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VALIDATION OF ADMINISTRATIVE CODES FOR CALCIUM PYROPHOSPHATE DEPOSITION: A Veterans Administration study

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Abstract

Background—Despite high prevalence, progress in calcium pyrophosphate deposition (CPPD) has been limited by poor awareness and absence of validated approaches to study it in large datasets.

Objectives—We aimed to determine the accuracy of administrative codes for the diagnosis of CPPD as a foundational step for future studies.

Methods—We identified all patients with an International Classification of Diseases-9-common modification (ICD-9-CM) code for chondrocalcinosis (712.1–712.39) or pseudogout/other disorders of mineral metabolism (275.49), and randomly selected a comparison group with gout (274.00–03 or 274.8–9), or rheumatoid arthritis (714.0) from 2009–2011 at a VA medical center. Each patient was categorized as having definite, probable, possible CPPD or absence of CPPD based on the McCarty and Ryan criteria using chart abstracted data including crystal analysis, radiographs, and arthritis history.

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Results—249 patients met the clinical gold standard criteria for CPPD based on medical records, while 48 patients met definite criteria, 183 probable, and 18 met possible criteria. The accuracy of administrative claims with a code of 712 or 275.49 for definite or probable CPPD was: 98% sensitivity (95% CI, 96%–99%), 78% specificity (74%–83%), 91% positive predictive value and 94% negative predictive value.

Conclusions—A single administrative code 275.49 or 712 accurately identifies patients with CPPD with a positive predictive value of 91%. These findings suggest that administrative codes have strong clinical accuracy and merit further validation to allow adoption in future epidemiologic studies of CPPD.

Indexing terms

Calcium pyrophosphate; chondrocalcinosis; ICD-9-CM code; veterans; CPPD disease

INTRODUCTION

Calcium pyrophosphate deposition (CPPD) is a common but understudied form of arthritis occurring in approximately 20% of adults over age 80 [1], and contributing to nearly 25% of knee osteoarthritis in older adults [2]. Despite its high prevalence, little is known regarding CPPD epidemiology due to a lack of awareness and the absence of validated approaches to study it rigorously in large databases. CPPD can produce an acute inflammatory gout-like arthritis, formally known as pseudogout, as well as several polyarticular syndromes which may resemble uniquely-distributed osteoarthritis or rheumatoid arthritis [3]. Proper diagnosis of CPPD relies upon accurately interpreting clinical findings including subtle radiographic abnormalities such as chondrocalcinosis, and identifying small, often sparse, weakly-birefringent CPP crystals in synovial fluid. The clinical criteria of Ryan and McCarty for CPPD [4] were not updated in the recent 2011 European League Against Rheumatism (EULAR) CPPD consensus recommendations, and they remain the most widely used clinical diagnostic criteria [3]. These criteria state that a definitive diagnosis of CPPD is defined by identification of both CPP crystals from tissue or synovial fluid and typical chondrocalcinosis on radiographs, with either feature supporting a probable diagnosis.

As a result of these challenges, there are few large epidemiologic studies of CPPD [1, 5, 6] and many important questions about this common arthritis remain unanswered. For example, in contrast to gouty arthritis, relationships between renal failure and CPPD have not been fully established [6]. One key limitation to pursuing such studies lies in the difficulty of defining CPPD cases in large population or administrative cohorts. As an initial step to evaluate the feasibility of using existing databases to study this condition, we set out to determine the accuracy of the ICD9-CM diagnostic codes for CPPD compared to the “clinical gold standard” criteria in a Veterans Affairs (VA) medical center.

MATERIALS and METHODS

This study was done in accordance with privacy and human studies regulations and authorized by the local institutional review board at the Zablocki VA Medical Center,

Milwaukee, WI with waiver of informed consent. A study cohort of potential cases was created by searching outpatient and inpatient medical encounter administrative claims for ICD-9-CM codes indicating chondrocalcinosis (712.1–712.39) or pseudogout or other disorders of calcium metabolism (275.49), from the years 2009–2011 at the Zablocki VA Medical Center. Patients were included in the study if they had at least one of these codes. A convenience sample control group was selected from patients with visits in the same center and time period with codes for rheumatoid arthritis (RA) (714.0; n=67) or gouty arthritis (274.00–03 or 274.8–9; n=23, including 2 with RA and gout) for comparison.

