Tests and Expenditures in the Initial Evaluation of Peripheral Neuropathy

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Background: Peripheral neuropathy is a common disorder in which an extensive evaluation is often unrevealing.

Methods: We sought to define diagnostic practice patterns as an early step in identifying opportunities to improve efficiency of care. The 1996-2007 Health and Retirement Study Medicare claims-linked database was used to identify individuals with an incident diagnosis of peripheral neuropathy using International Classification of Diseases, Ninth Revision, codes and required no previous neuropathy diagnosis during the preceding 30 months. Focusing on 15 relevant tests, we examined the number and patterns of tests and specific test utilization 6 months before and after the incident neuropathy diagnosis. Medicare expenditures were assessed during the baseline, diagnostic, and follow-up periods.

Results: Of the 12,673 patients, 1,031 (8.1%) received a new International Classification of Diseases, Ninth Revision, diagnosis of neuropathy and met the study inclusion criteria. Of the 15 tests considered, a median of 4 (interquartile range, 2-5) tests were performed, with more than 400 patterns of testing. Magnetic resonance imaging of the brain or spine was ordered in 23.2% of patients, whereas a glucose tolerance test was rarely obtained (1.0%). Mean Medicare expenditures were significantly higher in the diagnostic period than in the baseline period ($14,362 vs $8,067, \( P < .001 \)).

Conclusions: Patients diagnosed as having peripheral neuropathy typically undergo many tests, but testing patterns are highly variable. Almost one-quarter of patients receiving neuropathy diagnoses undergo high-cost, low-yield magnetic resonance imaging, whereas few receive low-cost, high-yield glucose tolerance tests. Expenditures increase substantially in the diagnostic period. More research is needed to define effective and efficient strategies for the diagnostic evaluation of peripheral neuropathy.

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PERIPHERAL NEUROPATHY IS A common and debilitating condition with a prevalence of 2% to 7% in the general population.\(^1,2\) The prevalence increases significantly in older adults, with a prevalence of approximately 15% in those older than 40 years.\(^3\) Distal symmetric polyneuropathy (DSP) is the most common subtype of neuropathy.\(^4\) Previous research suggests that a focused and directed evaluation is the optimal diagnostic approach in this patient population.\(^3\) The best evidence for diagnostic testing in DSP was recently summarized in a systematic review by the American Academy of Neurology (AAN).\(^4\) Fasting glucose levels, vitamin B\(_12\) levels, serum protein electrophoresis (SPEP), and 2-hour oral glucose tolerance tests (GTTs) were supported by the literature based on the yield of these tests and the potential for subsequent interventions.\(^4\) A fasting glucose level is the most frequently used test to diagnose diabetes, which is the most common cause of DSP.\(^6\) Vitamin B\(_12\) deficiency causes a potentially treatable neuropathy with different characteristics than those in idiopathic neuropathy.\(^7\) The use of GTTs and SPEP is supported by evidence\(^8-10\) that patients with neuropathy have a substantially increased prevalence of these abnormalities compared with control groups. Evidence to support other diagnostic tests in the evaluation of DSP is lacking.

See Invited Commentary at end of article

Even after an extensive evaluation, the cause of many peripheral neuropathy cases remains unknown.\(^11\) Furthermore, even when a specific cause is identified, only a few therapies exist. The most common etiology for DSP is diabetes, which is treated with glycemic control. Immunosuppressive medications are used for certain rare subtypes of neuropathy, such as chronic inflammatory demyelinating polyradiculoneuropathy and mononeuropathy multiplex.
However, there are few disease-modifying therapies for patients with DSP, and pain management becomes paramount regardless of etiology. Because DSP composes most peripheral neuropathy, many of these cases are idiopathic, and few treatments are available; efficient diagnostic testing is particularly important in this population.

