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Title:

Which Cost Components Influence the Cost of Palliative Care in the Last Hospitalization? A Retrospective Analysis of Palliative Care vs. Usual Care at a Swiss University Hospital

Authors:

Monika Hagemann, M.Sc.
(Research assistant at Center for Palliative Care, Inselspital Bern

Sofia Zambrano, PhD
(PostDoc at Center for Palliative Care, Inselspital Bern)

Lukas Bütikofer, PhD
(Senior Statistician at CTU Bern, University of Bern)

Antje Bergmann, Prof. Dr.
(Professor for General Practice, TU Dresden)

Karen Voigt, Dr. Dipl.-Soz. MPH
(Head of General Practice Research Department, TU Dresden)

Steffen Eychmüller, Prof. Dr.
(Director of Center for Palliative Care, Inselspital Bern)

Running title: Cost components influencing palliative care cost

Abstract

Context: Although the number of studies on the economic impact of palliative care (PC) is growing, the great majority report costs from North America.

Objectives: We aimed to provide a comprehensive overview of PC hospital cost components from the perspective of a European mixed funded health care system by identifying cost drivers of PC and quantifying their effect on hospital costs compared to usual care (UC).

Methods: We performed a retrospective, observational analysis examining cost data from the last hospitalization of patients who died at a large academic hospital in Switzerland comparing patients receiving PC versus UC.

Results: Total hospital costs were similar in PC and UC with a mean difference of CHF -2'777 [95% confidence interval (CI) -12'713 to 8'506, p=0.60]**.** Average costs per day decreased by CHF -3'224 [95% CI -3'811 to -2'631, p<0.001] for PC patients with significant reduction of costs for diagnostic intervention and medication. Higher cost components for PC patients were catering, room, nursing, social counselling and non-medical therapists. In sensitivity analyses, when we restricted PC exposure to 3 days from admission, total costs and average costs per day were significantly lower for PC.

Conclusion: Studies measuring the impact of PC on hospital costs should analyze various cost components beyond total costs in order to understand wanted and potentially unwanted cost-reducing effects. An international definition of a set of cost components, specific for cost-impact PC studies, may help avoid superficial and potentially dangerous cost discussions.

Key Words

Palliative care, hospitals, financial impact, cost components

Introduction

Palliative Care (PC) improves the quality of care at the end of life, reduces symptoms and leads to a higher patient, family, and physician satisfaction when compared to curative treatments on regular wards.[1-3]

The cost impact of PC has been explored in different contexts, but more often comparing hospital costs of PC vs. UC.[3-18] The majority of these studies have focused on average daily costs and total costs (see appendix I).[3-7,9,12-15] Other studies focus on direct costs that can be completely attributed to medications, procedures, or services such as patient care supplies and medication.[3,4,11,12,15-18] Of these, the majority report lower costs for PC than for UC.[3-7,9,11-16,18] In addition, some of the studies analyze individual cost components such as pharmacy, laboratory, imaging or intensive care unit (ICU) costs.[3,5,6,11,13,15,17] The majority of studies show a clear trend towards lower PC costs. Management, procedures or room costs are analyzed sporadically.[5,15,17] A deeper analysis of cost components such as detailed staff or catering costs, have not been examined to date. Since staff costs account for about 64.5 % of Swiss hospital revenues, it is surprising that none of the aforementioned studies performed in other countries have focused on this cost type.[19]

In addition, there is a lack of European research assessing the cost impact of PC, since most studies originate in the United States (US) and thus, concentrate on a privately funded healthcare system.[3-11,13-18] Findings from the US cannot generally be transferred to a mixed private and socially funded health care system, as it exists in Switzerland and other countries.

There are several reasons why the examination of PC from an economic perspective is crucial: One of the main global challenges in the next years is to keep fundable healthcare systems.[2] As an example, Swiss healthcare expenditures have been rising every year since 1990 by about 2%. The relative share of healthcare expenditures on the Gross Domestic Product was 8% in 2010, whereas it grew to 12.1% in 2015.[20] Additionally, Switzerland has a short history of encouraging PC. While in the US 60% of the hospitals report the existence of a PC program, in Switzerland 7.8% of stationary institutions run a certified PC program.[13,20-22] Finally, according to the Swiss Federal Statistical Office, in 2015 the proportion of the population aged 65 years and older was 18% and it is estimated that this share will increase to 26.4% in 2045.[24] Consequently, as the population ages and their needs become more complex, the greater need for PC will be inevitable.[25]

In this study, we aimed to retrospectively analyze the cost impact of in-hospital PC with a particular focus on exploring which specific cost components drive the cost of PC. The majority of existing PC cost studies focus only on individual cost components. Therefore, this is the first study that gives a comprehensive overview of all occurred direct and indirect hospital costs.

Methods

Study Design

After receiving ethical approval (KEK-2017-00400), we performed a retrospective, observational cost analysis examining administrative and medical patient data from a large academic University hospital in Switzerland.

Sample Selection

We captured data from the last hospital admission of patients who died between January 1st and December 31st, 2015. Patients with dissent to further use of medical data (Humanforschungsgesetz – HFG) were excluded, as were perinatal deaths, deceased children (patients younger than 18 years of age), and patients who, according to the ICD-10, died due to an external cause, such as an accident or an injury. These deletions reduced the number from 976 to 780 cases. Lastly, after exclusion of ambulatory patients and patients with missing cost data, the final sample size included 746 patients (see Figure 1). All included patients were observed once.

We classified patients as receiving PC if their time in PC accounted for more than 25% of the last stay and they had either: a) inpatient care at the PC ward; or b) if the patient was seen and evaluated by the PC team after a PC consultation was requested by the attending physician, or c) if the treating team received recommendations from the PC team. All other patients were classified as UC, including those who had PC input for less than 25% of the last hospitalization. Primarily, our rationale for the 25% criteria was because in Switzerland referrals to PC occur rather late in the care trajectory, including during the last hospitalization. Therefore, in order to include late referrals that may still have obtained a meaningful contribution from during the last hospitalization, we chose 25% of PC involvement as the minimum. In the end, we included 642 patients in UC and 104 in PC.

Clinical and Financial Data

To gain a comprehensive financial overview of hospital costs, we required clinical and financial data from several sources (see Table 1 for an overview of all hospital databases employed).

We derived clinical data from the patient characteristics' database, which provides administrative information about, age, sex, death date, residency and marital status, as well as medical data such as main diagnoses, main treatments, Casemix-Index and cost weight. The cost weight is an empirically determined relative weight describing the average treatment effort of a given group of patients.[26] The patient process database contains all in-house

movements of each patient, for instance patient movement from the emergency room (ER) to gastroenterology.

From the hospital's cost accounting system, we retrieved patient costs for each hospital day and for the entire admission period. The activity records database gives information about all services and items rendered including, staff activities, materials, laboratory and catering at the exact date and time when each activity occurred.

We retrieved the sum of the costs for each patient from the cost unit accounting database. This database provides information about the costs per case and unit. For example, a patient generates an expense of CHF 2'500 in the surgery room. However, it does not have exact information on the corresponding date nor differentiates between performances given over a period of more than one day. For PC patients, costs arising before the PC intervention were not differentiated.

As the activity records database does not include a detailed list of delivered medication, we gathered data from all in-house medication databases, namely the databases of the regular ward, the ER, and of the ICU.

Development of Cost Matrix

Accessing and merging the seven different databases was necessary to obtain the required level of detail, and which allowed for a comprehensive overview of all direct and indirect hospital costs. While direct costs can be completely attributed to medications, procedures, or services, indirect costs are not directly related to any specific service and involve different departments. In terms of hospital care, direct costs include, inter alia, patient care supplies, medication, imaging, pharmacy as well as room and board costs. Hospital overhead costs, such as general hospital administration, cleaning or facility services as well as information technology, are more difficult to assign to a patient and, therefore, are considered to be indirect or shared costs.[27-29]

In order to capture all relevant hospital costs, we thoroughly reviewed the existing literature (see Table 2 for an overview of all cost components used to date to explore cost differences between UC and PC and refer to Appendix I for a more detailed summary). Since the different cost components belong to different categories, we assigned the costs components to three different categories: total costs, cost types, and organizational units. The category "total costs" labels all cost components that describe total costs in general. The second group describes where certain costs arise, and thus, include organizational units of a hospital such as ICU and imaging. The category "cost types" summarizes the different kinds of costs.

We then matched the available hospital data with the already existing cost components from the literature. In order to get a comprehensive overview of all incurred hospital costs, we added

organizational units and cost types. Since we also had detailed information on staff, we split this cost type into four sub-cost components (nursing, physician, therapist, and social counselling). Table 3 shows the developed cost matrix.