A composite dataset was created combining cases and controls. Study physicians (KH and KP) were blinded to diagnoses codes and reviewed medical records for all patients. Medical records were reviewed from the date of the first diagnosis code encounter through all subsequent records. Using a standardized data collection form, study physicians abstracted patient age, sex, joint distribution, and presence or absence of chronic kidney disease and diabetes, and whether patients satisfied Ryan and McCarty's criteria for CPPD arthritis (Appendix 1) (4). *Definite CPPD* required documentation of arthritis and both confirmation of CPP crystals using polarizing microscopy, and radiographic evidence of chondrocalcinosis; *probable CPPD* was defined by arthritis and either crystal identification by microscopy or radiographic chondrocalcinosis. Patients with *possible CPPD* met clinical descriptions of either acute large joint/knee arthritis or chronic arthritis with atypical features. Radiographic chondrocalcinosis was considered present if documented in the radiologist's report or confirmed in review of all available joint radiographs by study physicians. We hypothesized that administrative codes will be accurate for definite or probable CPPD. Sensitivity analyses were performed for the accuracy of administrative codes for clinical definite or probable or possible CPPD.

Statistical Analyses

The accuracy of the ICD-9 diagnostic codes was compared to abstracted patient record data documenting the presence or absence of the clinical criteria. Using the clinical gold standard based upon abstraction data, we compared the accuracy of codes by analyzing the sensitivity, specificity, and positive and negative predictive values (PPV/NPV). Sensitivity was defined as the proportion of patients with the diagnosis according to the clinical criteria (clinical gold standard) that were correctly identified as positive by the ICD-9-CM code definition. Specificity was defined as the proportion of patients without the diagnosis according to the clinical standard that were correctly identified as negative by the ICD-9-CM code definition. PPV and NPV were defined as the proportion of patients with (or without) the diagnosis by data definition that met (or did not meet) the diagnosis according to the clinical gold standard. The kappa coefficient was used to describe agreement (beyond chance) between the clinical chart review diagnosis (clinical gold standard) and the ICD-9-CM code definitions. Analysis utilized SPSS version 20.

RESULTS

Overall 249 of the 337 patients met the clinical gold standard criteria for CPPD disease, based upon supporting clinical data abstracted from medical records. The mean age was 73

+/−12.2 years and 98% were men in this VA cohort (Table 1). 26% had comorbid diabetes and 34% had chronic kidney disease (CKD). All patients had arthritis, 64% had chondrocalcinosis, and 39% had morphologically identifiable CPP crystals on synovial analysis. The knees were the most commonly involved joints followed by wrists. At least one code for chondrocalcinosis (712.1–712.39) was present in 85 patients (34%), and 164 patients (66%) had a code for pseudogout/other disorders of calcium metabolism (275.49). In total, 48 patients met definite criteria, 183 probable, and 18 met possible criteria for CPPD.

Sensitivity of these ICD-9-CM codes for definite or probable CPPD was 98% (96%, 99%) (Table 2). Twenty three patients had a code for CPPD, but did not meet criteria for definite or probable CPPD reducing specificity to 78% (74%, 83%). Overall the PPV of the codes was 91% (88%, 94%) compared to the clinical gold standard for definite/probable CPPD. The NPV was 94% (92%, 97%) compared to clinical definite or probable CPPD. Among 88 controls, 5 patients (4 with rheumatoid arthritis and 1 gout) had clinical evidence of CPPD based on radiographic chondrocalcinosis yet lacked an ICD-9-CM code. No control patients had prior synovial fluid CPP crystal documentation. Kappa agreement between the codes and documented clinical criteria for definite or probable CPPD was excellent at 0.78. Sensitivity analyses examining the accuracy of administrative codes for CPPD disease with clinical gold standard being definite, probable or possible CPPD were similar to the main analyses (Table 2).

DISCUSSION

The present work demonstrates that the administrative ICD-9-CM codes currently used for CPPD were both sensitive and specific for CPPD in this VA population. Strong positive and negative predictive values lend further support to the validity of using administrative codes to identify CPPD cases. These data suggest that this code search strategy may be applied to larger studies of the VA national database or other cohorts to identify CPPD cases and perform future epidemiologic association studies.