No previous studies, to our knowledge, have described the evaluation of peripheral neuropathy in routine clinical care. This information is important because it can provide insights into opportunities for optimizing care and setting future research priorities. In this study, we used a large, nationally representative health survey, the Health and Retirement Study (HRS), that is linked to Medicare claims data to identify a cohort with incident peripheral neuropathy and to determine evaluation practices by all physicians.

METHODS

POPULATION

Data for this analysis came from respondents to 1 or more waves of the HRS biennial interview between January 1998 and December 2006, with linked Medicare Standard Analytical Files data. This database combines the rich demographic detail from the HRS with the extensive health care utilization data available in Medicare claims. We identified individuals with incident peripheral neuropathy, defined as persons who had an International Classification of Diseases, Ninth Revision (ICD-9), diagnosis of peripheral neuropathy and no previous diagnosis during the preceding 30 months (incident diagnoses range from March 1998–June 2007). All the ICD-9 codes for peripheral neuropathy were included (354.5, 356.0-9, and 357.0-9). Individuals were included if they were at least 65 years old at the start of the baseline period, were continuously enrolled in Medicare parts A and B fee-for-service from 30 months preceding the index diagnosis through 6 months after the index diagnosis, and completed an HRS interview within 3 years before the diagnosis date. We also identified a matched comparison group using a propensity score method (eMethods; http://www.archinternmed.com).

DEMOGRAPHICS AND HEALTH MEASURES

Key demographic variables that were identified from the HRS interview included age, sex, race/ethnicity, educational level, body mass index, alcohol intake, and limitations in activities of daily living. The Medicare claims database provided the diabetes status of the patient based on the Chronic Condition Data Warehouse definition (≥1 inpatient, skilled nursing, or home health claim or 2 outpatient or carrier claims with diagnostic codes 249.x, 250.x, 357.2, 362.01, 362.02, or 366.31 during the 2-year matching period). Moreover, ICD-9 diagnosis codes identified patients with diabetic complications other than neuropathy. Medicare claims also provided information on chronic kidney disease, rheumatoid arthritis and osteoarthritis, and cancer.

DIAGNOSTIC TESTS

Tests were identified by Current Procedural Terminology codes and included fasting glucose level, hemoglobin A1c level, GTT, SPEP, B12 level, antinuclear antibody test, erythrocyte sedimentation rate, thyrotropin level, complete blood cell count, and comprehensive metabolic panel. Electrodiagnostic tests and magnetic resonance imaging (MRI) studies (brain, cervical, thoracic, or lumbar spine) were also identified. These tests were selected based on their relevance to the diagnostic evaluation of DSP.

MEDIATEX EXPENDITURES

Medicare payment information was obtained from the Medicare Standard Analytical Files and included all payments found in the Medicare Provider Analysis and Review, outpatient, carrier, home health, hospice, and durable medical equipment files. We evaluated expenditures during the baseline (6-18 months before diagnosis), diagnostic (6 months before and after diagnosis), and follow-up (6-18 months after diagnosis) periods.

STATISTICAL ANALYSIS

The number and patterns of testing were assessed during the diagnostic period (6 months before and after the index diagnosis). This time frame was chosen because tests are frequently ordered for this condition before the firm establishment of a diagnosis. Medicare expenditures were calculated during the baseline, diagnostic, and follow-up periods. Tests were used when comparing continuous variables. Sensitivity analyses were conducted after the exclusion of patients with a diagnosis of mononeuritis multiplex, demyelinating neuropathy, or hereditary neuropathy. All the analyses were performed using a commercially available software program (SAS, version 9.1; SAS Institute, Inc.).

RESULTS

POPULATION

Of the 12,673 patients in the HRS-Medicare claims database, 1031 (8.1%) received a new ICD-9 diagnosis of peripheral neuropathy during the 10-year study and met the inclusion criteria. Demographic and other characteristics of the population are given in the Table. The mean age of this population was 77.6 years, and 54.0% were female. Twelve percent of the patients were non-Hispanic black and 8.0% were Hispanic; 41.5% met the Chronic Condition Data Warehouse definition of diabetes and 16.3% had other diabetic complications. Demographics and clinical variables from a matched comparison group are given in eTable 1.

