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Evaluation of the Direct Cost in Patients with Dementia Hospitalized for Pneumonia

Pnömoni Tanısı ile Hospitalize Edilen Demanslı Hastalarda Direkt Maliyetin Değerlendirilmesi

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ABSTRACT Objective: Pneumonia is an indisputable cause of morbidity and mortality in elderly patients especially if they have dementia. We aimed to compare the cost of pneumonia for hospitalized patients with and without dementia and to investigate the factors affecting the direct cost of hospitalization. **Material and Methods:** The study group consisted of 58 dementia patients hospitalized for pneumonia compared with a matched cohort of 54 patients without dementia. The data were collected from the hospital record system between May 2017 and June 2019. Demographic features, comorbidities, characteristics of pneumonia and factors contributing to the total cost of hospitalization were analysed retrospectively. **Results:** The total mean cost of all patients for hospitalization of pneumonia was 653.1±1,059.9 American Dollars. The mean cost in the dementia group is 976.14±1,433.83 and 339.01±180.81 American Dollars for the control group per episode (p=0.001). The mean length of stay is 10.24±6.97 days and 7.24±2.89 days in the dementia and control groups, respectively (p<0.05). The number of consultations, pharmacy costs, examination costs and the total costs of patients with dementia were significantly higher than those without dementia and independent of the parameters associated with the characteristics of pneumonia. **Conclusion:** This study shows that pneumonia in elderly patients with dementia produces a burdensome financial cost which is lower in a matched population of patients without dementia. Advances in elderly care, precautions for pneumonia and assessment of aspiration risk in dementia patients might be rational solutions for decreasing the cost of pneumonia.

Keywords: Dementia; elderly; hospital costs; pneumonia

ÖZET Amaç: Pnömoni, özellikle yaşlı hastalarda tartışılmaz bir morbidite ve mortalite nedenidir. Çalışmamızın amacı, pnömoni tanısı ile hospitalize edilen demansı olan ve olmayan hastaların, hastanede yatış maliyetini karşılaştırmak ve direkt maliyete etki eden faktörleri değerlendirmektir. **Gereç ve Yöntemler:** Çalışmaya, pnömoni tanısı ile interne edilip, tedavi edilen demans tanılı 58 hasta ve benzer özellikteki demans tanısı olmayan 54 hasta dâhil edildi. Hastane kayıt sistemine Mayıs 2017 ile Haziran 2019 tarihleri arasında kaydedilen hasta verileri incelendi. Hastaların demografik özellikleri, komorbiditeleri, pnömoniye ait özellikler ve direkt hastane maliyetine etki eden faktörler retrospektif olarak değerlendirildi. **Bulgular:** Pnömoni tanısı ile hospitalize edilen hastaların toplam direkt maliyeti 653,1±1.059,9 Amerikan Doları olarak değerlendirildi. Demansı olan hastalarda, yatış başına ortalama maliyet 976,14±1.433,83 Amerikan Doları iken demansı olmayan hastalarda maliyetin 339,01±180,81 Amerikan Doları olduğu gözlendi (p=0,001). Ortalama yatış süresi demanslı hastalarda ve kontrol grubunda sırasıyla 10,24±6,97 gün ve 7,24±2,89 gün idi (p<0,05). Konsültasyon sayısı, ilaç maliyetleri, muayene ücretleri ve toplam maliyetin, demanslı hastalarda pnömoninin klinik özelliklerinden bağımsız olarak kontrol grubuna göre anlamlı ölçüde daha yüksek olduğu gözlendi. **Sonuç:** Bu çalışmanın sonuçları, pnömoni tanısı ile interne edilen demanslı hastaların, benzer özellikteki demansı olmayan hastalara göre anlamlı oranda fazla direkt finansal maliyeti olduğunu göstermiştir. Yaşlı bakımındaki gelişmeler, pnömoni gelişiminin önlenmesi için alınacak tedbirler ve aspirasyon riskinin değerlendirilmesi ile demanslı hastalarda aşırı maliyet yükünden kaçınılması mümkün olabilmektedir.