Interestingly, a minority of patients in our study satisfied criteria for definite CPPD and most fell into the probable category. Much of this was related to cases with radiographic findings without synovial fluid crystal confirmation. This is particularly important given recent EULAR recommendations to require crystal diagnosis and questioning the role of chondrocalcinosis in CPPD diagnosis, citing low specificity (29%) in a 1975 series of 18 patients with gold standard crystal evaluation. [7, 8] Although EULAR authors stopped short of formally proposing new diagnostic criteria, we believe the role of chondrocalcinosis merits further evaluation. While prior studies have demonstrated poor sensitivity of radiographic chondrocalcinosis (~40% of CPPD cases) [9], others have also questioned the single aspirate sensitivity (60%) and inter-observer reliability of crystal examination for CPPD [10]. No large contemporary study has re-examined the specificity of chondrocalcinosis. In our study fewer than 40% of cases had prior crystal proven diagnosis versus 64% with chondrocalcinosis. Given that aspiration has even lower utilization in the community (<5% in community gout cases [11]), we believe it would be a mistake to remove chondrocalcinosis from diagnostic classification criteria without more evidence.

Nevertheless, these data suggest that even in a center with readily available rheumatologists and trained lab technicians, arthrocentesis with crystal review is under-utilized.

Use of CPPD diagnosis codes to detect cases may be contrasted with use of diagnostic codes in other health conditions and other strategies to capture physician diagnosed CPPD cases. Compared to previous VA administrative claim validation studies in RA [12, 13] and spondyloarthropathy [14] which demonstrated strongest coding accuracy only with multiple codes, here a single CPPD code had strong positive predictive value. This contrasts with a VA study that noted low specificity of two ICD-9 codes for gout (≤36%) versus standard classification criteria [15]. When coded by rheumatologists however, ICD-9 codes for gout were supported 73% of the time. We speculate that the CPPD codes are typically used by rheumatologists or other specialists who are familiar with this disease, and thus mis-coding would be infrequent, increasing the specificity and sensitivity of the single CPPD codes compared to other diseases. A recent epidemiology report from The Health Improvement Network in the UK captured CPPD cases based upon any general practitioner's diagnosis of CPPD using automated text searching [6], although this was not compared to gold standard clinical diagnostic criteria.

While this study was designed to assess validity of administrative codes to identify CPPD cases and not designed to investigate the epidemiologic associations of CPPD, it was reassuring that basic characteristics of CPPD cases were as expected. The CPPD population was older than controls (mean 73.3+/−12.2 v. 66.1 +/−11.8 years old) consistent with higher reported CPPD rates in older populations [16]. The knees and wrists were commonly involved joints as expected. While CPPD gender ratios are reportedly nearly 1:1 in most studies [4] the large majority of men in both the CPPD (98%) and non-CPPD (93%) groups likely reflects Veteran demographics in affected age groups. We did observe slightly more frequent diabetes (26% v. 21%, p=0.25) and chronic kidney disease (35% v. 31%, p=0.4) in CPPD cases compared to controls, though this did not reach statistical significance. Overall, small sample size and lack of multivariable analyses limit firm conclusions regarding clinical associations.

The strengths of this work include the use of a structured abstraction for clinical gold standard CPPD criteria in both suspected CPPD cases and randomly selected controls, and application of multiple statistical measures to evaluate ICD-9-CM code validity. Limitations of our study include the use of a single VA medical center which may not be generalizable to non-VA health care settings. There were differences in the age groups between the controls and the CPPD subjects including older age in potential CPPD subjects which might have reduced false positives, but this is unlikely to strongly influence results. The main purpose of our study was to examine the validity of these ICD-9-CM codes using gold standard clinical definitions in a VA system. Likely many prevalent cases of CPPD go undiagnosed clinically and by ICD-9-CM coding. OA for instance, is often present or discussed but not coded with sensitivity of 32% in general practice [17]. Overall, although ICD searches likely miss some CPPD cases, we found that codes at our center were generally accurate when used. Findings should be replicated in other settings recognizing that this study was performed in a center with a special interest in CPPD. Lab technicians at this VA were well versed in identifying CPPD crystals given active collaboration of site

rheumatologists. In usual care settings published technician accuracy has been questionable [18–20]. While distinctions of this site may limit generalizability, the unique collaborative diagnostic process in this setting may also support similar models for improving CPPD diagnostic accuracy.

