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Original Research

Excess Cost and Healthcare Resources Associated With Delayed Diagnosis of Charcot Foot

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ABSTRACT

The purpose of the present study was to demonstrate the effect of a delayed diagnosis of Charcot foot on acute care cost and usage. We used International Classification of Disease, Ninth Revision, Clinical Modification codes, and the California Office for Statewide Health Planning and Development 2009 to 2012 public patient discharge files to identify patients with type 2 diabetes mellitus and Charcot foot. The costs and length of stay were compared for those with a diagnosis of Charcot foot on admission compared with those who received a delayed diagnosis of Charcot foot before discharge. Patient demographic data, diagnoses often mistaken for Charcot foot, and procedures often performed for Charcot foot were assessed to determine the potential effect on costs and length of stay in Charcot foot subjects. A delayed Charcot foot diagnosis was associated with 10.8% greater inpatient costs and 12.1% longer length of stay. These patients required greater resource usage owing to the significantly greater number of procedures performed. A significantly greater number of patients underwent lower extremity amputation when the diagnosis was delayed, resulting in a 30.4% increase in costs and 31.6% longer length of stay. A greater rate of diabetic foot ulcers, foot infections, and osteomyelitis was also observed; however, the cost was only affected by osteomyelitis, and the length of stay was not significantly affected. A delayed diagnosis of Charcot foot at admission resulted in significantly increased acute care costs and longer lengths of stay.

Charcot foot (CF) is a devastating complication of the neuropathic diabetic foot. It has severe ramifications from its initial onset throughout the remainder of a patient's life. At its onset, CF presents as a red, hot, and swollen foot that can present with pain despite the neuropathic status of the patient. The foot progresses to osseous fragmentation owing to fractures and dislocations, through coalescence of the fragments, and then, finally, to remodeling into a substantial deformity. The patient is often left with a rocker bottom deformity and is challenged by the limited footwear options available and prominent areas of plantar pressure, which increases the risk of ulcerations, infections, and, eventually, amputations. Despite long-term therapy and successful treatment, patients have self-reported a significantly reduced quality of life (QoL) that often fails to improve (1). Additionally, the 5-year mortality rates can reach ≤40%, with life expectancy reduced by 14.4 years (2).

Early recognition and treatment of CF can decrease the incidence of these serious complications (3); however, delayed diagnoses and misdiagnoses continue to occur regularly. The failure to accurately diagnose CF in a timely fashion arises from a lack of clinical expertise with its presentation, which mimics other often-related pathology, delaying the diagnosis (3,4). Also complicating the clinical scenario are diabetic foot ulcers, which are present in 58.6% of patients with CF (5). In the acute stage, CF presents similarly to related pathology such as diabetic foot ulcers and infections. In its chronic phase, it appears more similar to osteomyelitis. During the acute stage, CF can also appear similar to deep vein thrombosis, complex regional pain syndrome, or an ankle sprain when patients report a trivial traumatic event (6).

Achieving successful healing in the presence of acute CF can be time consuming, with Game et al (7) reporting a median time of 9 months when initially treated with a nonremovable off-loading device versus 12 months for those without a nonremovable device. The reported time ranged from 3 to 36 months (7). Because most healthcare costs occur in the acute care setting and a delayed diagnosis or misdiagnosis can

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result in more significant destruction of the foot (8,9), our aim was to identify an association between cost and usage of healthcare resources with a delayed diagnosis in CF inpatients. We hypothesized that a delayed diagnosis would result in greater costs of care and resource usage.

Materials and Methods

Using the CUPID, version 2.0, software (SpeedTrack, Inc., Placentia, CA), patients with Charcot arthropathy and diabetes mellitus were identified in the 2009 to 2012 California Office of Statewide Health Planning and Development (OSHPD) public patient discharge files based on the International Classification of Diseases, Ninth Revision, Clinical Modification codes, which are listed in Table 1. Inclusion in the study was restricted to those subjects with charges and cost-to-charge ratios reported. The inclusion criteria were also restricted to subjects who were discharged with a diagnosis of type 2 diabetes mellitus and CF as the principal discharge diagnosis or within the first 5 secondary discharge diagnoses. A delayed diagnosis of CF was defined as a discharge with a CF diagnosis but without a CF diagnosis at admission. Using this definition, the subjects were divided into 2 cohorts: group 1 included those with a CF discharge diagnosis present at admission (diagnosed); and group 2 included a CF discharge diagnosis not present on admission (delayed diagnosis).

Patient demographics (age, gender, race, and ethnicity) and the number of chronic conditions were recorded for both groups. The demographic variables have varying populaton sizes oiwng to the OSHPD standard protocols used to de-identify the public discharge files. The number of chronic conditions was determined using the chronic conditions indicators from the Agency of Healthcare Research and Quality. This database uses International Classification of Diseases, Ninth Revision, Clinical Modification codes to facilitate health services research using administrative data sets by identifying chronic conditions.

The primary outcomes were acute care cost and length of stay (LOS). The cost was calculated by adjusting the inpatient charges by the hospital's cost-to-charge ratio. This estimated cost was then adjusted to 2012 US dollars using the consumer price index for medical services (10).

The LOS served as a measure of resource usage. The disposition of each subject was also used as a proxy for resource usage, because it represents the level of care needed after discharge. The disposition was compared to the admission source site to determine whether changes in the level of ambulatory care services were needed.