Data Analysis

Continuous and categorical patient characteristics are presented with mean and standard deviation (sd) or median and quartiles (lower, upper), and relative and absolute frequencies. PC and UC groups were compared using Mann-Whitney-Wilcoxon or chi-squared tests for continuous and categorical variables.

The crude cost data (see appendix II) are presented with mean and standard deviation for each group and compared between PC and UC using linear regression with robust standard error. We used bootstrapping with 2'000 repetitions to correct for bias and calculate 95% confidence intervals (95% CI).[34] Cost data were adjusted using inverse probability weighting based on propensity scores. This method is used widely in observational studies to adjust for cofounding effects and to control for selection bias and has been shown to improve estimates of the effect of an intervention on costs.[30-32] We derived propensity scores through a logistic regression with "age", "marital status" (as binary variable, married yes/no), "insurance class", "primary diagnosis" and "location prior to entry" (e.g. home, other hospitals, psychiatric clinic) as covariates. For the inverse probability weighting, we used stabilized weights and calculated potential outcome means (POM) and average treatment effects (ATE) based on weighted linear regression.[32] P-values were derived using the bias-corrected point estimate and the bootstrap standard errors with a normal approximation.

As a sensitivity analysis, we used generalized linear models with gamma distribution and log-link to fit the cost data. The estimated model coefficients are presented on the exponentiated scale and can be interpreted as mean per group and as mean ratio between groups. Crude estimates were calculated from intercept only models for each group and a model with group as covariate (see appendix V). The analysis was adjusted using inverse probability weighting by propensity scores as described above (see appendix III+IV).

To allow for international comparisons, instead of the 25% criteria to define PC exposure, we followed the 3-day criteria from admission followed by others[35] and performed further sensitivity analyses.

Results

Patient Characteristics

Patients in the PC group were younger than those in UC (64.7 years vs. 70.8 years, p<0.001). The majority were male and married. Over three quarters of patients from both groups had public insurance plans. Primary diagnoses differed between UC and PC significantly (p<0.001). More than half of UC patients (377, 59%) died of a cardiovascular disease followed by malignant neoplasms (108, 17%) while most of the PC patients died of malignant neoplasms (77, 74%) followed by cardiovascular diseases (12, 12%). In UC, two thirds of patients (423, 66%) were admitted to the hospital from home and 193 (30%) from other hospitals, while within PC, 87 (84%) patients were admitted from home and only 10 (10%) from another hospital.

Admissions to the ER were significantly higher for UC patients (474, 74%) than for PC (62, 60%), as well as to the ICU, where 420 (65%) UC patients were admitted at least once, while only 27 (26%) PC patients were admitted there (p<0.001). Moreover, there was a significant difference in average length of stay of 8.8 days (p<0.001) with PC patients having longer stays (refer to Table 4 for patient characteristics).

Financial Analysis

All cost components: With respect to all cost components aggregated, total costs over the whole stay were relatively similar for PC (CHF 38’381, 95%CI 30’230 to 48’132) and UC patients (CHF 41’158, 95%CI 36’191 to 47’731) leading to a mean difference of CHF -2’777 with a wide 95% confidence interval (-12’713 to 8’506) that included 0 (Table 5). Average daily costs for a PC patient were significantly lower (CHF -3’244, 95%CI -3’811 to -2’631) than for UC (Table 6).

Organizational units: The results presented in Table 5 and 6 show a clear trend that PC patients had lower total costs than UC patients in radiology (CHF -1’457, 95%CI -1'937 to -1'027), ICU (CHF -8’895 95%CI -12'734 to -5'772) and surgery (CHF -1’555, 95%CI -3'529 to 731). The same was true for average daily costs in the same organizational units. The opposite effect was observed for hotel costs (total costs CHF 1’701, 95%CI 1'204 to 2'272 and average daily costs CHF 16, 95%CI 1 to 33). Ward costs were lower in terms of average daily costs for PC than for UC patients (CHF -814 CHF, 95%CI -1'176 to -444), but were higher in terms of total costs (CHF 7’385 95%CI 596 to 14'785). Emergency room costs were similar in both groups.

Cost types: The effect on total and average daily costs showed the same direction for catering, laboratory, material, other, pharmacy and room costs. Laboratory, material, pharmacy, and other costs were cheaper for PC patients, while the other costs showed the opposite trend

(Table 5 and 6). Total patient management and staff costs were similar in both groups, whereas average daily costs were lower in PC.

Staff detail: Nursing (costs per day: CHF 180, 95%CI -137 to 550; total costs: CHF 9’625, 95%CI 5'300 to 14'763), social counselling (costs per day: CHF 48, 95%CI 28 to 66; total costs: CHF 282, 95%CI 164 to 415) and therapist costs (costs per day: CHF 60, 95%CI 33 to 105; total costs: CHF 347, 95%CI 134 to 609) were higher for PC patients than for UC patients. The opposite effect was observed for physicians, who had lower average daily costs (CHF -1’644, 95%CI -2'177 to -1'139) and total costs (CHF -8’288, 95%CI -13'021 to -3'918) for PC patients compared to UC patients.

Sensitivity Analyses

The results remained similar when a generalized linear model with gamma distribution and log-link was used instead of the linear model (see appendix III-IV). Total costs were similar in both groups with a mean ratio of PC vs UC of 0.94 (95%CI 0.68 to 1.18), whereas costs per day were reduced in the PC group by 58% (95% CI 49 to 66%).

With the 3-day after admission criteria defining PC exposure (n=41), average daily costs were not much affected by the different grouping, but total costs shifted in favor of PC—overall costs were e.g. reduced by CHF 14’461 (5’203 to 25’721) in PC compared to UC; in the main analysis the groups were closer together. The main drivers for this difference were surgery, ward and staff costs, which were all shifted in favor of PC (appendix VI-VII).

Discussion

Our analysis suggests that PC reduces average daily costs but may not reduce total costs as patients stayed longer. A reduction of average daily costs by PC has been observed before.[3,5-7,11-13,15] but may not be as significant for policymakers than a reduction in total costs. A significant reduction of total costs was only seen when PC exposure was defined as 'referral to PC within 3 days from admission to the hospital'. The exposure chosen in our study (based on a 25% threshold on the exposure to PC) may explain why compared to international trends,[3,4,7,9,13,15] total costs in our sample were not significantly lower for PC. In particular, long-stayers with high total costs who did not start PC right away may still be considered as receiving PC in our setting.

Individual cost components, which are significantly higher for PC compared to UC patients, are hotel (organizational unit), catering and room (cost types), as well as nursing, social counselling and therapist costs (staff detail). In contrast to lower cost components such as radiology, laboratory, material and pharmacy costs, the higher costs in PC for direct care such as nursing staff and therapists may be those that contribute to increased quality of care for the patient and their family members. Catering and room cost differences between PC and UC are similar to the results of the study (room and board costs) from May et al. (2015). Only Penrod et al. (2010) examined the differences in total nursing costs. However, an opposite trend resulting in significant lower costs for PC patients than for UC patients was reported. The differences in the cost components such as materials, physician, social counselling and other therapists have not been reported to date.

Like in many other developed countries, economic pressure also weighs on the Swiss healthcare sector. Therefore, hospitals increasingly have to justify their health offers, including whether and how PC contributes to in-hospital costs.[35,37] Our in-depth approach can comprehensively show that the cost components of PC which are significantly higher are direct costs due to a longer hospital stay. However, length of stay in hospital depends largely on the availability of surrounding healthcare offers such as mobile home care teams and nursing homes. Thus, cost components driven by the length of stay are directly dependent on the possibility to transfer complex patients to another setting of care when patients are stable and which may not be regarded as valid factors/ measurements for cost evaluation studies in end of life and PC. Keeping a balance between the quality of care at the end of life and its incurred costs will be a challenging task for healthcare systems in the near future.[12]

There are a number of limitations to our study. In particular, the generalizability of the results might be questioned. Data was collected from one University hospital and thus does not contain cost data from other health settings including other hospitals, hospices, as well as different hospital types such as private, non-profit and public hospitals. An international or inter-

institutional comparison may provide a better basis to further understand the cost saving impact, as well as to support discussions between stakeholders, such as in reimbursement negotiations. In this case, an agreed set of cost components (leaving out components that are directly linked to length of stay) is needed as a common basis. Whether some types of cost data are preferable to others could be the focus of future studies. Moreover, increasing the sample size by adding data from other years could have help increase power in our comparisons. To avoid bias, future research should also include all patients' discharges (alive and dead).[36] In addition, a prospective longitudinal design across settings of care may provide more comprehensive results. Costs in retrospective studies might appear higher because PC is added to conventional therapy. As an example, this study defined a PC patient as a patient who receives PC on the PC ward or a PC consultation only. However, we did not distinguish between both interventions. Another limitation might be the potential self-selection bias, which "arises when a rule other than simple random sampling is used to sample the underlying population",[37] however, we tried to reduce this problem using simple exclusion criteria. With respect to the study's statistical methodology, propensity-score weighting might fail to adjust adequately for unmeasured variables and we only measured a limited set of confounders. Psychosocial factors and unobserved complications in a patient's condition throughout the hospital stay may also affect the cost estimates. However, we tried to provide a valid comparison between PC and UC patients using all available data at the time of hospital admission.[16] The development of the cost matrix can be questioned but the data from the accounting system leave little room for cost allocation varieties. The advantage of this matrix is the option to analyze individual costs blocks separately (e.g. only ward costs). The correlation of costs and quality of care needs to be discussed in further research. Finally, the definition of PC based on a 25% threshold on the exposure to PC may have led to the dilution of the sample by patients that did not profit from the PC intervention, including long-stayers with high total costs. Other authors[17,35] have employed referral within a few days from admission as adequate timeframes, which have shown that the earlier the exposure the greater the chances of positive impacting on cost. Indeed, such an approach favored the PC group in our analysis with respect to total costs.

