



# Development and Validation of Case-Finding Algorithms to Identify Prosthetic Joint Infections after Total Knee Arthroplasty

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## BACKGROUND AND STUDY AIM

- Total knee arthroplasties (TKAs) are one of the most common elective surgeries in the US and prosthetic joint infection (PJI) is an infrequent but dreaded adverse outcome, with high morbidity for patients
- Electronic health databases could serve as valuable sources of information to study the epidemiology of PJIs following TKA
  - Potentially large, representative, and well characterized study samples
  - Longitudinal follow-up
- To study the epidemiology of PJIs, methods to identify these events within the data sources must be developed and validated
- To address this need, we determined the ability of case-finding algorithms consisting of ICD-9 or ICD-10 hospital discharge diagnosis codes and procedure codes, in combination with relevant Current Procedural Terminology (CPT) codes, to identify cases of PJI

## METHODS: STUDY DESIGN

- Study design: Cross-sectional study
- Data source: Electronic health record (EHR) data from the Veterans Health Administration (VHA)
  - Largest integrated health care system in the US
  - Data from all ambulatory, ED and hospital encounters including:
    - Demographics
    - ICD-9, ICD-10 diagnostic codes, procedure codes
    - Laboratory and microbiology results, pathology reports
    - Dispensed medications
    - Hospital notes, hospital discharge summaries, operation reports

## METHODS: ALGORITHM AND PATIENT SELECTION

- Algorithms developed with these four requirements:
  - Hospital discharge ICD-9 or ICD-10 diagnosis of PJI (any position) recorded between January 1, 2000 and October 31, 2020
  - TKA ICD-9, ICD-10 or CPT procedure code any time prior to the PJI diagnosis
  - CPT code for a knee X-ray  $\pm$  90 days from the PJI diagnosis date; and
  - CPT code for either arthrocentesis, arthrotomy, blood culture or unlisted microbiologic culture  $\pm$  90 days from the PJI diagnosis date.
- Patients selected for validation: Stratified sampling method by site annual TKA volume
  - Sample of 80 patients meeting criteria for ICD-9-based algorithm, and 80 patients meeting criteria for ICD-10 based algorithm

## METHODS: PROSTHETIC JOINT INFECTION DEFINITION

- A PJI event was confirmed if the patient met the clinical case definition for definite or probable PJI below, adapted from the Musculoskeletal Infection Society and International Consensus Group 2013 definitions for PJI:

Definite Prosthetic Joint Infection	Probable Prosthetic Joint Infection
<p><u>One</u> of the following criteria present during admission or <math>\leq</math>30 days prior:</p> <ul style="list-style-type: none"> <li>Two positive periprosthetic cultures with phenotypically identical organisms</li> <li>A sinus tract communicating with the joint</li> </ul> <p><b>OR</b></p> <p><u>Three or more</u> the following findings present during admission or <math>\leq</math>30 days prior:</p> <ul style="list-style-type: none"> <li>Serum C-reactive protein of <math>\geq</math>10 mg/L (or <math>\geq</math>1.0 mg/dL) AND erythrocyte sedimentation rate <math>\geq</math> 30 mm/hr</li> <li>Synovial fluid white blood cell count of <math>\geq</math>3,000 cells/<math>\mu</math>L OR + or ++ change on leukocyte esterase test strip</li> <li>Synovial fluid polymorphonuclear neutrophil percentage of <math>\geq</math>80%</li> <li>&gt;5 neutrophils per high power field in 5 high power fields (x400) or acute inflammation reported on pathology</li> <li>A single positive synovial fluid culture</li> </ul>	<p><u>Two or more</u> of the following present during admission or <math>\leq</math> 30 days prior:</p> <ul style="list-style-type: none"> <li>Serum C-reactive protein of <math>\geq</math>10 mg/L (or <math>\geq</math> 1.0 mg/dL) AND erythrocyte sedimentation rate <math>\geq</math> 30 mm/hr</li> <li>Synovial fluid white blood cell count of <math>\geq</math>3,000 cells/<math>\mu</math>L OR + or ++ change on leukocyte esterase test strip</li> <li>Synovial fluid polymorphonuclear neutrophil percentage of <math>\geq</math>80%</li> <li>&gt;5 neutrophils per high power field in 5 high power fields (x400) or acute inflammation reported on pathology</li> <li>A single positive synovial fluid culture</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Prescription for antibiotic at time of PJI event, for minimum of 4-week course</li> </ul>

## METHODS: CONFIRMATION OF OUTCOMES & STATISTICS

- Electronic medical record data hosted by the VHA were abstracted onto structured forms using REDCap
- Abstraction forms independently reviewed by two infectious diseases clinicians to determine if criteria for PJI occurred (recorded as definite, probable or no event). Disagreement on classification resulted in review by the third infectious diseases clinician to arbitrate the event
- Calculated the PPV with 95% CI of the ICD-9 and ICD-10-based algorithms separately for confirmed definite or probable PJI.
- Calculated percent agreement between two adjudicators, using weighted kappa (weight 0.8 for agreement for disagreement between definite and probable, weight 0.0 for agreement for disagreements between no event and either definite or probable)

## RESULTS

- PPVs (with 95% CIs) of algorithms to identify prosthetic joint infection among Veterans with TKAs:

ICD Version	No. Adjudicated as Having PJI	PPV <sup>†</sup> (95% CI)	Reasons for Lack of Algorithm Adjudication (No.)
ICD-9	60	75.0% (64.1-84.0%)	<ul style="list-style-type: none"> <li>Superficial skin/soft tissue infection (3)</li> <li>Other orthopedic infection (1)</li> <li>Non-orthopedic infection (1)</li> <li>Non-infectious complication (3)</li> <li>2nd-stage of 2-stage revision (2)</li> <li>Did not meet criteria for PJI (10)</li> </ul>
ICD-10	68	85.0% (75.3-92.0%)	<ul style="list-style-type: none"> <li>Superficial skin/soft tissue infection (3)</li> <li>Other orthopedic infection (2)</li> <li>Did not meet criteria for PJI (7)</li> </ul>

<sup>†</sup> Positive predictive value based on cases adjudicated as definite or probable events.

- The percent agreement among adjudicators was 95.63% (Kappa 0.88; p<0.0001)

## CONCLUSIONS

- Employing a combination of ICD-9, ICD-10 and CPT codes, we were able to achieve a  $\geq$ 75% PPV for confirmed PJI events following TKA procedures. These algorithms can be used in future epidemiologic studies of PJI following TKA in VHA data.

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