A comparison of patient demographics between the CF diagnosis and CF delayed diagnosis groups was not performed because the OSHPD de-identification methods are not randomized and the significant number of redacted information prevents an accurate comparison between groups. The number of subjects, costs, and LOS was recorded for subjects in each group with comorbidities commonly mistaken for CF. These diagnoses included diabetic foot ulcer, diabetic foot infection, or osteomyelitis. The diagnoses were the principal discharge diagnosis or 1 of the first 5 secondary diagnoses recorded and present at admission. The number of patients, cost, and LOS for the number of procedures performed during hospitalization and specific procedures, including diagnostic imaging, intravenous antibiotics, procedures frequently performed for CF (exostectomy, foot or ankle arthrodesis, application of an external fixator), and lower extremity amputations (LEAs) were also recorded. Futhermore, LEAs were subdivided into minor and major amputations. Minor amputations were defined as amputations of the foot or partial foot and major amputations as amputations at or proximal to the ankle (Table 1).

All statistical calculations were performed using SPSS, version 22.0 (IBM Corp., Armonk, NY) and using an a priori significance level of $p < .05$. Continuous variables were analyzed using an unpaired, 2-tailed t test, and a χ^2 test was used for the categorical variables. A linear regression model was used to determine the effect of the number of procedures performed during the acute care stay. A correlation coefficient of ≥0.7 was considered a strong correlation, a correlation coefficient of 0.3 to 0.69 was deemed a moderate correlation, and one of <0.3, a weak correlation.

Table 1
International Classification of Diseases, Ninth Revision, Clinical Modification codes used to identify patients, alternative diagnoses, and procedures

Variable	ICD-9-CM Code
Diagnosis	
Type 2 diabetes mellitus	250.00 to 250.93
Charcot foot	0.94, 713.5
DFU	707.13 to 707.15
DFI	681.1, 682.6, 682.7
Osteomyelitis	730.06 to 730.07; 730.16 to 730.17; 730.26 to 730.27; 730.86 to 730.87; 730.96 to 730.97
Procedure	
Diagnostic imaging	88.28, 88.38, 88.94, 92.14
IV antibiotics	99.21
Minor LEA	84.10 to 84.12
Major LEA	84.13 to 84.19
Exostectomy	77.67 to 77.68; 77.87 to 77.88; 77.97 to 77.98
Arthrodesis	81.11 to 81.15
Application Ex Fix	84.71 to 84.73

Abbreviations: Ex Fix, external fixation; DFI, diabetic foot infection; DFU, diabetic foot ulcer; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; IV, intravenous; LEA, lower extremity amputation.

Results

A total of 8587 discharges of patients living with diabetes with CF from California acute care hospitals from 2009 to 2012 who met the financial reporting inclusion criteria was found. Only 4363 (50.8%) of these patients met the diagnostic inclusion criteria by having discharge diagnoses of type 2 diabetes mellitus and Charcot arthropathy as the principal discharge diagnosis or 1 of the first 5 secondary diagnoses. After dividing the these subjects into their respective cohorts, group 1 had 3786 (86.8%) discharges with a diagnosis of CF at admission and group 2 had 577 (13.2%) discharges without a CF diagnosis at admission.

The patient demographics are summarized in Table 2. The population size varied among the demographic variables owing to the redacted data in accordance with the OSHPD de-identification protocols for the public discharge records.

The inpatient hospital costs per patient for group 1 were $18,347 ± $21,091, with an average LOS of 6.6 ± 9.0 days. The acute care costs were $1987 (10.8%) greater in group 2 ($p \leq .05$), and the LOS was 0.8 days (12.1%) longer with a delayed diagnosis ($p \leq .05$). A moderate correlation between LOS and cost was observed for both the diagnosis ($r = 0.392$) and delayed diagnosis ($r = 0.661$) groups.

Usage, which was assessed using disposition, to compare costs and LOS, is presented in Table 3. No significant difference was found in the disposition of either group. The level of care services needed at discharge compared with the level of care required before admission also showed no significant difference between the 2 groups for the proportion of subjects requiring more or fewer healthcare services on discharge, the costs of acute care, and the LOS.

Diabetic foot ulcers were diagnosed in 17.9% of group 1 subjects compared with 27.2% of group 2 subjects ($p < .001$). Also, a diabetic

Table 2
Patient demographics for those with Charcot foot at the time of admission and those with Charcot foot who had a delayed diagnosis

Variable	Correct Diagnosis	Delayed Diagnosis
Total	3786 (86.8)	577 (13.2)
Gender		
Male	1371 (36.2)	229 (39.7)
Female	1001 (26.4)	152 (26.3)
Redacted	1414 (37.3)	196 (34.0)
Age (y)		
18 to 34	95 (2.5)	25 (4.3)
35 to 64	1811 (47.8)	306 (53.0)
≥65	873 (23.1)	110 (19.1)
Redacted	1007 (26.6)	136 (23.6)
Race		
Native American/Alaskan Native	3 (0.1)	0 (0.0)
Asian/Pacific Islander	31 (0.8)	6 (1.0)
Black/African American	103 (2.7)	27 (4.7)
Other	234 (6.2)	42 (7.3)
White	1826 (48.2)	282 (48.9)
Redacted/unknown	1589 (42.0)	127 (22.0)
Ethnicity		
Hispanic/Latino	506 (13.4)	108 (18.7)
Non-Hispanic/non-Latino	1592 (42.0)	235 (40.7)
Redacted	1688 (44.6)	234 (40.6)

Data presented as n (%).