Conclusion

We contribute to the growing literature a comprehensive analysis of hospital cost components from three different perspectives: (1) organizational units (2) cost types and (3) staff detail. We identified main triggers that influence the cost components in PC and UC patients, which can be the basis for comprehensive and reliable cost analyses. Such analysis enhances transparency for internal and external stakeholders and can serve as a potential controlling

instrument. The recognition of these differences between and within costs can be an advantage to justify health offers in financially tense healthcare industries in the future.

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The authors declare that they have no competing interests.

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Tables and Figures

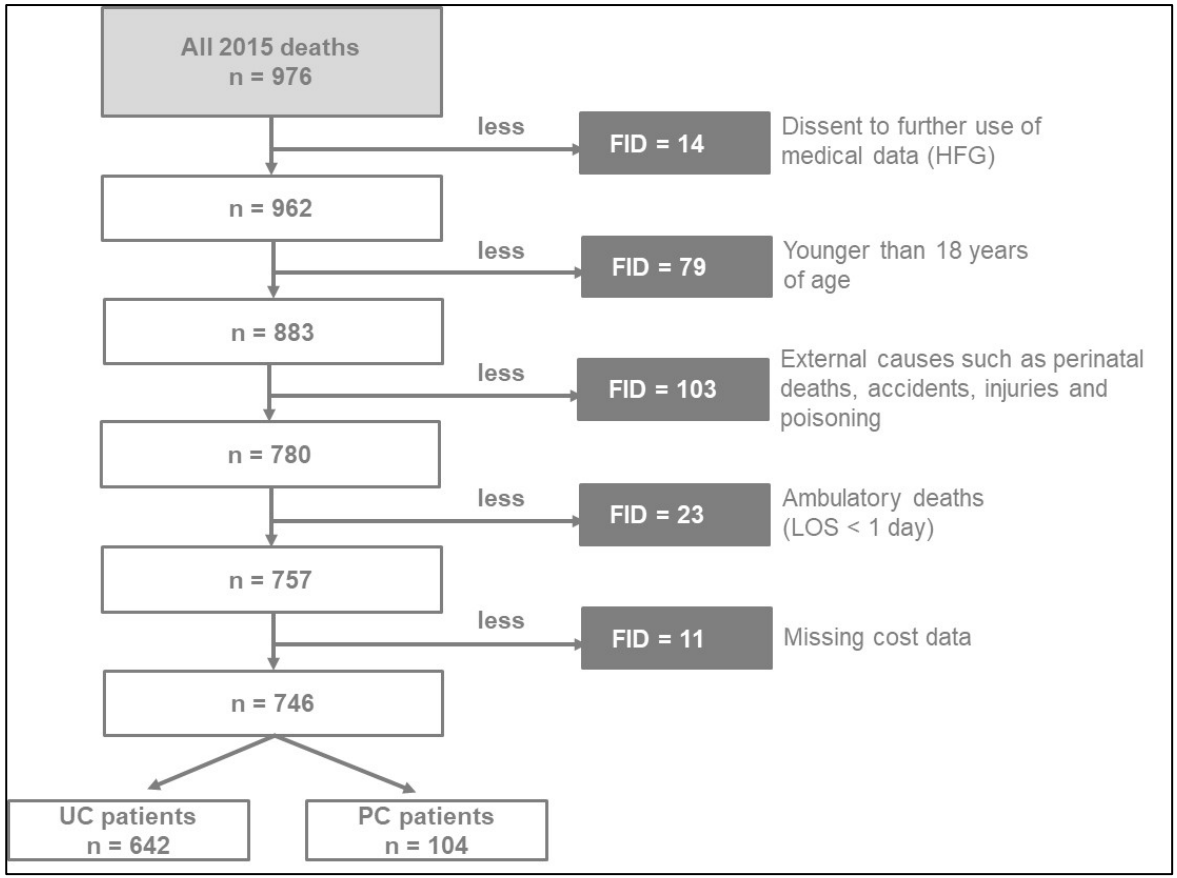


Figure 1: Exclusion flowchart for initial sample list

Table 1: Applied hospital databases

Nr.	Hospital database	Data
1	Patient characteristics	Administrative and medical patient data
2	Patient process	Inhospital movements of patients
3	Activity records	Rendered services and items
4	Cost unit accounting	Costs per unit
5	Medication database 1	Medication data for regular wards
6	Medication database 2	Medication data for emergency room
7	Medication database 3	Medication data for ICU

Table 2: Cost components from existing literature

Cost components	Number of studies*	Studies with costs lower in PC vs. UC*	Studies with costs higher in PC vs. UC*	Assigned cost categories
Total costs per day	11 (9)	10 (8)	1 (1)	total
Total costs	11 (8)	10 (8)	1 (0)	total
Pharmacy costs	10 (5)	8 (4)	2 (1)	cost type
Laboratory costs	10 (5)	9 (6)	1 (0)	cost type
Imaging costs	10 (3)	9 (2)	1 (1)	organizational unit
Total direct costs	9 (5)	7 (5)	2 (0)	total
ICU costs	8 (5)	8 (5)	0 (0)	organizational unit
Direct costs	5 (4)	4 (4)	1 (0)	total
Total direct costs per day	3 (3)	3 (3)	0 (0)	total
Direct costs per day	2 (2)	2 (2)	0 (0)	total
Management costs	2 (2)	1 (1)	1 (1)	cost type
Procedure costs	2 (1)	2 (1)	0 (0)	cost type
Room and board costs	2 (1)	1 (0)	1 (1)	cost type
Test costs	2 (0)	2 (0)	0 (0)	cost type
Total variable costs per day	1 (1)	1 (1)	0 (0)	total
Nursing costs	1 (1)	1 (1)	0 (0)	cost type
Total variable costs	1 (0)	1 (0)	0 (0)	total
Supplies and equipment costs	1 (0)	1 (0)	0 (0)	cost type

* The number of studies appears in parentheses, which found significantly differences between costs

Table 3: Cost matrix

Cost components			Cluster 1 "Organizational units"					
			Emergency room costs	Hotel costs	Radiology costs	ICU costs	Surgery room costs	Ward costs
Cluster 2 "Cost types"	Catering costs			+				
	Laboratory costs		+		+	+	+	+
	Material costs		+		+	+	+	+
	Other costs		+	+	+	+	+	+
	Patient management costs		+	+	+	+	+	+
	Pharmacy costs		+		+	+	+	+
	Room costs			+				
	Staff costs		+		+	+	+	+
	Cluster 3 "Staff detail"	Nursing costs	+		+	+	+	+
		Physician costs	+		+	+	+	+
		Social counselling costs				+		+
		Therapist costs				+		+

Grey marked fields represent cost components already analyzed in previous studies (Table 2).

The “+” indicates that these cost types are part of the organizational unit and the cost type or staff detail.