Anahtar Kelimeler: Demans; yaşlı; hastane maliyetleri; pnömoni

In 2010, the estimated number of people to live with dementia worldwide was 35.6 million. Given that the numbers are expected to almost double every 20 years, the world's population with dementia will reach 65.7 million in 2030 and 115.4 million in 2050.[1] Dementia is one of the most demanding and costly diseases for society, because of the high prevalence and the great need for caregiving. The total es-

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timated worldwide cost of dementia was 604 billion American Dollars ($AD), of which about 70% was incurred in Western Europe and North America in 2010.[2]

Individuals with dementia are more likely to be diagnosed with pneumonia compared with elderly people without dementia.[3] Dementia has been reported as a risk factor for pneumonia.[4] Furthermore, the risk of death due to pneumonia in patients with dementia is twice as high as in elderly patients without dementia.[5] Pneumonia is also a comorbidity that contributes to the increased total length of stay (LOS) in patients hospitalized for several other conditions. It has been reported that dementia patients were more likely than non-dementia patients to have complications (Relative risk: 2.5) and these complications comprised 22.0% of the extra costs ($AD 49 million/$AD 226 million), despite only accounting for 10.4% of the hospital episodes (44,488/426,276).[6]

The purpose of our study was to assess the direct cost of pneumonia for elderly patients discharged from a tertiary center mostly dealing with geriatric population and to compare the costs for patients with and without dementia. This article also discusses the influencing factors and possible ways to decrease the total direct cost of hospitalization for pneumonia in dementia patients.

MATERIAL AND METHODS

PATIENTS

The study group consisted of 58 dementia patients hospitalized for pneumonia compared with a matched cohort of 54 patients without dementia who were chosen from elderly patients evaluated by a neurologist and did not have a diagnosis associated with dementia in the last two-year period.

The patients were involved in the dementia group if dementia was ever documented as a primary or secondary diagnosis during an inpatient or outpatient visit over the two-year period. The International Statistical Classification of Diseases and Related Health Problems (ICD-10) codes (F00, F01, F02, G30, and G31) associated with dementia diagnosis were included.

This group consisted of patients with severe dementia who could not take care of themselves without the help of a caregiver. All the patients in non-dementia group were examined by a consultant neurologist and dementia was excluded.

DATA COLLECTION

Data were collected from the hospital record system between May 2017 and June 2019. Patients' demographic information, the parameters associated with the characteristics of pneumonia [initial and ultimate white blood cell (WBC) count, initial and ultimate C-reactive protein (CRP), ultimate erythrocyte sedimentation rate (ESR) "no data were available for initial" ESR given that most of the patients were initially evaluated in the emergency department where ESR is excluded in the routine biochemical examination], the total number of lobes affected in thorax computed tomography, sputum culture; the number of consultations and additional procedures increasing the cost of hospitalization such as additional imaging, monitorisation, albumin or electrolyte replacement; blood transfusion, total parenteral nutrition, renal replacement, pressure injury care, bronchoscopy, percutaneous endoscopic gastrostomy, and non-invasive or invasive mechanic ventilation were evaluated. The comorbidities were assessed by using the Charlson index (CI).

This study was conducted in accordance with Ethical Principles for Medical Research Involving Human Subjects (Helsinki Declaration 2008) and was approved by the Recep Tayyip Erdoğan University Non-interventional Clinical Research Ethics Committee (Date: 10/1/2020, Number: 2019/206).

DATA ANALYSIS

The average LOS for each group was calculated by using the publicly available hospital data. The total direct cost of hospitalization was calculated using the hospital documents, and detailed cost analysis were calculated using the invoice breakdown. The costs were converted into $AD at the exchange rate approved by the Central Bank of Turkey on the day the patients were discharged.

STATISTICAL ANALYSIS

Statistical data were analysed using the Statistical Package for the Social Sciences version 21.0 program (SPSS IBM Corp.; Armonk, NY, USA).

Descriptive statistical methods such as frequency, percentage, mean and standard deviation were used to evaluate the study data. Student's t-test was used for pairwise comparisons in independent groups showing normal distribution of quantitative data. Mann-Whitney U test was used in paired comparisons in independent groups with non-normal distribution. Comparison of dependent paired groups with non-normal distribution was performed by using Wilcoxon test. Spearman correlation analysis was used for calculations of correlation coefficients. Multiple linear regression analysis was used to determine the effects of independent variables on the dependent variables. The value of $p<0.05$ was considered as statistically significant.