In patients with diabetes, the most common ICD-9 neuropathy diagnosis was polyneuropathy in diabetes (44.4%), followed by different idiopathic classifications (47.8%). In addition, 6.6% of patients with diabetes were classified as having neuropathy due to other diseases (including toxins, drugs, and inflammatory conditions), 1.4% as having hereditary neuropathies, and 0.2% as having acute inflammatory demyelinating polyradiculoneuropathy. Of patients without diabetes, 80.0% had an ICD-9 diagnosis of idiopathic neuropathy, followed by 11.7% with neuropathy due to other diseases, 4.7% with hereditary neuropathies, 3.5% with diabetes (new diagnosis of diabetes), 1.0% with mononeuritis multiplex, 1.0% with acute inflammatory demyelinating polyradiculoneuropathy, and 0.3% with chronic inflammatory demyelinating polyradiculoneuropathy.
Of the 15 relevant tests assessed, the median number of tests performed per patient was 4 (interquartile range, 2-5). There were more than 400 patterns of testing in this population, with no single pattern occurring in more than 4.8% of patients. Furthermore, no particular test was common to all the top patterns.

A fasting glucose level was ordered in 23.4% of patients with neuropathy, and a hemoglobin A1c level was ordered in 43.2% (Figure 1). B12 levels were ordered in 32.6% of patients with neuropathy and SPEP was performed in 13.3%. In the nondiabetic population, a hemoglobin A1c level was ordered in only 17.1% of cases, B12 levels in 40.6%, and SPEP in 18.7% (Figure 1). Only 10 patients (1.0%) received a GTT. In contrast, 23.2% of patients received at least 1 MRI of the brain or spinal cord (Figure 2). The most common types of MRI performed were brain (13.7%), lumbar spine (9.6%), cervical spine (5.0%), and thoracic spine (1.9%). An electromyogram was performed in 19.8% of patients with neuropathy. Of those receiving an electrodiagnostic test, the mean (SD) number of nerves evaluated on nerve conduction studies was 8.79 (6.89) (median, 7.0; interquartile range, 5-10; range, 1-48). Patients with 1 to 14 nerves evaluated on nerve conduction studies were 2.8 (95% CI, 2.1-3.9) times more likely to have an MRI than were those who received no test. Those with 15 or more nerves evaluated (>1 SD greater than the mean) were 5.2 (95% CI, 2.6-10.3) times more likely to have an MRI than were those who received no test.

In the baseline period, before ICD-9 diagnosis of neuropathy, the mean Medicare expenditures were $8067. During the diagnostic period, the mean expenditures increased significantly to $14,362 ($P < .001). This increase was also observed after excluding patients with diabetes (mean: $12,190 vs $6633, P < .001). In the follow-up pe-
Using a nationally representative sample of older US adults, we found that more than 8.1% of the individuals had a new diagnosis of neuropathy and met the inclusion criteria during this 10-year study. Many tests were ordered during the diagnostic period for peripheral neuropathy, but the evaluation was highly variable. Magnetic resonance images of the brain and spine were frequently ordered, whereas the GTT was rarely ordered. Significant increases in cost occurred during the diagnostic period compared with the baseline period. These findings suggest substantial opportunity to improve efficiency in the evaluation of peripheral neuropathy.

The large variation in testing indicates little consensus on an appropriate testing strategy in this population. With more than 400 total patterns of tests and no pattern accounting for more than 4.8% of the total number, no standard approach to the evaluation of peripheral neuropathy currently exists. Similarly, the number of nerves tested on nerve conduction studies exhibited substantial variation but the mean was close to the recommended number of nerves for patients entering a clinical trial as suggested by a 2009 AAN practice parameter. Substantial utilization of diagnostic tests was observed, exhibited by a median of 4 tests ordered of the 15 tests evaluated. Patients with more nerves evaluated on nerve conduction studies also had a higher chance of undergoing an MRI, another expensive test. More research is needed to determine the optimal approach to this prevalent condition and to disseminate this information to the physicians who care for these patients.