Table 4: Patient characteristics

Results		UC patients (n = 642)	PC patients (n = 104)	p-value
Age (years)	Mean (sd)	70.8 (14.0)	64.7 (14.3)	<0.001
	Median (quartiles)	73.0 (62.0, 82.0)	67.0 (55.5, 75.0)	
Gender	Female	276 (43.0 %)	44 (42.3 %)	0.896
	Male	366 (57.0 %)	60 (57.7 %)	
Marital status	Married	359 (55.9 %)	65 (62.5 %)	0.035
	Divorced	78 (12.1 %)	11 (10.6 %)	
	Single	78 (12.1 %)	19 (18.3 %)	
	Widowed	108 (16.8 %)	9 (8.7 %)	
	Unknown	19 (3.0 %)	0 (0.0 %)	
Citizenship	Swiss	576 (89.7 %)	86 (82.7 %)	0.152
	Italian	16 (2.5 %)	6 (5.8 %)	
	German	9 (1.4 %)	2 (1.9 %)	
	Other	41 (6.4 %)	10 (9.6 %)	
Insurance class	Public	525 (81.8 %)	81 (77.9 %)	0.291
	Semi-private	95 (14.8 %)	21 (20.2 %)	
	Private	22 (3.4 %)	2 (1.9 %)	
Primary diagnosis	Malignant neoplasms	108 (16.8 %)	77 (74.0 %)	<0.001
	Cardiovascular diseases	377 (58.7 %)	12 (11.5 %)	
	Neurological diseases	23 (3.6 %)	2 (1.9 %)	
	Infectious diseases	57 (8.9 %)	5 (4.8 %)	
	Gastrointestinal diseases	43 (6.7 %)	4 (3.8 %)	
	Others	34 (5.3 %)	4 (3.8 %)	
Location prior to entry	Home	423 (65.9 %)	87 (83.7 %)	<0.001
	Other hospital	193 (30.1 %)	10 (9.6 %)	
	SPITEX*	6 (0.9 %)	5 (4.8 %)	
	Elderly home	7 (1.1 %)	1 (1.0 %)	
	Psychatric clinic	2 (0.3 %)	1 (1.0 %)	
	Penal institution	1 (0.2 %)	0 (0.0 %)	

	Other	10	(1.6 %)	0	(0.0 %)	
Inhospital admission	Emergency room admission	474	(73.8 %)	62	(59.6 %)	0.003
	ICU admission	420	(65.4 %)	27	(26.0 %)	<0.001
	Radiology admission	530	(82.6 %)	91	(87.5 %)	0.210
	Surgery room admission	477	(74.3 %)	53	(51.0 %)	<0.001
	Ward admission	642	(100.0 %)	104	(100.0 %)	-
ALOS	Mean (sd)	7.2 (9.5)		16.0 (12.0)		<0.001
Casemix-Index	Mean (sd)	2.791(3.515)		1.991 (1.464)		<0.001

* Home along with ambulatory nursing care

Table 5: Total costs

	Usual care [95% CI]	Pallitiave care [95% CI]	Mean difference (in %) [95% CI]	P-value
Total costs	41'158 [36'191, 47'731]	38'381 [30'230, 48'132]	-2'777 (-7%) [-12'713, 8'506]	0.60
Cluster 1: Organizational unit				
Emergency room costs	781 [725, 839]	824 [591, 1'068]	43 (5%) [-203, 297]	0.73
Hotel costs	1'136 [1009, 1'273]	2'837 [2341, 3'388]	1'701 (150%) [1204, 2'272]	<0.001
Radiology costs	2'584 [2253, 3'012]	1'127 [889, 1'444]	-1'457 (-56%) [-1'937, -1'027]	<0.001
ICU costs	11'634 [9385, 14'810]	2'740 [864, 5'462]	-8'895 (-76%) [-12'734, -5'772]	<0.001
Surgery room costs	4'584 [3743, 5'576]	3'029 [1352, 5'331]	-1'555 (-34%) [-3'529, 731]	0.15
Ward costs	20'440 [17'819, 23'549]	27'825 [21'550, 34'602]	7'385 (36%) [596, 14'785]	0.038
Cluster 2: Cost type				
Catering costs	265 [229, 305]	668 [506, 842]	402 (152%) [234, 584]	<0.001
Laboratory costs	2'143 [1807, 2'570]	1'402 [1030, 1'935]	-741 (-35%) [-1'296, -142]	0.013
Material costs	2'604 [2177, 3'124]	520 [323, 816]	-2'085 (-80%) [-2'663, -1'591]	<0.001
Other costs	3'954 [3146, 5'148]	2'659 [1506, 4'193]	-1'294 (-33%) [-2'839, 321]	0.11
Patientmanagement costs	197 [189, 212]	234 [184, 322]	37 (19%) [-13, 125]	0.31
Pharmacy costs	4'405 [3349, 5'691]	2'076 [1193, 3'574]	-2'330 (-53%) [-3'893, -576]	0.005
Room costs	673 [582, 773]	1'935 [1596, 2'363]	1'262 (187%) [920, 1'690]	<0.001
Staff costs	26'916 [23'715, 31'049]	28'887 [22'812, 36'000]	1'972 (7%) [-5'268, 10'099]	0.61
Cluster 3: Staff detail				
Nursing costs	8'560 [7585, 9'682]	18'185 [13'973, 23'156]	9'625 (112%) [5300, 14'763]	<0.001
Physician costs	17'866 [15'343, 21'606]	9'578 [6703, 13'740]	-8'288 (-46%) [-13'021, -3'918]	<0.001
Social counseling costs	102 [87, 125]	384 [267, 517]	282 (277%) [164, 415]	<0.001
Therapist costs	410 [338, 491]	757 [565, 1'018]	347 (84%) [134, 609]	0.005

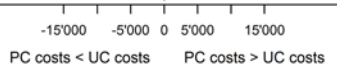
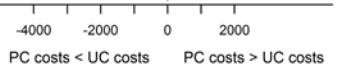


Table 6: Average daily costs

	Usual care [95% CI]	Pallitiave care [95% CI]	Mean difference (in %) [95% CI]	P-value
Total costs	5'530 [5141, 5'988]	2'306 [1924, 2'808]	-3'224 (-58%) [-3'811, -2'631]	<0.001
Cluster 1: Organizational unit				
Emergency room costs	652 [605, 704]	642 [429, 888]	-10 (-2%) [-232, 245]	0.93
Hotel costs	155 [149, 161]	171 [156, 185]	16 (10%) [1, 33]	0.043
Radiology costs	1'154 [957, 1'386]	510 [399, 631]	-644 (-56%) [-896, -426]	<0.001
ICU costs	3'063 [2763, 3'398]	1'048 [308, 2'502]	-2'015 (-66%) [-2'837, -511]	<0.001
Surgery room costs	2'235 [1883, 2'661]	1'379 [695, 2'331]	-857 (-38%) [-1'670, 111]	0.05
Ward costs	2'537 [2339, 2'779]	1'723 [1466, 2'038]	-814 (-32%) [-1'176, -444]	<0.001
Cluster 2: Cost type				
Catering costs	20 [19, 22]	37 [29, 44]	16 (80%) [8, 24]	<0.001
Laboratory costs	292 [263, 326]	165 [136, 196]	-128 (-44%) [-173, -84]	<0.001
Material costs	1'245 [1051, 1'462]	140 [106, 191]	-1'105 (-89%) [-1'328, -914]	<0.001
Other costs	916 [781, 1'085]	211 [134, 294]	-705 (-77%) [-892, -543]	<0.001
Patientmanagement costs	66 [62, 72]	20 [16, 27]	-47 (-70%) [-53, -38]	<0.001
Pharmacy costs	775 [623, 976]	130 [81, 203]	-645 (-83%) [-845, -477]	<0.001
Room costs	68 [64, 72]	114 [106, 122]	46 (68%) [37, 56]	<0.001
Staff costs	3'755 [3521, 4'026]	2'061 [1682, 2'534]	-1'694 (-45%) [-2'169, -1'196]	<0.001
Cluster 3: Staff detail				
Nursing costs	1'228 [1169, 1'298]	1'408 [1101, 1'783]	180 (15%) [-137, 550]	0.28
Physician costs	3'513 [3236, 3'809]	1'869 [1440, 2'339]	-1'644 (-47%) [-2'177, -1'139]	<0.001
Social counseling costs	28 [24, 33]	76 [57, 94]	48 (169%) [28, 66]	<0.001
Therapist costs	59 [54, 66]	119 [93, 165]	60 (101%) [33, 105]	<0.001