RESULTS

Of the 112 patients hospitalized with pneumonia, (male/female: 59/53), 58 were dementia and, 54 were non-dementia patients (control group). The mean age was 85.43±6.44 years in the dementia group ($p<0.001$) and 80.15±6.69 years in the controls. The CI score of all patients ranged from 0 to 27.6, with a mean of 5.50±5.21. The mean CI score of the dementia patients was 7.02±5.56, whereas that of the non-dementia patients was 4.16±4.53 ($p=0.004$). The total direct cost of hospitalization due to pneumonia for all patients was $AD 653.1±1,059.9. Table 1 summarises the other demographic features and the characteristics of pneumonia. Both the number of days in intensive care unit (ICU) and the total LOS were significantly higher in patients with dementia compared with the controls. The number of consultations, pharmacy costs, examination costs and the total costs of patients with dementia were significantly higher than those without dementia (Table 2).

The correlation analysis showed a strong positive correlation between the total cost and actual LOS ($r=0.763$; $p=0.001$). The number of consultations moderately affected the LOS ($r=0.428$; $p=0.001$) whereas comorbidities had a weak effect ($r=0.246$; $p=0.016$). However, there was no significant relationship between the length of hospital and ICU stay, initial WBC, initial CRP and the extent of radiological involvement ($p>0.05$).

TABLE 1: Demographic, clinical and radiological characteristics of the patients.

Parameters	Mean±SD	Minimum	Maximum
Age (years)	82.8±7.1	65	100
Gender (male/female)	59/53		
Dementia (n, %)	58 (51.8%)		
DM (n, %)	15 (13.4%)		
COPD (n, %)	19 (17%)		
CI	5.50±5.21	0	27.6
Actual length of stay (n)	8.8±5.5	2	45
# of pts w ICU requirement (n)	13 (11.6%)		
# of days in ICU (n)	0.7±2.7	0	21
Initial WBC (x103)	11.9±5.4	1.8	35
Initial CRP (mg/dL)	12.1±8.2	0.1	36
Ultimate WBC (x103)	8.1±2.7	1.1	19
Ultimate CRP (mg/dL)	5.2±3.7	0	11
# of pts w multilobar involvement (n, %)	52 (44.4%)		
Daily cost (TL)	251.8±122	83.1	721.3
Total cost (TL)	2.541±3.322	374	30.111
Daily cost ($AD)	62.7±39.3	23.4	234.4
Total Cost ($AD)	653.1±1.059.9	98.5	10.116.2

SD: Standard deviation; DM: Diabetes mellitus; COPD: Chronic obstructive pulmonary disease; CI: Charlson index; #: Number; pts: Patients; w: With; ICU: Intensive care unit; WBC: White blood cells; CRP: C-reactive protein; TL: Turkish Liras; $AD: American Dollars.

The correlation analysis revealed a strong positive correlation between the total cost and the number of days of hospitalization ($r=0.771$; $p=0.005$). However, no significant relationship was noted between the duration of ICU stay and initial WBC, initial CRP, the number of consultations, comorbidities and the extent of radiological involvement ($p>0.05$).

There was no statistically significant relationship between the parameters associated with the characteristics of pneumonia such as initial WBC and CRP, and the number of consultations needed or comorbidities ($p>0.05$).

The number of consultations also moderately positively affected the total cost ($r=0.432$; $p=0.001$). However, no significant relationship was indicated between the number of consultations and comorbidities or other parameters associated with the characteristics of pneumonia ($p>0.05$).

TABLE 2: Comparison of variables between groups.

	Dementia group (n=54)		Controls (n=58)		
	Mean±SD	Minimum-Maximum (Median)	Mean±SD	Minimum-Maximum (Median)	p[b] value
Age	85.43±6.44	69-100 (86)	80.15±6.69	65-94 (80)	0.001**
	Female (n, %)	Male (n, %)	Female (n, %)	Male (n, %)	
Gender	26 (48.1%)	28 (51.9%)	32 (57.1%)	24 (42.9%)	0.353
Charlson index	7.02±5.56	3.4-27.6 (3.40)	4.16±4.53	0-20.7 (56.00)	0.004**
Actual length of stay (days-n)	10.24±6.97	3-45 (8)	7.24±2.89	2-16 (8)	0.016*
# of days in ICU (n)	1.56±3.82	0-21 (0)	0.02±0.13	0-1 (0)	0.001**
Initial WBC (mg/dL)	11,960.74±5,620.83	2,930-35,000 (11,140)	11,683.27±5,258.28	1,320-29,000 (10,570)	0.884
Initial CRP	10.9±7.24	0.1-30 (9.1)	13.38±8.8	1.2-36 (11.7)	0.124
Ultimate WBC	8,291.82±3,141.09	1,090-19,000 (7,900)	8,088.28±2,705.21	4,030-17,900 (7,900)	0.707
Ultimate ESR	4.91±4.68	0.1-24.8 (3.74)	3.67±4.15	0-26.5 (2.7)	0.095
Cost of medications	367.51±380.7	18.86-1,923.5 (269.26)	160.35±118	26.84-572.04 (142.29)	0.001**
Cost of examinations	608.63±1,281.77	24.63-9,519.57 (236.75)	178.65±83.48	52.44-466.7 (160.61)	0.001**
# of consultations	2.54±3.28	0-13 (1)	1.17±1.98	0-11 (0)	0.023*
Additional procedure requirement	(n) 34	(%) (44.7%)	(n) 42	(%) (55.3%)	0.246