In summary, presence of a single code 275.49 or 712 is an accurate method to identify patients with clinically definite or probable CPPD with a positive predictive value of 91%. Studies in additional cohorts, including other VA facilities, will further validate the accuracy of the CPPD codes. Future investigations are planned including national or population-based descriptions of key clinical characteristics and disease associations for this common and understudied arthritis.

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Appendix 1. Diagnostic Criteria for CPPD disease

Diagnostic criteria*
I. Demonstration of CPP crystals, obtained by biopsy, necropsy or aspirated synovial fluid, by definitive means.
II. A. Identification of monoclinic or triclinic crystals showing a weakly positive, or a lack of birefringence by compensated polarized light microscopy.
B. Presence of typical calcifications on radiographs.
III. A. Acute arthritis, especially of knees or other large joints with or without concomitant hyperuricemia.
B. Chronic arthritis, especially of knee, hip, wrist, carpus, elbow, shoulder, and metacarpophalangeal joints, particularly if accompanied by acute exacerbations; the chronic arthritis shows the following features helpful in differentiating it from osteoarthritis.
1.Uncommon site for primary osteoarthritis.
2.Radiographic appearance.
3.Subchondral cyst formation.
4.Severe progressive degeneration, with subchondral bony collapse (microfractures), and fragmentation, with formation of intraarticular radiodense bodies.
5.Variable and inconstant osteophyte formation.
6.Tendon calcifications, especially of Achilles, triceps and obturator tendons.
7.Involvement of the axial skeleton with subchondral cysts of apophyseal and sacroiliac joints, multiple levels of disc calcification and vacuum phenomenon and sacroiliac vacuum phenomenon.
Categories
A. Definite – criteria I or II (A) and II (B) must be fulfilled
B. Probable – criteria IIA or IIB must be fulfilled

Diagnostic criteria[*]
C. Possible – criteria IIIA or IIIB should alert the clinician to the possibility of underlying CPPD deposition

[*] Rosenthal AK, Ryan LM. In Arthritis and Allied Conditions. Koopman, WJ (Ed) (14th edition). Philadelphia: Williams and Wilkins pg. 2348–71, 2001.

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Key points

1. CPPD codes had a high positive predictive value (91%) for definite/probable clinical CPPD.
2. Future studies should validate CPPD codes elsewhere facilitating national analyses of this understudied arthritis.

Table 1

Characteristics of cohort meeting clinical criteria for definite, probable or possible CPPD (n=249)

Characteristic	Frequency n (%)
Age, mean (SD)	73.3 (12.2)
Male gender	245 (98%)
Diabetes	87 (35%)
Renal disease	65 (26%)
Patients with CPP crystals	96 (39%)
Knee alone	39 (15%)
Wrist alone	25 (10%)
Other/Multiple	32 (14%)
Patients with chondrocalcinosis	159 (64%)
Knee alone	87 (35%)
Wrist alone	7 (3%)
Other/Multiple	69 (26%)
Patients with acute arthritis	166 (67%)
Knee alone	40 (16%)
Wrist alone	12 (5%)
Other/Multiple	114 (46%)
Patients with chronic arthritis	208 (84%)
Knee alone	39 (16%)
Wrist alone	2 (1%)
Other/Multiple	167 (67%)

Abbreviations: SD=Standard Deviation; CPP=Calcium Pyrophosphate

Table 2

Accuracy of a CPPD code compared to clinical criteria for definite, probable or possible CPPD

Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	Kappa (95% CI)
Definite or Probable CPPD (n=231/337)				
0.98 (0.96, 0.99)	0.78 (0.74, 0.83)	0.91 (0.88, 0.94)	0.94 (0.92,0.97)	0.78 (0.73, 0.87)
Definite or Probable or Possible CPPD (n=249/337)				
0.98 (0.96, 0.99)	0.94 (0.92, 0.97)	0.98 (0.96, 0.99)	0.94 (0.92, 0.97)	0.92 (0.87, 0.97)

Abbreviations: PPV= Positive Predictive Value; NPV=Negative Predictive Value; CI=Confidence Interval