Appendices

Appendix I: Literature Review

Year of Publication	Author(s)	Country	Study Period	Design	Intervention Group (Palliative Care Patients)		Total costs per day	Total costs	Pharmacy costs	Laboratory costs	Imaging costs	Total direct costs	ICU costs	Direct costs	Total direct costs per day	Direct costs per day	Management costs	Procedure costs	Room and board costs	Test costs	Total variable costs per day	Nursing costs	Total variable costs	Supplies and equipment costs
2003	Smith et al.	USA	05.2000 - 12.2000	Retrospective case-control analysis	38 discharges	38 discharges		***				***		***										
2004	Cowan et al.	USA	07.2000 - 06.2001	Retrospective cohort analysis	164 discharges	152 discharges	***																	
2006	Penrod et al.	USA	10.2002 - 09.2003	Retrospective observational analysis	82 discharges	232 discharges	***			*** a)														
2007	Ciemins et al.	USA	01.2004 - 12.2006	Retrospective matched ohort analysis	27 discharges	128 discharges	***	***																
2008	Bendaly et al.	USA	01.2005 - 12.2005	Retrospective analysis	61 discharges	55 discharges																		
2008	Gade et al.	USA	06.2002 - 12.2003	Prospective randomized trial	275 discharges	237 discharges		***																
2008	Hanson et al.	USA	07.2002 . 06.2005	Prospective observational analysis	104 discharges	1'813 discharges															**			
2008	Morrison et al.	USA	01.2002 - 12.2004	Retrospective analysis	2'630 live discharges	18'427 live discharges	***	**		***		***	***	***	***	***								
					2'278 death discharges	2'124 death discharges	***	***	**	***		***	***	***	***	***								
2010	Penrod et al.	USA	10.2004 - 09.2006	Retrospective observational analysis	606 discharges	2'715 discharges			sig.	sig.		sig.	sig.		sig.							sig.		
2010	Simoens et al.	Belgium	01.2007- 06.2007	Retrospective cohort analysis	89 live discharges	57 discharges	***																	
					37 [b] death discharges	57 discharges	**																	
2011	Morrison et al.	USA	01.2004 - 12.2007	Retrospective analysis	290 live discharges	1'427 live discharges	***	**					***											
					185 death discharges	149 deaths discharges	***	**	**															
2013	Starks et al.	USA	01.2005 - 12.2008	Retrospective observational analysis	756 live discharges	731 live discharges																		
					1'059 death discharges	1'059 discharges																		
2013	Whitford et al.	USA	01.2003 - 12.2008	Retrospective case-control analysis	1'177 live discharges	3'531 live discharges			sig.		sig.						sig.							
					300 death discharges	3'531 death discharges		sig.	sig.	sig.	sig.	sig.	sig.				sig.	sig.						
2015	McCarthy	USA	01.2009- 06.2012	Retrospective observational study design	1'816 live discharged	33'574 live discharged																		
					572 death discharges	1'246 death discharges																		
2015	May et al.	USA	01.2007 - 12.2011	Prospective observational cohort analysis	256 discharges	713 discharges				***		c)							***					
2018	May et al.	USA	01.2009 - 12.2015	Retrospective cohort analysis	1139 discharges	5'622 discharges								***										
Number of analyses (number of significant studies)							**11 (9)**	**11 (8)**	**10 (5)**	**10 (5)**	**10 (3)**	**9 (5)**	**8 (5)**	**5 (4)**	**3 (3)**	**2 (2)**	**2 (2)**	**2 (1)**	**2 (1)**	**2 (0)**	**1 (1)**	**1 (1)**	**1 (0)**	**1 (0)**
Number of analyses with costs/days PC < UC (number of significant studies)							**10 (8)**	**10 (8)**	**8 (4)**	**9 (6)**	**9 (2)**	**7 (5)**	**8 (5)**	**4 (4)**	**3 (3)**	**2 (2)**	**1 (1)**	**2 (1)**	**1 (0)**	**2 (0)**	**1 (1)**	**1 (1)**	**1 (0)**	**1 (0)**
Number of analyses with costs/days PC > UC (number of significan studies)							**1 (1)**	**1 (0)**	**2 (1)**	**1 (0)**	**1 (1)**	**2 (0)**	**0 (0)**	**1 (0)**	**0 (0)**	**0 (0)**	**1 (1)**	**0 (0)**	**1 (1)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**
Number of analyses with costs/days PC = UC (number of significant studies)							**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**		**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**

a) Combined analysed cost types

b) Patients not from PC unit, but from PC within cardiology, geriatric, and oncology wards

c) PC intervention within at least 6 days has a positive significant cost effect (p=0.04); within 2 days (p=0.002) the study distinguishes between patients from PC unit (p=0.07) and PC consultation (p<0.001)

d) The study distinguishes between patients from PC unit (p=0.07) and PC consultation (p<0.001)

Appendix II: Crude Data

Total costs per patient in CHF						
		Total (N = 746)	**UC patients (N = 632)**	**PC patients (N=104)**	**PC vs UC patients**	**p-Value**
Total	mean*	37'602 (52'825)	38'262 (56'098)	33'529 (24'064)	-4'733 (-15'697, 6'231)	0.400
	median**	21'455 [7'904, 45'339]	20'625 [7'305, 45'315]	28'619 [16'780, 46'482]	0.576 (0.517 to 0.634)	**0.012**
Cluster 1 "Organizational units"						
Emergency room	mean*	789 (739)	799 (733)	731 (771)	-68.2 (-221 to 85.1)	0.380
	median**	742 [0.000, 1303]	770 [0.000, 1299]	504 [0.000, 1333]	0.462 (0.404 to 0.521)	0.200
Hotel	mean*	1'285 (1'658)	1'017 (1'426)	2'941 (2'000)	1'924 (1'609 to 2'239)	**0.000**
	median**	563 [242, 1694]	424 [218, 1147]	2498 [1489, 4031]	0.860 (0.815 to 0.894)	**0.000**
ICU	mean*	9'586 (23'631)	10'920 (25'176)	1353 (3'871)	-9567 (-14'426 to -4'709)	**0.000**

	median**	1'116 [0.000, 8755]	2'381 [0.000, 10965]	0.000 [0.000, 0.000]	0.268 (0.222 to 0.322)	**0.000**
Radiology	mean*	2'408 (4'651)	2'541 (4'935)	1'591 (2'020)	-950 (-1913 to 13.8)	0.050
	median**	955 [215, 2079]	955 [206, 2113]	916 [333, 1934]	0.499 (0.440 to 0.558)	0.970
Surgery	mean*	4'083 (9'948)	4'447 (10'561)	1'838 (3'959)	-2'609 (-4'666 to -552)	**0.013**
	median**	634 [0.000, 2125]	765 [0.000, 2425]	129 [0.000, 1216]	0.370 (0.316 to 0.428)	**0.000**
Ward	mean*	19'450 (28'458)	18'538 (29'681)	25'076 (18'387)	6'538 (647 to 12'428)	**0.030**
	median**	9'107 [2'990, 24'929]	8'025 [2624, 21568]	21'532 [9'605, 35'612]	0.695 (0.638 to 0.746)	**0.000**

Cluster 2
"Cost types"

Catering	mean*	303 (494)	235 (434)	720 (622)	485 (388 to 581)	**0.000**
	median**	61.7 [0.000, 421]	23.9 [0.000, 289]	667 [269, 961]	0.813 (0.766 to 0.852)	**0.000**
Laboratory	mean*	1'819 (3'490)	1'893 (3'675)	1'365 (1'945)	-528 (-1251 to 196)	0.150

	median**	623 [178, 1'989]	598 [173, 2'038]	732 [223, 1'631]	0.500 (0.441 to 0.559)	1.000
Material	mean*	2'431 (6'032)	2'741 (6'436)	520 (1'070)	-2'221 (-3'463 to -978)	**0.000**
	median**	243 [65.5, 1'864]	274 [61.5, 2'559]	174 [74.4, 461]	0.432 (0.374 to 0.491)	**0.025**
Other	mean*	3'474 (9'165)	3'752 (9'787)	1'758 (2'837)	-1'994 (-3'892 to -96.3)	**0.039**
	median**	754 [0.000, 2'630]	788 [0.000, 2'658]	356 [0.000, 2'600]	0.470 (0.412 to 0.529)	0.320
Patient-management	mean*	196 (145)	196 (143)	194 (160)	-2.32 (-32.5 to 27.9)	0.880
	median**	188 [147, 202]	188 [147, 204]	181 [147, 188]	0.404 (0.348 to 0.463)	**0.002**
Pharmacy	mean*	3'479 (10'153)	3'689 (10'764)	2'180 (4'737)	-1'509 (-3'615 to 596)	0.160
	median**	525 [155, 1'996]	503 [146, 2'010]	771 [216, 1'982]	0.531 (0.471 to 0.589)	0.320
Room	mean*	787 (1'205)	586 (1'021)	2'027 (1'487)	1'441 (1'213 to 1'669)	**0.000**
	median**	266 [60.2, 1051]	189 [60.2, 620]	1681 [932, 2773]	0.869 (0.826 to 0.902)	**0.000**
Staff	mean*	25'115 (33'814)	25'171 (35'760)	24'766 (17'652)	-405 (-7'426 to 6'616)	0.910

	median**	14'757 [5'652, 30'512]	13'032 [4'952, 30'432]	20'195 [11'358, 33'262]	0.606 (0.547 to 0.662)	**0.000**
Cluster 3 "Staff detail"						
Nursing	mean*	9'046 (12'110)	7'891 (11'652)	16'174 (12'496)	8'283 (5'840 to 10'726)	**0.000**
	median**	4'414 [1'978, 11'718]	3'787 [1'659, 8'775]	12'902 [6'310, 22'164]	0.773 (0.720 to 0.817)	**0.000**
Physician	mean*	15'536 (27'687)	16'828 (29'532)	7'560 (6'535)	-9'268 (-14'979 to -3'558)	**0.002**
	median**	5'863 [2'210, 17'484]	60'71 [2'013, 19'690]	5'642 [3'323, 9'306]	0.477 (0.418 to 0.537)	0.450
Social counselling	mean*	123 (228)	92.1 (189)	314 (331)	222 (177 to 266)	**0.000**
	median**	35.4 [11.8, 133]	29.5 [11.8, 82.6]	204 [92.0, 412]	0.823 (0.775 to 0.862)	**0.000**
Therapist	mean*	427 (866)	377 (870)	737 (771)	360 (182 to 538)	**0.000**
	median**	51.3 [0.000, 520]	0.000 [0.000, 437]	487 [181, 1018]	0.728 (0.676 to 0.773)	**0.000**