[b]Mann-Whitney U test; *p<0.05; **p<0.01; SD: Standard deviation; #-n: Number; ICU: Intensive care unit; WBC: White blood cells; CRP: C-reactive protein; ESR: Erythrocyte sedimentation rate.

TABLE 3: Correlation analysis showing the relationship between the total cost and other variables.

Parameters	r value	p value
Actual length of stay	**0.763**	***0.001**
# of days in ICU	**0.0771**	***0.005**
Initial WBC	0.151	0.130
Initial CRP	0.180	0.069
# of lobes affected in thorax CT	0.018	0.849
# of consultations	**0.432**	***0.001**
Charlson index	**0.285**	***0.005**

ICU: Intensive care unit; WBC: White blood cells; CRP: C-reactive protein; CT: Computed tomography; #: Number.

TABLE 4: Multiple linear regression analysis findings for interpretation of factors affecting total cost of hospitalization.

Model variables	B	Std.Error	β	t value	p value
Actual length of stay	0.994	0.131	0.585	7.615	0.001**
# of days in ICU	0.051	0.012	0.308	4.334	0.001**
# of consultations	0.098	0.073	0.095	1.34	0.184
Comorbidities	0.053	0.06	0.059	0.883	0.38
Radiological involvement	0.054	0.127	0.028	0.426	0.671
Sputum culture sampling	0.002	0.078	0.002	0.022	0.982
Additional procedure requirement	0.002	0.046	0.001	0.01	0.992

*p<0.05; **p<0.01; ICU: Intensive care unit; #: Number.

A weak but positive correlation was observed between the total cost and comorbidities (r=0.285; p=0.005) (Table 3).

Multiple linear regression analysis determined the statistically significant effect of total hospital stay, ICU stay, the number of consultations, comorbidities, the extent of radiological involvement, sputum culture sampling and additional procedure requirement on the total cost (p<0.01). The independent variables in the model explained 64.2% of the total variance of the total cost (p<0.01).

According to the regression analyses, the total number of days in the hospital and the number of days in ICU have a positive and significant effect on the total cost. Thus, the total cost increases as the total number of days in the hospital and the number of days in ICU increases (Table 4).

DISCUSSION

One of the most effective factors contributing to the cost of pneumonia is advanced age. The medical burden of community-acquired pneumonia (CAP) (i.e. the incidence, hospitalization and mortality associated with CAP) increases with advanced age.[7] In a study by Lee et al., the burden of CAP in elderly patients in Korea was investigated and the total cost was found to be higher in patients aged over 65 years than in those aged under 65 ($AD 2,088 vs $AD 1,701).[8] In the present study, although the mean ages of both groups were over 80, the study group was signifi-

cantly older than the control. Thus, age might be a factor increasing the total cost of hospitalization.

In a study designed to estimate the costs of CAP, the total cost was $AD 1,305 per episode, and the mean age of the study population was 69 years.[9] Another study reported the estimated total mean cost as $AD 708.34±1,331.19.[10] In our study, the mean cost of all patients per episode was $AD 653.1±1,059.9 and exhibited variability (minimum: $AD 98.5 and maximum: $AD 10,116.2). The discordance in data might represent the international diversity of medical approach, the prices of drugs and medications used and the category of health center in charge.

