25 OR, Odds ratio

26 **Competing interests**

27 The authors declare that they have no competing interests.

28 **Authors' contributions**

29 Zhong Li, Zijing Pan, Pei Zhang, Liang Zhang and Boyang Li designed this study;

30 Zhong Li, Zijing Pan, Chengzhong Xu, Fangfang Lu collected and analyzed the data;

31 Zhong Li drafted the manuscript; Ruibo He, Shan Jiang, Boyang Li and Liang Zhang
32 modified the manuscript. All authors read and approved the final manuscript.

33 **Fundings**

34 This project was funded by National Natural Science Foundation of China (71734003,
35 71673099, 71804053).

36 **Acknowledgements**

37 We thank all the staff involved in the establishment of the Yichang Health Management
38 Data Analysis Center, including experts from Yichang Centre for Disease Control and
39

1
2
3
4 Prevention.

5 **Data sharing statement**

6 All the research data is available upon reasonable request.

7 **Reference**

- 8
9
10
11 1. Torre L A, Bray F, Siegel R L, et al. Global cancer statistics, 2012[J]. CA: a cancer
12 journal for clinicians, 2015, 65(2): 87-108.
13
14 2. Farmer P, Frenk J, Knaul FM, et al. Expansion of cancer care and control in countries
15 of low and middle income: a call to action. Lancet 2010,376(9747):1186.
16
17 3. Jönsson B, Hofmarcher T, Lindgren P, et al. The cost and burden of cancer in the
18 European Union 1995-2014. European Journal of Cancer 2016,66:162.
19
20 4. Røe O D. The high cost of new cancer therapies—a challenge of inequality for all
21 countries[J]. JAMA oncology, 2017, 3(9): 1169-1170.
22
23 5. Ramsey S. What do we want from our investment in cancer research? Health Affairs
24 2005, 24 Suppl 2(6):W5R101-4.
25
26 6. Sullivan R. Delivering affordable cancer care in high-income countries. Lancet
27 Oncology 2011,12(10):933-80.
28
29 7. Bainbridge D, Seow H, Jonathan Sussman MD MSc. Common Components of
30 Efficacious In-Home End-of-Life Care Programs: A Review of Systematic Reviews[J].
31 Journal of the American Geriatrics Society, 2016, 64(3):632-639.
32
33 8. Lockett T, Davidson PM, Lam L, et al. Do community specialist palliative care
34 services that provide home nursing increase rates of home death for people with life-
35 limiting illnesses? A systematic review and meta-analysis of comparative studies.
36 Journal of Pain & Symptom Management 2013,45(2):279-97.
37
38 9. Wennberg JE, Bronner K, Skinner JS, et al. Inpatient care intensity and patients'
39 ratings of their hospital experiences. Health Affairs 2009, 28(1):103-12.
40
41 10. Chitnis XA, Georghiou T, Steventon A, et al. Effect of a home-based end-of-life
42 nursing service on hospital use at the end of life and place of death: a study using
43 administrative data and matched controls. BMJ Support Palliative Care 2013,3(4):422-
44 30.
45
46 11. the Dartmouth Atlas of health care. Inpatient days per decedent during the last six
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 months of life by gender and level of care intensity.2015.

5 Available from: <http://www.dartmouthatlas.org/data/topic/topic.aspx?cat=18>

6
7 12. Pizzo P, Walker D, Bomba P. Dying in America: Improving quality and honoring
8 individual preferences near the end of life. Washington, DC: Insitute of Medicine. 2015.

9
10 13. Divi V, Tao L, Whittemore A, et al. Geographic variation in Medicare treatment
11 costs and outcomes for advanced head and neck cancer. *Oral Oncology* 2016,61:83-88.

12
13 14. Pivodic L, Van dBL, Pardon K, et al. Burden on family carers and care-related
14 financial strain at the end of life: a cross-national population-based study. *European
15 Journal of Public Health* 2014,24(5):819-26.

16
17 15. Earle CC, Landrum MB, Souza JM, et al. Aggressiveness of cancer care near the
18 end of life: is it a quality-of-care issue? *Journal of Clinical Oncology Official Journal
19 of the American Society of Clinical Oncology* 2008,26(23):3860.

20
21 16. Langton JM, Blanch B, Drew AK, et al. Retrospective studies of end-of-life
22 resource utilization and costs in cancer care using health administrative data: a
23 systematic review. *Palliative Medicine* 2014,28(10):1167-96.

24
25 17. AEB, Mcclellan MB, Kagay CR, et al. Trends in Inpatient Treatment Intensity
26 among Medicare Beneficiaries at the End of Life. *Health Services Research*
27 2004,39(2):363-75.