* Mean (sd), mean difference (95% CI), linear regression with robust standard errors

**Median [lower quartile, upper quartile], Mann-Whitney statistic (95% CI), Wilcoxon-Mann-Whitney test

Costs per day per patient in CHF						
		Total (N = 746)	**UC patients (N = 632)**	**PC patients (N=104)**	**PC vs UC patients**	**p-Value**
Total	mean*	5'194 (5'511)	5'699 (5'777)	2'073 (759)	-3'626 (-4'740 to -2'511)	**0.000**
	median**	3'480 [2'048, 6'476]	4'046 [2'361, 7'124]	1'849 [1'576, 2'314]	0.184 (0.144 to 0.232)	**0.000**
Cluster 1 "Organizational units"						
Emergency room	mean*	652 (647)	669 (652)	542 (604)	-127 (-261 to 6.87)	0.060
	median**	558 [0.000, 1048]	591 [0.000, 1060]	406 [0.000, 921]	0.433 (0.376 to 0.492)	**0.026**
Hotel	mean*	156 (77.2)	152 (80.7)	186 (39.8)	34.0 (18.2 to 49.9)	**0.000**
	median**	163 [101, 201]	152 [101, 201]	188 [166, 203]	0.661 (0.603 to 0.714)	**0.000**
ICU	mean*	2782 (4204)	3136 (4391)	598 (1506)	-2538 (-3392 to -1684)	**0.000**

	median**	819 [0.000, 4023]	1'274 [0.000, 4'563]	0.000 [0.000, 0.000]	0.267 (0.221 to 0.320)	**0.000**
Radiology	mean*	1'110 (2'693)	1'178 (2'861)	690 (1'151)	-487 (-1'045 to 70.9)	0.090
	median**	394 [178, 843]	402 [178, 867]	355 [145, 656]	0.471 (0.412 to 0.530)	0.330
Surgery	mean*	2114 (4979)	2290 (5280)	1026 (2101)	-1265 (-2294 to -235)	**0.016**
	median**	565 [0.000, 1673]	652 [0.000, 1769]	129 [0.000, 795]	0.361 (0.307 to 0.419)	**0.000**
Ward	mean*	2'434 (2'880)	2'576 (3'074)	1'556 (530)	-1'020 (-1'614 to -427)	**0.000**
	median**	1'557 [1'030, 2'630]	1'598 [992, 3'036]	1'394 [1'183, 1'770]	0.449 (0.391 to 0.509)	0.100

Cluster 2
"Cost types"

Catering	mean*	22.1 (24.3)	18.7 (23.4)	43.1 (18.3)	24.5 (19.7 to 29.2)	**0.000**
	median**	12.6 [0.000, 43.1]	4.79 [0.000, 38.1]	48.5 [34.1, 56.3]	0.800 (0.752 to 0.840)	**0.000**
Laboratory	mean*	273 (417)	294 (443)	143 (138)	-150 (-237 to -64.5)	**0.000**

	median**	153 [89.4, 288]	163 [100, 306]	107 [59.0, 183]	0.351 (0.297 to 0.409)	**0.000**
Material	mean*	1'174 (2'764)	1'342 (2'944)	142 (229)	-1199 (-1767 to -632)	**0.000**
	median**	117 [47.2, 643]	131 [47.8, 916]	83.5 [40.3, 151]	0.374 (0.319 to 0.434)	**0.000**
Other	mean*	856 (1975)	964 (2107)	194 (286)	-769 (-1176 to -363)	**0.000**
	median**	242 [0.000, 937]	321 [0.000, 1032]	53.0 [0.000, 292]	0.372 (0.318 to 0.430)	**0.000**
Patient-management	mean*	62.4 (66.5)	69.2 (68.7)	20.3 (23.5)	-49.0 (-62.3 to -35.6)	**0.000**
	median**	36.6 [15.7, 93.8]	46.9 [19.2, 96.9]	12.6 [7.53, 22.1]	0.207 (0.165 to 0.257)	**0.000**
Pharmacy	mean*	673 (2087)	760 (2235)	138 (277)	-622 (-1053 to -191)	**0.005**
	median**	127 [41.3, 359]	151 [49.8, 423]	51.3 [24.8, 91.0]	0.300 (0.250 to 0.357)	**0.000**
Room	mean*	71.8 (52.6)	63.6 (51.4)	122 (24.7)	58.5 (48.5 to 68.6)	**0.000**
	median**	70.5 [15.0, 114]	60.2 [13.6, 102]	127 [108, 142]	0.852 (0.807 to 0.887)	**0.000**
Staff	mean*	3'540 (2'860)	3'836 (2'959)	1'719 (881)	-2'117 (-2'691 to -1'543)	**0.000**

	median**	2'770 [1'574, 4'887]	3'171 [1'782, 5'134]	1'501 [1'159, 1'893]	0.208 (0.166 to 0.259)	**0.000**

Cluster 3
"Staff detail"

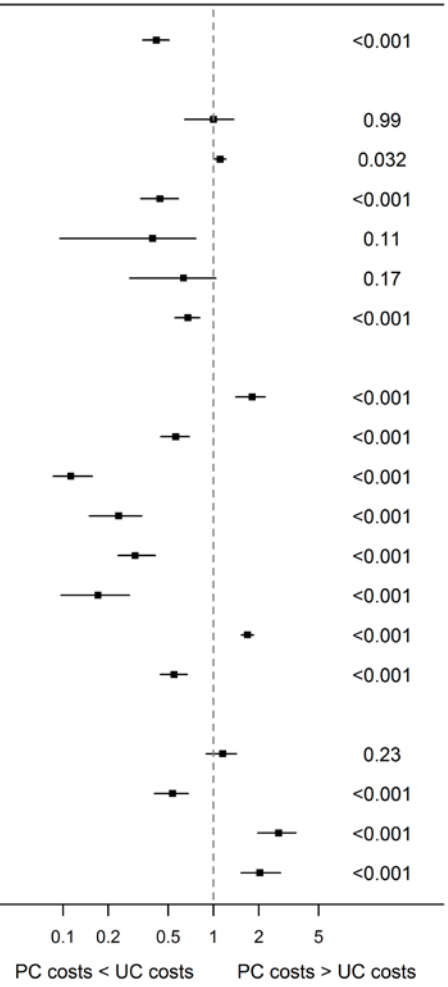
Nursing	mean*	1'217 (803)	1'238 (834)	1'089 (564)	-149 (-315 to 17.6)	0.080
	median**	1'019 [738, 1'479]	1'040 [724, 1'519]	920 [772, 1'231]	0.461 (0.402 to 0.520)	**0.020**
Physician	mean*	3'315 (3'461)	3'600 (3'630)	1'554 (1'000)	-2'046 (-2'749 to -1'343)	**0.000**
	median**	2'129 [948, 4'659]	2'409 [1'007, 5'083]	1'264 [771, 2'136]	0.320 (0.268 to 0.377)	**0.000**
Social counselling	mean*	32.4 (54.1)	27.0 (52.9)	65.5 (49.7)	38.5 (27.6 to 49.4)	**0.000**
	median**	7.38 [5.90, 32.3]	6.55 [5.90, 14.0]	58.1 [28.9, 81.7]	0.823 (0.775 to 0.862)	**0.000**
Therapist	mean*	64.7 (78.8)	57.8 (76.8)	107 (77.5)	49.6 (33.6 to 65.5)	**0.000**
	median**	51.3 [0.000, 121]	0.000 [0.000, 115]	108 [87.0, 131]	0.684 (0.630 to 0.732)	**0.000**

* Mean (sd), mean difference (95% CI), linear regression with robust standard errors

**Median [lower quartile, upper quartile], Mann-Whitney statistic (95% CI), Wilcoxon-Mann-Whitney test

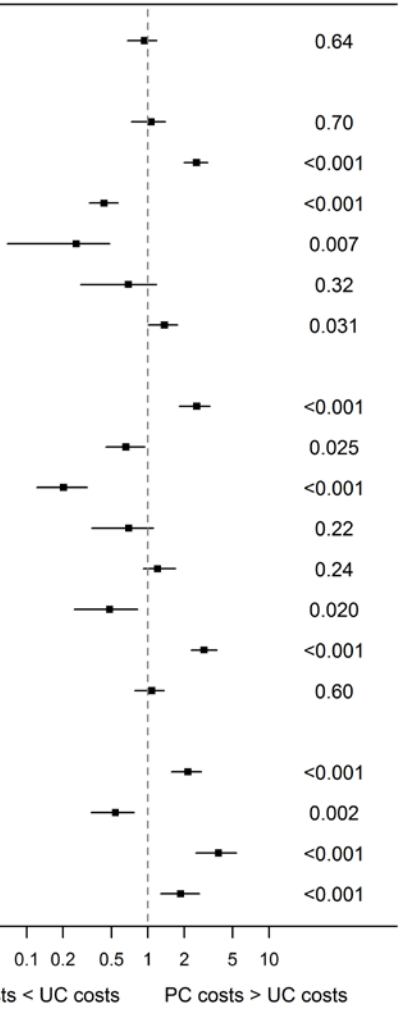
Appendix III: Comparison of costs per day of PC vs UC using generalized linear model with gamma distribution and log-link adjusted by inverse probability weighting.

	Usual care [95% CI]	Pallitiave care [95% CI]	Mean difference (in %) [95% CI]	P-value
Total costs	5'542 [5157, 5'986]	2'299 [1883, 2'749]	0.42 [0.34, 0.51]	<0.001
Cluster 1: Organizational unit				
Emergency room costs	652 [601, 702]	640 [425, 886]	1.00 [0.64, 1.36]	0.99
Hotel costs	155 [148, 162]	171 [156, 185]	1.11 [1.00, 1.21]	0.032
Radiology costs	1'158 [949, 1'368]	509 [402, 620]	0.44 [0.33, 0.58]	<0.001
ICU costs	3'057 [2739, 3'408]	1'035 [287, 2'245]	0.39 [0.10, 0.76]	0.11
Surgery room costs	2'250 [1907, 2'659]	1'359 [655, 2'275]	0.63 [0.28, 1.04]	0.17
Ward costs	2'547 [2343, 2'779]	1'719 [1454, 2'039]	0.68 [0.55, 0.81]	<0.001
Cluster 2: Cost type				
Catering costs	20 [19, 23]	37 [29, 44]	1.80 [1.40, 2.20]	<0.001
Laboratory costs	294 [264, 330]	165 [134, 195]	0.56 [0.45, 0.69]	<0.001
Material costs	1'247 [1042, 1'468]	140 [109, 188]	0.11 [0.08, 0.16]	<0.001
Other costs	918 [779, 1'079]	212 [139, 296]	0.23 [0.15, 0.33]	<0.001
Patientmanagement costs	66 [61, 72]	20 [15, 27]	0.30 [0.23, 0.41]	<0.001
Pharmacy costs	783 [634, 988]	131 [80, 208]	0.17 [0.10, 0.28]	<0.001
Room costs	68 [64, 72]	114 [106, 123]	1.68 [1.53, 1.85]	<0.001
Staff costs	3'758 [3543, 4'051]	2'052 [1664, 2'451]	0.55 [0.44, 0.67]	<0.001
Cluster 3: Staff detail				
Nursing costs	1'228 [1169, 1'298]	1'404 [1089, 1'728]	1.15 [0.89, 1.42]	0.23
Physician costs	3'517 [3252, 3'822]	1'868 [1418, 2'326]	0.53 [0.40, 0.68]	<0.001
Social counseling costs	28 [24, 33]	76 [57, 95]	2.71 [1.96, 3.52]	<0.001
Therapist costs	59 [54, 66]	119 [92, 162]	2.03 [1.52, 2.79]	<0.001



Appendix IV: Comparison of total costs of PC vs UC using generalized linear model with gamma distribution and log-link adjusted by inverse probability weighting.

	Usual care [95% CI]	Pallitiave care [95% CI]	Mean ratio [95% CI]	P-value
Total costs	41'184 [36'184, 48'339]	38'336 [29'606, 47'729]	0.94 [0.68, 1.18]	0.64
Cluster 1: Organizational unit				
Emergency room costs	781 [725, 842]	822 [575, 1'070]	1.06 [0.73, 1.39]	0.70
Hotel costs	1'135 [1019, 1'271]	2'846 [2339, 3'411]	2.52 [1.99, 3.11]	<0.001
Radiology costs	2'587 [2237, 2'999]	1'120 [902, 1'410]	0.43 [0.33, 0.57]	<0.001
ICU costs	11'611 [9493, 15'072]	2'702 [769, 5'314]	0.26 [0.07, 0.48]	0.007
Surgery room costs	4'599 [3783, 5'579]	3'013 [1314, 5'071]	0.69 [0.28, 1.17]	0.32
Ward costs	20'472 [17'779, 23'863]	27'833 [21'461, 34'592]	1.37 [1.01, 1.75]	0.031
Cluster 2: Cost type				
Catering costs	266 [231, 306]	669 [503, 842]	2.53 [1.81, 3.25]	<0.001
Laboratory costs	2'152 [1801, 2'614]	1'405 [1047, 1'960]	0.66 [0.45, 0.94]	0.025
Material costs	2'609 [2177, 3'091]	516 [339, 804]	0.20 [0.12, 0.31]	<0.001
Other costs	3'962 [3172, 5'140]	2'680 [1459, 4'171]	0.70 [0.35, 1.11]	0.22
Patientmanagement costs	197 [189, 211]	234 [183, 331]	1.20 [0.92, 1.69]	0.24
Pharmacy costs	4'439 [3395, 5'809]	2'086 [1177, 3'567]	0.48 [0.25, 0.82]	0.020
Room costs	673 [589, 775]	1'944 [1588, 2'372]	2.90 [2.28, 3.69]	<0.001
Staff costs	26'887 [23'717, 31'237]	28'803 [22'149, 35'844]	1.08 [0.78, 1.36]	0.60
Cluster 3: Staff detail				
Nursing costs	8'555 [7583, 9'728]	18'163 [13'720, 23'059]	2.14 [1.57, 2.76]	<0.001
Physician costs	17'844 [15'377, 21'726]	9'517 [6556, 13'504]	0.54 [0.34, 0.77]	0.002
Social counseling costs	101 [86, 124]	384 [265, 519]	3.82 [2.49, 5.37]	<0.001
Therapist costs	409 [340, 492]	756 [557, 1'031]	1.86 [1.28, 2.65]	<0.001



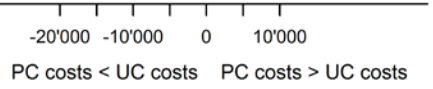
Appendix V: Crude analysis of total costs and costs per day using generalized linear models with gamma distribution and log-link

	Palliative care costs (95% CI)	Usual care costs (95% CI)	Mean ratio (95% CI)	P-value
Total costs				
Total	33640 (29211 to 38428)	38300 (34333 to 42991)	0.88 (0.74 to 1.04)	0.15
Cluster 1: "Organizational units"				
Emergency room	736 (585 to 877)	798 (741 to 857)	0.92 (0.73 to 1.13)	0.45
Hotel	2947 (2598 to 3378)	1020 (910 to 1127)	2.90 (2.46 to 3.45)	<0.001
ICU	1431 (719 to 2274)	10955 (9138 to 13097)	0.13 (0.06 to 0.22)	<0.001
Radiology	1604 (1236 to 2047)	2542 (2186 to 2935)	0.63 (0.46 to 0.82)	0.002
Surgery	1888 (1172 to 2744)	4468 (3642 to 5341)	0.42 (0.26 to 0.64)	<0.001
Ward	25143 (21872 to 28781)	18564 (16401 to 20933)	1.36 (1.12 to 1.61)	0.001
Cluster 2: "Cost types"				
Catering	723 (612 to 851)	236 (201 to 267)	3.07 (2.47 to 3.81)	<0.001
Laboratory	1379 (1045 to 1785)	1899 (1635 to 2211)	0.73 (0.53 to 0.99)	0.047
Material	534 (361 to 784)	2750 (2269 to 3278)	0.19 (0.13 to 0.30)	<0.001
Other	1774 (1283 to 2368)	3764 (3091 to 4616)	0.48 (0.32 to 0.68)	<0.001
Patientmanagement	195 (175 to 242)	196 (188 to 211)	0.99 (0.87 to 1.20)	0.88
Pharmacy	2248 (1437 to 3286)	3718 (2973 to 4657)	0.60 (0.37 to 0.95)	0.036
Rooms	2032 (1780 to 2352)	588 (511 to 665)	3.46 (2.85 to 4.20)	<0.001
Staff	24838 (21513 to 28305)	25187 (22539 to 28153)	0.99 (0.83 to 1.17)	0.89
Cluster 3: "Staff detail"				
Nursing	16213 (13985 to 18681)	7899 (7055 to 8847)	2.06 (1.71 to 2.46)	<0.001
Physician	7608 (6432 to 8903)	16852 (14747 to 19336)	0.45 (0.36 to 0.56)	<0.001
Social counseling	315 (255 to 383)	93 (80 to 109)	3.42 (2.64 to 4.37)	<0.001
Therapist	739 (591 to 893)	378 (319 to 453)	1.97 (1.49 to 2.54)	<0.001
Total costs per day				
Total	2077 (1938 to 2228)	5699 (5279 to 6171)	0.36 (0.33 to 0.41)	<0.001
Cluster 1: "Organizational units"				
Emergency room	546 (432 to 660)	668 (620 to 721)	0.81 (0.64 to 1.01)	0.08
Hotel	186 (178 to 194)	152 (146 to 158)	1.22 (1.16 to 1.30)	<0.001
ICU	624 (339 to 928)	3143 (2824 to 3511)	0.20 (0.11 to 0.30)	<0.001