When examining test utilization, 2 significant deviations from expected clinical practice and the tests supported by the best available evidence were discovered. The first was that a large proportion of these patients received MRIs of the brain or spine. In fact, each segment of the neuroaxis (brain, cervical, thoracic, and lumbar spine) underwent MRI at a higher-than-expected frequency. When combining all MRI tests together, utilization was even more dramatic, with nearly 1 in 4 undergoing at least 1 MRI. For a condition that affects the peripheral nervous system, this degree of utilization is substantial and suggests that many physicians have significant uncertainty when localizing neuropathy symptoms to the peripheral nervous system. The use of MRI may also result from the large proportion of patients with idiopathic neuropathy, from the fact that results of electrophysiological studies can be nondiagnostic or normal, or from patient preferences. Another possibility is that patients with neuropathy are at higher risk for other conditions or symptoms that warrant MRI.

The second deviation from expected practice is that GTTs are rarely ordered. In fact, only 1.0% of this neuropathy population received GTTs. The prevalence of impaired glucose tolerance in otherwise idiopathic patients with neuropathy is higher compared with that of historical controls, and the type of neuropathy in these patients is different (more sensory and painful neuropathies).9,10 Therefore, emerging data support impaired glucose tolerance as potentially one of the most common etiologies of neuropathy, although controversy still exists.13-15 This condition is also one of the few potentially treatable causes of neuropathy, with diet and exercise preventing a large percentage of patients from going on to develop diabetes and its inherent risk of neuropathy progression.16 One potential reason for the extremely low utilization of this test is the fact that many physicians use hemoglobin A1c levels to identify individuals with prediabetes.16 However, the cutoff point used to define prediabetes with this test has low sensitivity, and many patients in the Diabetes Prevention Program would not have been included using this criterion.17 These results indicate that 2 of the first steps in increasing the effectiveness and efficiency of the evaluation of peripheral neuropathy may be investigating why so many MRIs are ordered and determining the barriers to utilization of the GTT.

The other 3 tests supported by the AAN systematic review (fasting glucose level, B12 level, and SPEP) were ordered less frequently than expected. In fact, only 49.8% of patients with neuropathy received 1 or more of these 3 tests, and only 17.3% received 2 or more. Although some patients with peripheral neuropathy may not need these tests if they have a well-established cause, these numbers are still significantly lower than if the 25% to 40% of patients that end up with an idiopathic diagnosis were evaluated.11 B12 levels are ordered much more frequently than is SPEP, emphasizing the fact that many physicians do not recognize the evidence in support of ordering this test. Although these data were collected from a period before release of the AAN review, they highlight that physicians were not ordering the tests with the highest levels of evidence to support their use. Understanding the obstacles to the utilization of these tests will be paramount to improving the efficiency of diagnostic testing in this population.
Medicare expenditures in this population rose substantially during the diagnostic period. The expenditures decreased during 12 months of follow-up but did not return to baseline. This pattern is not surprising given the findings that patients with a new diagnosis of neuropathy undergo an extensive evaluation. These expenditures, however, may also reflect other broad expenditures related to their disabling condition, including orthotic devices, walking assist devices, office visits, and hospitalizations, to name a few. These other expenditures likely explain the persistent increase in expenditures in this population, but the transient increase in the diagnostic period is at least partially explained by costs associated with diagnostic tests. Therefore, understanding the relative impact of these tests is important in allowing physicians to practice efficient care, especially in a patient population in whom the etiology frequently remains unclear and there are few disease-modifying therapies. Future studies examining which diagnostic tests are associated with diagnostic test-related expenditures. On the other hand, the GTT, a low-yield test, is frequently performed during the diagnostic period for neuropathy. On the other hand, the GTT, the optimal test for identifying one of the most common and treatable causes of DSP (impaired glucose tolerance and diabetes), is rarely performed. The evaluation and management of peripheral neuropathy is associated with substantial increases in health expenditures. These findings indicate an important opportunity to improve the effectiveness and efficiency of the diagnostic evaluation of this prevalent disease.