28
29 18. Teno JM, Curtis JR. Family Perspectives on Aggressive Cancer Care Near the End
30 of Life. *JAMA* 2016,315(3):284.

31
32 19. Zhong Li, Shan Jiang, Ruibo He, et al. Trajectories of Hospitalization Cost Among
33 Patients of End-Stage Lung Cancer: A Retrospective Study in China *International
34 Journal of Environmental Research and Public Health* 2018, 15(12), 2877.

35
36 20. National Center for Health Statistics and Information. The Fifth National Health
37 Service Survey and Analysis Report.2013.

38
39 21. Chen W, Zheng R, Baade PD, et al. Cancer statistics in China, 2015. *CA Cancer
40 Journal for Clinicians* 2016,66(2):115.

41
42 22. Zeng H, Chen W, Zheng R, et al. Changing cancer survival in China during 2003–
43 15: a pooled analysis of 17 population-based cancer registries. *The Lancet Global
44 Health* 2018, 6(5):e555-e67.

- 1
2
3
4 23. World Bank Group, World Health Organization, Ministry of Finance, National
5 Health and Family Planning Commission, Ministry of Human Resources and Social
6 Security. Health China: Deepening health reform in China building high-quality and
7 value-based service quality. Available from:
8
9
10
11 [https://](https://openknowledge.worldbank.org/bitstream/handle/10986/24720/HealthReformInChina.pdf)
12 [openknowledge.worldbank.org/bitstream/handle/10986/24720/](https://openknowledge.worldbank.org/bitstream/handle/10986/24720/HealthReformInChina.pdf)
13 [HealthReformInChina.pdf](https://openknowledge.worldbank.org/bitstream/handle/10986/24720/HealthReformInChina.pdf). Accessed 29 Apr 2018.
14
15 24. Unit EI. the 2015 Quality of death index: Ranking palliative care across the world
16 . 2015 Available from:
17
18
19 [https://www.eiuperspectives.economist.com/sites/default/files/2015%20EIU%20Quality%20of%](https://www.eiuperspectives.economist.com/sites/default/files/2015%20EIU%20Quality%20of%20Death%20Index%20Oct%2029%20FINAL.pdf)
20 [20Death%20Index%20Oct%2029%20FINAL.pdf](https://www.eiuperspectives.economist.com/sites/default/files/2015%20EIU%20Quality%20of%20Death%20Index%20Oct%2029%20FINAL.pdf)
21
22
23 25. Huang H-Y, Shi J-F, Guo L-W, et al. Expenditure and financial burden for common
24 cancers in China: a hospital-based multicentre cross-sectional study. *The Lancet* 2016,
25 388:S10.
26
27
28 26. Narang AK, Nicholas LH. Out-of-Pocket Spending and Financial Burden Among
29 Medicare Beneficiaries With Cancer. *JAMA Oncology* 2016,3(6):757.
30
31
32 27. Yang T, Chu J, Zhou C, et al. Catastrophic health expenditure: a comparative
33 analysis of empty-nest and non-empty-nest households with seniors in Shandong,
34 China. *BMJ Open* 2016, 6(7):e010992.
35
36
37 28. Wang Z, Li X, Chen M. Catastrophic health expenditures and its inequality in
38 elderly households with chronic disease patients in China. *International Journal for*
39 *Equity in Health* 2015,14(1):8.
40
41
42 29. Haiying An, Jinghua Sun, Jiqi Zhao, Research on the palliative care nursing for the
43 patients with end-stage cancer. *Practice and Research on Nursing*. 2008, 5(18):65-66.
44 [in Chinese]
45
46
47 30. Ethical reflection of the health resource allocation for the palliative care services—
48 —an study on the medical cost of 215 patients with the end-stage cancer. *Chinese*
49 *Journal of Medical Ethics*, 1995(4):26-27. [in Chinese]
50
51
52 31. Jufang Shi, Chunlei Shi, Xinpei Yue, et al. Economic burden of cancer in China
53 during 1996-2014 : a systematic review. *Chinese Journal of Oncology*,
54 2016;38(12):929-41.
55
56
57
58
59
60

- 1
2
3
4 32. WHO. the International Statistical Classification of Diseases and Related Health
5 Problems 10th Revision (ICD-10).
6
7 33. Florence KLTPD, Sujha SPD, M.P.H SASMD, et al. End-of-Life Medical Costs of
8 Medicaid Cancer Patients. *Health Services Research* 2015, 50(3):690–709.
9
10 34. Earle CC, Neville BA, Landrum MB, et al. Trends in the aggressiveness of cancer
11 care near the end of life. *Journal of Clinical Oncology Official Journal of the American*
12 *Society of Clinical Oncology* 2004, 22(2):315-21.
13
14 35. Earle CC, Neville BA, Landrum MB, et al. Evaluating claims-based indicators of
15 the intensity of end-of-life cancer care. *International Journal for Quality in Health Care*
16 *Journal of the International Society for Quality in Health Care* 2005,17(6):505-9.
17
18 36. Setoguchi S, Earle CC, Glynn R, et al. Comparison of Prospective and
19 Retrospective Indicators of the Quality of End-of-Life Cancer Care. *Journal of Clinical*
20 *Oncology Official Journal of the American Society of Clinical Oncology*
21 2008,26(35):5671-8.
22
23 37. Grunfeld E, Urquhart R, Mykhalovskiy E, et al. Toward population-based indicators
24 of quality end-of-life care. *Cancer* 2008,112(10):2301–08.
25
26 38. Grunfeld E, Lethbridge L, Dewar R, et al. Towards using administrative databases
27 to measure population-based indicators of quality of end-of-life care: testing the
28 methodology. *Palliative Medicine* 2006,20(8):769-77.
29
30 39. World Bank Group, ICP 2011: International Comparison Program. -
31 Available from:
32 http://siteresources.worldbank.org/ICPEXT/Resources/ICP_2011.html
33
34 40. Barber J, Thompson S. Multiple regression of cost data: use of generalised linear
35 models. *J Health Serv Res Policy* 2004,9(4):197-204.
36
37 41. Diehr P, Yanez D, Ash A, et al. Methods for analyzing health care utilization and
38 costs. *Annual Review of Public Health* 1999,20(1):125.
39
40 42. Bekelman JE, Halpern SD, Blankart CR, et al. Comparison of Site of Death, Health
41 Care Utilization, and Hospital Expenditures for Patients Dying With Cancer in 7
42 Developed Countries. *JAMA* 2016,315(3):272.
43
44 43. Hung Y N, Liu T W, Wen F H, et al. Escalating Health Care Expenditures in Cancer

1
2
3
4 Decedents' Last Year of Life: A Decade of Evidence from a Retrospective Population-
5 Based Cohort Study in Taiwan. *Oncologist*, 2017, 22(4):460.

6
7 44. Bremner K E, Krahn M D, Warren J L, et al. An international comparison of costs
8 of end-of-life care for advanced lung cancer patients using health administrative data.
9 *Palliative medicine*, 2015, 29(10): 918-928.

10
11 45. Gielen B, Remacle A, Mertens R. Patterns of health care use and expenditure during
12 the last 6 months of life in Belgium: differences between age categories in cancer and
13 non-cancer patients. *Health Policy* 2010,97(1):53-61.

14
15 46. Langton JM, Reeve R, Srasuebkul P, et al. Health service use and costs in the last
16 6 months of life in elderly decedents with a history of cancer: a comprehensive analysis
17 from a health payer perspective. *British Journal of Cancer* 2016,114(11):1293-302.

18
19 47. Yabroff KR, Lamont EB, Mariotto A, et al. Cost of care for elderly cancer patients
20 in the United States. *Journal of the National Cancer Institute* 2008,100(9):630-41.

21
22 48. Cabreraalonso J, Long MJ, Bangalore V, et al. Marital status and health care
23 expenditures among the elderly in a managed care organization. *Health Care Manager*
24 2003,22(3):249.

25
26 49. Zeng H, Zheng R, Guo Y, et al. Cancer survival in China, 2003-2005: A population-
27 based study. *International Journal of Cancer* 2015,136(8):1921-30.

28
29 50. Zuckerman RB, Stearns SC, Sheingold SH. Hospice Use, Hospitalization, and
30 Medicare Spending at the End of Life. *J Gerontol B Psychol Sci Soc Sci*
31 2016;71(3):gbv109.

32
33 51. Z O, M M, S A, et al. Association between the Medicare hospice benefit and health
34 care utilization and costs for patients with poor-prognosis cancer. *JAMA* 2014,
35 312(18):1888-96.

36
37 52. Hou XY, Chu K. Emergency department in hospitals, a window of the world: A
38 preliminary comparison between Australia and China. *World Journal of Emergency*
39 *Medicine* 2010,1(3):180.

40
41 53. Obermeyer Z, Makar M, Abujaber S, et al. Association Between the Medicare
42 Hospice Benefit and Health Care Utilization and Costs for Patients With Poor-
43 Prognosis Cancer. *Journal of the American Medical Association* 2014,312(18):1888.

1
2
3
4 54. Davies NJ, Batchup L. Towards a personalised approach to aftercare: a review of
5 cancer follow-up in the UK. *Journal of Cancer Survivorship* 2011,5(2):142-51.

6
7 55. Temel J S, Greer J A, Muzikansky A, et al. Early palliative care for patients with
8 metastatic non-small-cell lung cancer. *New England Journal of Medicine*, 2010, 363(8):
9 733-742.

10
11 56. Carlson MD, Herrin J, Du Q, et al. Impact of hospice disenrollment on health care
12 use and medicare expenditures for patients with cancer. *Journal of Clinical Oncology*
13 Official Journal of the American Society of Clinical Oncology 2010,28(28):4371.
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 1. Basic characteristics of the enrolled patients

Demographic characteristics	patients (N=894)	%
Age (year), Median (range)	69 (25,102)	
<65	315	35.2
65-80	440	49.2
>80	139	15.6
Gender		
Male	597	66.8
Female	297	33.2
Marital status		
Unmarried	9	1.0
Married	742	83.0
Widow	126	14.2
Divorced	17	1.9
Insurance type		
Urban Employee Basic Medical Insurance (UEBMI)	518	57.9
Urban Resident-based Basic Medical Insurance (URBMI)	181	20.3
New Rural Cooperative Medical Scheme (NRCMS)	195	21.8
Education		
≤ Junior school	675	75.5
Senior school	141	15.8
≥ College	78	8.7
Place of death (POD)		
Health institution	558	62.4
Home	336	37.6
Survival time from cancer diagnosis #		
< 3 months	260	29.3
3-6 months	231	26.0
7-12 months	219	24.6
> 12 months	179	20.1

Survival time of five patients was not obtained.

Table 2. The ICD-10 codes of first cancer type when diagnosed

First cancer type	codes	patients (N=894)	%
Lung	C34.x	310	34.7
Stomach	C16.x	60	6.7

Colorectum	C18.x, C19.x, C20.x	85	9.5
Liver	C22.x	125	14.0
Pancreas	C25.xl	39	4.4
Biliary tract	C23.x, C24.x	19	2.1
Blood	C81.x-C86.x, C91.x-C95.x	0	0
Prostate	C61.x	15	1.7
Breast	C50.x	28	3.1
Others	C00.x-C15.x, C17.x, C21.x,C26.x,C30.x-C33.x, C37.x-C41.x,C43.x-C49.x,C51.x-C58.x, C60.x,C62.x,C80.x,C88.x,C90.x,C96.x,C97.x	213	23.8

Table 3. Healthcare services utilization and cost of the enrolled patients*

Variable	mean	Std. error	median	range
Outpatient services	4.86	7.67	2	59
Inpatient hospitalization services	2.23	2.16	2	39
Emergency department visit	1.44	2.91	1	13
Intensive care unit admission	0.06	0.25	0	2
Cost during the last 1 week	2085	6829	1195	66437
Cost during the last 1 month	6349	18469	6640	195182
Cost during the last 3 months	13043	37434	13901	431158
Cost during the last 6 months	18234	34583	19276	723144

* The International Purchasing Power Parities using rate for Chinese Yuan to US dollars (¥2.03=\$1) in health from International Comparison Program (ICP) 2011.