Surgery	1047 (673 to 1499)	2301 (1917 to 2735)	0.46 (0.29 to 0.68)	<0.001
Radiology	699 (498 to 948)	1182 (960 to 1412)	0.59 (0.40 to 0.86)	0.007
Ward	1558 (1462 to 1666)	2577 (2355 to 2831)	0.60 (0.54 to 0.68)	<0.001
Cluster 2: "Cost types"				
Catering	43 (39 to 47)	19 (17 to 20)	2.31 (2.02 to 2.61)	<0.001
Laboratory	144 (119 to 172)	295 (262 to 331)	0.49 (0.40 to 0.62)	<0.001
Material	145 (109 to 198)	1345 (1127 to 1575)	0.11 (0.08 to 0.15)	<0.001
Other	195 (144 to 253)	966 (818 to 1139)	0.20 (0.14 to 0.28)	<0.001
Patientmanagement	20 (17 to 25)	69 (64 to 75)	0.29 (0.23 to 0.37)	<0.001
Pharmacy	142 (91 to 199)	764 (612 to 941)	0.18 (0.12 to 0.29)	<0.001
Room	122 (118 to 127)	64 (60 to 68)	1.92 (1.78 to 2.07)	<0.001
Staff	1723 (1567 to 1907)	3834 (3607 to 4084)	0.45 (0.40 to 0.51)	<0.001
Cluster 3: "Staff detail"				
Nursing	1091 (989 to 1205)	1238 (1179 to 1312)	0.88 (0.79 to 0.98)	0.024
Physician	1559 (1381 to 1762)	3599 (3341 to 3897)	0.43 (0.37 to 0.50)	<0.001
Social counseling	66 (56 to 76)	27 (23 to 31)	2.42 (1.96 to 3.00)	<0.001
Therapist	108 (95 to 125)	58 (52 to 64)	1.86 (1.58 to 2.26)	<0.001

Appendix VI. Comparison of total costs of PC vs UC defining PC exposure when referral to PC occurred within 3 days from admission – Total costs

	Usual care (N=705)	Pallitiave care (N=41)	Mean cost difference [95% CI]	P-value
	mean costs [95% CI]			
Total costs	39'482 [35'432, 44'292]	25'022 [14'943, 33'669]	-14'461 (-37%) [-25'721, -5'203]	0.007
Cluster 1: Organizational unit				
Emergency room costs	788 [736, 850]	851 [410, 1'344]	63 (8%) [-386, 555]	0.79
Hotel costs	1'295 [1'169, 1'441]	2'332 [1'441, 3'100]	1'038 (80%) [65, 1'791]	0.020
Radiology costs	2'491 [2'144, 2'829]	877 [585, 1'442]	-1'613 (-65%) [-2'092, -1'043]	<0.001
ICU costs	10'255 [8'436, 12'468]	345 [73, 1'281]	-9'910 (-97%) [-12'103, -7'970]	<0.001
Surgery room costs	4'331 [3'596, 5'183]	141 [24, 398]	-4'190 (-97%) [-5'029, -3'440]	<0.001
Ward costs	20'323 [18'297, 22'806]	20'475 [10'864, 28'618]	152 (1%) [-9'983, 8'612]	0.97
Cluster 2: Cost type				
Catering costs	306 [271, 353]	434 [254, 626]	127 (42%) [-67, 310]	0.18
Laboratory costs	1'972 [1'698, 2'290]	668 [378, 987]	-1'304 (-66%) [-1'717, -882]	<0.001
Material costs	2'512 [2'086, 3'010]	151 [106, 184]	-2'360 (-94%) [-2'862, -1'934]	<0.001
Other costs	3'660 [3'015, 4'491]	2'018 [365, 3'679]	-1'641 (-45%) [-3'466, 24]	0.07
Patientmanagement costs	197 [188, 211]	208 [162, 257]	10 (5%) [-37, 62]	0.69
Pharmacy costs	3'834 [3'046, 4'771]	493 [328, 691]	-3'341 (-87%) [-4'287, -2'543]	<0.001
Room costs	791 [704, 899]	1'691 [997, 2'285]	900 (114%) [159, 1'499]	0.009
Staff costs	26'210 [23'663, 29'299]	19'359 [11'463, 25'951]	-6'851 (-26%) [-15'457, 22]	0.09
Cluster 3: Staff detail				
Nursing costs	9'273 [8'417, 10'384]	14'212 [7'702, 19'800]	4'938 (53%) [-1'789, 10'757]	0.12
Physician costs	16'397 [14'272, 18'990]	4'470 [3'147, 5'545]	-11'926 (-73%) [-14'639, -9'588]	<0.001
Social counseling costs	121 [106, 140]	185 [106, 402]	64 (53%) [-19, 291]	0.37
Therapist costs	440 [382, 515]	492 [275, 813]	52 (12%) [-185, 371]	0.71



Appendix VII. Comparison of total costs of PC vs UC defining PC exposure when referral to PC occurred within 3 days from admission – Average daily costs

	Usual care (N=705)	Pallitiave care (N=41)	Mean cost difference [95% CI]	P-value
	mean costs [95% CI]			
Total costs	5'306 [4'891, 5'708]	2'107 [1'779, 2'532]	-3'199 (-60%) [-3'712, -2'579]	<0.001
Cluster 1: Organizational unit				
Emergency room costs	651 [604, 709]	513 [250, 875]	-138 (-21%) [-417, 207]	0.38
Hotel costs	155 [149, 161]	186 [177, 198]	31 (20%) [20, 45]	<0.001
Radiology costs	1'128 [935, 1'335]	634 [369, 1'102]	-494 (-44%) [-843, -59]	0.010
ICU costs	2'875 [2'495, 3'183]	206 [51, 679]	-2'669 (-93%) [-3'008, -2'104]	<0.001
Surgery room costs	2'207 [1'847, 2'625]	87 [20, 217]	-2'120 (-96%) [-2'556, -1'738]	<0.001
Ward costs	2'473 [2'273, 2'689]	1'598 [1'391, 1'751]	-875 (-35%) [-1'159, -616]	<0.001
Cluster 2: Cost type				
Catering costs	22 [20, 24]	30 [24, 38]	9 (41%) [2, 16]	0.014
Laboratory costs	281 [251, 315]	138 [82, 207]	-143 (-51%) [-205, -62]	<0.001
Material costs	1'204 [1'007, 1'424]	76 [57, 90]	-1'128 (-94%) [-1'349, -930]	<0.001
Other costs	878 [738, 1'043]	237 [57, 415]	-641 (-73%) [-876, -414]	<0.001
Patientmanagement costs	63 [58, 68]	28 [19, 41]	-35 (-55%) [-45, -21]	<0.001
Pharmacy costs	710 [552, 871]	101 [32, 278]	-609 (-86%) [-792, -389]	<0.001
Room costs	70 [66, 74]	127 [112, 139]	57 (82%) [41, 69]	<0.001
Staff costs	3'613 [3'382, 3'845]	1'682 [1'448, 1'960]	-1'931 (-53%) [-2'244, -1'563]	<0.001
Cluster 3: Staff detail				
Nursing costs	1'225 [1'168, 1'292]	1'274 [981, 1'682]	49 (4%) [-257, 464]	0.79
Physician costs	3'374 [3'098, 3'633]	1'721 [1'144, 2'279]	-1'653 (-49%) [-2'275, -1'023]	<0.001
Social counseling costs	32 [28, 36]	70 [41, 97]	38 (117%) [9, 67]	0.012
Therapist costs	64 [59, 71]	84 [57, 109]	19 (30%) [-10, 45]	0.16