In another study by Verma et al. which was designed to determine the prevalence and cost of conditions treated by general internal medicine inpatient services, the costliest conditions established were stroke and neurologic conditions such as delirium, dementia, and cognitive disorders.[11] Pneumonia is the leading cause of hospitalization and often a terminal event among nursing home residents with advanced dementia. Treating pneumonia in the hospital, compared with the nursing home, causes no improvement in the survival of patients with dementia.[12] No nursing home patients were included in our study. Cultural differences determine the hospitalization or treatment strategies of the patients with advanced dementia. Nursing home patients may probably be less easily hospitalized under conditions such as pneumonia. Conditions related with patient selection for hospitalization are subjects of ethical discussions and will not be discussed here because they are out of scope of this paper.

In a study by Konomura et al., CAP episodes that involved dementia were associated with high treatment costs, and this result was probably due to the high admission rate. In the study period of approximately five years, 135 inpatient CAP episodes by 194 dementia patients were recorded. General ward costs accounted for 90% of the total cost of $AD 936,780.[4]

A solution to decrease the risk of aspiration and associated complications, such as fever or pneumonia, might improve the oral hygiene of susceptible populations including nursing home residents. Professional oral health care administered by dental hygienists to a group of elderly patients needing daily nursing care was associated with the reduced prevalence of fever and fatal pneumonia.[13] Although not well established, several studies accentuated the importance and cost effectiveness of professional oral health care for preventing pneumonia in the elderly.[14]

Despite the lack of evidence for their benefits on clinical conditions including aspiration, pneumonia, hydration, nutrition and mortality; texture-modified foods (TMFs) are often used in patients with dysphagia secondary to dementia. Further research is required to clarify the appropriate management of aspiration in dementia patients with significant dysphagia requiring TMF.[15]

Takenoshita et al. conducted a study comparing the frequency of pneumonia in patients with severe dementia before and after tube feeding (TF). The study reported a decrease in the frequency of pneumonia and the use of intravenous antibiotics after the initiation of TF.[16]

Percutaneous endoscopic gastrostomy (PEG) is also a frequently used method for patients with swallowing failure due to advanced dementia. In a study by Kumagai et al., PEG caused no decrease in the frequency of pneumonia but showed a positive effect on the survival compared with a group of patients with TF.[17]

A study comparing the long-term outcomes of patients receiving PEG and total parenteral nutrition (TPN), reported severe dementia as a poor prognostic factor after PEG. In the same study, statistically significant increase in serious pneumonia was demonstrated in the PEG group (50.9% vs 25.5%, p=0.010), however the rate of sepsis was higher in the TPN group (10.9% vs 30.9%, p=0.018).[18]

Pneumococcal vaccination may be another beneficial attempt to decrease pneumonia in elderly patients with or without dementia. Both pneumococcal polysaccharide vaccine (23-valent) (PPSV23) and pneumococcal conjugate vaccine (13-valent) (PCV13) is more favourable than no vaccination for elderly subjects over the age of 65 years. Instead of a single-dose PPSV23; a single dose PCV13 or subse-

quent application of PPSV23 plus PCV13 vaccinations is more cost-effective.[19]

Studies working on the effectiveness of influenza vaccination to prevent viral with/without bacterial pneumonia are uncertain with regards to recommending annual vaccination in the elderly. Further studies are needed to better understand the effectiveness of vaccination against influenza and pneumococci in a modern context, which is characterised by high vaccine uptake and antiviral use.[20]

CONCLUSION

The care for patients with dementia is complex. The disease should be considered as a whole to better understand the commonly encountered conditions interacting with each other especially for advanced cases. Improvements in models of care and caregiver skills show promise in the prevention of conditions such as pneumonia for dementia patients. Despite the current lack in fully effective means of preventing pneumonia in patients with dysphagia, the prevention of aspiration and vaccination is partially influential. Possible ways of reducing the cost of pneumonia in patients with dementia will be uncovered by investigating the causes of prolonged hospitalization.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Bilge Yılmaz Kara;* ***Design:*** *Bilge Yılmaz Kara, Songül Özyurt;* ***Control/Supervision:*** *Songül Özyurt, Neslihan Özçelik;* ***Data Collection and/or Processing:*** *Bilge Yılmaz Kara, Neslihan Özçelik, Songül Özyurt;* ***Analysis and/or Interpretation:*** *Neslihan Özçelik, Songül Özyurt, Bilge Yılmaz Kara;* ***Literature Review:*** *Bilge Yılmaz Kara, Neslihan Özçelik;* ***Writing the Article:*** *Bilge Yılmaz Kara;* ***Critical Review:*** *Songül Özyurt.*

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