Table 4. Results of the four generalized linear models

Variables	Group	Model 1			Model 2			Model 3			Model 4		
		OR	P	95% CI	OR	P	95% CI	OR	P	95% CI	OR	P	95% CI
Gender(e)	Female	0.906	0.305	(0.751,1.094)	1.016	0.903	(0.789,1.308)	0.824	0.127	(0.643,1.056)	0.946	0.722	(0.694,1.288)
Age(f)	65-80 (2)	1.098	0.369	(0.895,1.347)	1.347	0.036	(1.02,1.779)	1.017	0.901	(0.779,1.329)	1.241	0.212	(0.885,1.74)
	>80 (3)	0.831	0.224	(0.616,1.12)	1.043	0.834	(0.702,1.551)	0.767	0.156	(0.531,1.107)	0.932	0.778	(0.568,1.527)
Insurance	NRCMS (2)	1.21	0.230	(0.886,1.652)	1.302	0.215	(0.858,1.977)	1.349	0.117	(0.928,1.961)	1.982	0.005	(1.228,3.2)
Type(g)	UEBMI (3)	1.79	<0.001	(1.313,2.44)	2.172	<0.001	(1.464,3.222)	2.132	<0.001	(1.46,3.113)	2.532	<0.001	(1.548,4.139)
Marriage status(h)	Married (1)	2.457	0.069	(0.933,6.468)	1.205	0.757	(0.371,3.919)	1.07	0.906	(0.349,3.276)	1.239	0.764	(0.305,5.031)
	Widow (2)	2.163	0.132	(0.792,5.905)	0.893	0.855	(0.264,3.017)	1.27	0.687	(0.397,4.064)	1.004	0.996	(0.231,4.355)
Education(i)	Divorced (3)	2.504	0.112	(0.808,7.763)	1.074	0.922	(0.257,4.489)	1.248	0.746	(0.327,4.772)	1.572	0.607	(0.28,8.824)
	Senior (2)	1.143	0.242	(0.913,1.431)	1.004	0.978	(0.73,1.382)	1.043	0.791	(0.767,1.418)	0.921	0.702	(0.605,1.403)
POD(j)	≥College (3)	0.996	0.981	(0.737,1.346)	1.227	0.358	(0.794,1.897)	1.255	0.277	(0.833,1.891)	1.244	0.406	(0.743,2.086)
	Hospital	1.488	0.001	(1.187,1.864)	2.323	<0.001	(1.712,3.151)	3.481	<0.001	(2.585,4.688)	5.371	<0.001	(3.653,7.897)
Survival(k)	3-6 months (2)							0.648	0.008	(0.47,0.893)	0.624	0.023	(0.416,0.937)
	7-12 months (3)				0.827	0.186	(0.623,1.096)	0.661	0.02	(0.466,0.937)	0.54	0.007	(0.346,0.845)
	> 12 months (4)	1.026	0.787	(0.854,1.231)	0.683	0.032	(0.482,0.968)	0.507	0.002	(0.333,0.771)	0.346	<0.001	(0.199,0.599)
OS		1.007	0.13	(0.998,1.016)	0.998	0.842	(0.981,1.015)	0.993	0.441	(0.974,1.011)	1.005	0.679	(0.98,1.031)
EMR		0.997	0.824	(0.975,1.02)	0.98	0.267	(0.945,1.016)	0.98	0.343	(0.941,1.022)	0.971	0.273	(0.922,1.023)
'H'IS		1.305	<0.001	(1.25,1.362)	1.353	0.001	(1.253,1.461)	1.357	<0.001	(1.248,1.477)	1.369	<0.001	(1.229,1.526)
ICU		1.835	0.001	(1.292,2.606)	2.378	<0.001	(1.438,3.932)	3.205	<0.001	(1.994,5.152)	3.456	<0.001	(3.456,6.299)
No		398			629			807			868		

Model 1: cost during the last 6 months; Model 2: cost during the last 3 months; Model 3: cost during the last 1 months; Model 4: cost during the last 1 week. # Reference: (e)Male; (f)<65; (g) URBMI; (h)Unmarried; (i) Junior or below; (j)Home; (k)< 3 months In Model 1 and 2, we took the patients survived 7-12 months and 3-6 months as reference, respectively. Results of additional models: Model 1: Agegroup: 2 vs.3 (OR=1.322, P=0.033, 95% CI=1.022-1.710); Insurnace type: 3 vs.2 (OR=1.480, P=0.002, 95% CI=1.160-1.887); Model 2: Insurnace type: 3 vs.2 (OR=1.668, P=0.002, 95% CI=1.206-2.305); Model 3: Insurnace type: 3 vs.2 (OR= 1.581 , P=0.004, 95% CI=1.161-2.152); Model 4: Survival: 4 vs.2 (OR=0.554, P=0.017, 95% CI=0.341-0.900); 5 vs.2 (OR=1.602, P=0.023, 95% CI=1.067-2.405);4 vs.3 (OR=0.640,

1
2
3
4
5 P=0.048, 95% CI=0.411-0.997); OS, outpatient services; IHS, inpatient hospitalization services; No, number of observation; AIC, Akaike Information Criterion; OR,
6 odds ratio, CI, Confidential Interval.
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

For peer review only

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*
Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1-2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	4-5
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	Not required
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-5
Bias	9	Describe any efforts to address potential sources of bias	4-5
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	4-5
		(b) Describe any methods used to examine subgroups and interactions	4-5
		(c) Explain how missing data were addressed	4-5
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	4-5

		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage	6 6
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	6 6-7 6
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6-7 6-7 6-7
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	6-7 6-7 6-7
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6-7
Discussion			
Key results	18	Summarise key results with reference to study objectives	8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8-9, 1
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9, 1
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-9, 1

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.