In conclusion, in routine practice from 1998 to 2007, the evaluation of peripheral neuropathy involved substantial use of diagnostic tests, with wide variation in testing patterns. Magnetic resonance imaging, a costly and low-yield test, is frequently performed during the diagnostic period for neuropathy. On the other hand, the GTT, the optimal test for identifying one of the most common and treatable causes of DSP (impaired glucose tolerance and diabetes), is rarely performed. The evaluation and management of peripheral neuropathy is associated with substantial increases in health expenditures. These findings indicate an important opportunity to improve the effectiveness and efficiency of the diagnostic evaluation of this prevalent disease.

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REFERENCES

Diagnosis of Neuropathy

We Can (and Must) Do Better

Observe, record, tabulate, communicate. Use your five senses. Learn to see, learn to hear, learn to feel, learn to smell, and know that by practice alone you can become expert.

Sir William Osler

Well, if you don't look, you don't see, and what you don't see can be very hard to find!

Ms Frizzle—The Magic School Bus, “Ups and Downs”

Physicians take pride in their history and examination. We teach students that the patient always tells us what is wrong, and we marvel at the examination’s elegance. We are quick to criticize the speed with which others revert to shotgun testing rather than applying core clinical skills. However, we often fail to critically evaluate our own performance. In this issue of the Archives, Callaghan et al provide a sobering reminder of the value of such introspection.

Peripheral neuropathy is one of the most common neurologic disorders, with a prevalence of approximately 15% in individuals older than 40 years. Neuropathy is the most common microvascular complication of diabetes mellitus, and one of the most disabling. In 2003, its direct health care costs were more than $13 billion. Diagnosis is based on a history and examination demonstrating “length-dependent” numbness and sensory loss (“stocking-glove distribution”). Nerve conduction studies (NCS) are the gold standard diagnostic test. Individuals with small-fiber neuropathy have painful dysesthesias, and results of NCS are frequently normal. In this situation, skin biopsy with assessment of intraepidermal nerve fiber is often ordered. There is growing literature to guide diagnostic evaluation. The American Academy of Neurology recently published a practice guideline supporting evaluation for diabetes mellitus, vitamin B12 deficiency, and monoclonal gammopathy in all patients. Several studies indicate that patients with idiopathic neuropathy have an elevated risk of impaired glucose tolerance. Thus, patients who have a normal laboratory evaluation should undergo oral glucose tolerance testing (OGTT). These recommendations are familiar to most neurologists, but do we follow them?

Callaghan and colleagues used data from the Health and Retirement Study to examine how physicians diagnose neuropathy. The Health and Retirement Study gathered demographic data, body mass index, alcohol use, and functional abilities. These data were linked to Medicare Standard Analytic File data, permitting association of clinical information with diagnostic codes and health care utilization data. Of 12,673 Medicare patients seen between 1998 and 2006, 1031 (8.1%) had a new neuropathy diagnosis. Of these, 41.5% had diabetes. Only 19.8% underwent NCS, but nearly 1 in 4 underwent magnetic resonance imaging (MRI), most often of the brain (13.7%), followed by the lumbar (9.6%), cervical (5.0%), and thoracic (1.9%) spines. Analysis of test utilization did not reveal any single recurring diagnostic pattern. In individuals without diabetes, hemoglobin A1c level was assessed in only 17.1%, vitamin B12 in 40.6%, and serum

References:


