Infection burden in total hip and knee arthroplasties: an international registry-based perspective

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Background: Infection remains a leading cause of failure of hip and knee replacements. Infection burden is the ratio of implants revised for infection to the total number of arthroplasties performed in a given period, measuring the steady state of infection in a registry. We hypothesized infection burden would be similar among arthroplasty registries.

Methods: We evaluated publicly reported data from 6 arthroplasty registries (Australian Orthopaedic Association National Joint Replacement Registry [AOANJRR], New Zealand Joint Registry, Swedish Hip Arthroplasty Register, Swedish Knee Arthroplasty Register, National Joint Registry of England, Wales, Northern Ireland, and the Isle of Man, and the American Joint Replacement Registry) for revisions performed with an infection diagnosis over the last 6 years.

Results: The 2015 hip infection burden varied between registries from 0.76% (AOANJRR) to 1.24% (Swedish Hip Arthroplasty Register), and the unweighted average was 0.97%. In 2012, 2013, and 2014, average hip infection burden held steady at 0.87%, 0.93%, and 0.94%, respectively, higher than the preceding 2 years. The 2015 knee infection burden varied from 0.88% (AOANJRR) to 1.28% (Swedish Knee Arthroplasty Register), and the unweighted average was 1.03%. In 2012, 2013, and 2014, knee infection burden was 1.04%, 1.11%, and 1.02%, respectively. These numbers were also higher than the preceding 2 years.

Conclusions: Infection burden may be one measure of the overall success in registry populations as well as monitoring the steady state of infection worldwide. Despite global efforts to reduce postoperative infection, infection burden has actually increased in the selected registries over time.

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A recent study by McGrory et al. [9] evaluated the concept of revision burden for THA and TKA across total joint registries worldwide. They found that the revision burden for THA had decreased over a 4-year period, but had remained relatively constant for TKA.

Although there has been a decline in revision surgeries for loosening and wear over time, periprosthetic joint infection (PJI) rates have not improved, resulting in PJI becoming one of the most common modes of failure in THA and TKA [5,6]. Studies project that revision for PJI will dramatically increase over the next two decades.[4,7,8]. A recent study by McGrory et al. [9] evaluated the concept of revision burden for THA and TKA across total joint registries worldwide. They found that the revision burden for THA had decreased over a 4-year period, but had remained relatively constant for TKA.

Infection burden was defined as the ratio of the total number of revisions due to infection to the total number of arthroplasties (primaries and revisions) performed in 1 year. Infection burden was calculated for the last 6 years or since registry inception. Designation as an infection-related revision or removal of components was based on the specific criteria and definitions of revision used by each individual registry. We sought to count a revision or removal of components for infection only once for a given infection episode when subsequent procedures were carried out on the same joint. That is, if a component exchange and debridement failed, or if a patient underwent a 2-stage procedure, these procedures were combined and counted as a single revision/removal of components for infection. We developed the following parameters for acceptable definitions for each variable analyzed.

### Material and methods

Infection burden for both hip and knee arthroplasties was calculated from publicly reported data (ie, annual reports or other reporting methods) from national hip and knee arthroplasty registries. The comparative review included 6 national registries: AOANJRR, New Zealand Joint Registry, SHAR, SKAR, National Joint Registry of England, Wales, Northern Ireland, and the Isle of Man, and the American Joint Replacement Registry [AJRR]. The secondary purpose of this study was to determine if the burden of revision for PJI has decreased over a 4-year period, but had remained relatively constant for TKA.

### Hip

- **Primary hip arthroplasty** was defined as a total hip procedure that replaces both the femoral and acetabular sides of the joint, but we excluded hip resurfacing and hemiarthroplasty.
- **Hip component revision** included all procedures, where one or more of the prosthetic components were exchanged or removed as part of either a 1-stage or 2-stage process.
- **Hip revision due to infection** was defined as any repeat or revision surgery on an existing device, where one of the diagnoses for the revision procedure included infection (per the reporting registry criteria).

### Knee

- **Primary knee arthroplasty** was defined as a total knee procedure that replaces the femorotibial articulation, and excluded unicompartmental procedures (unicondylar and patellofemoral procedures).
- **Knee component revision** included all procedures, where one or more of the prosthetic components were exchanged or removed as part of either a 1-stage or 2-stage process.
- **Knee revision due to infection** was defined as any repeat or revision surgery on an existing device, where one of the diagnoses for the revision procedure included infection (per the reporting registry criteria).

### Results

The overall results for infection burden for THA and TKA for the 6 surveyed registries are summarized in Table 1. The 2015 infection burden for THA varied from 0.76% in AOANJRR to 1.24% in the SHAR, and the unweighted average was 0.97%. In 2012, 2013, and 2014, the THA infection burden (unweighted average) held steady at 0.87%, 0.93%, and 0.94%, respectively. This is higher than the preceding 2 years (0.79% and 0.84%). Each registry with 6-year data showed an increase in infection burden for THA over the period of the survey. AOANJRR analysis excluded data for metal-on-metal THA with a head greater than 32 mm for 2013, 2014, and 2015, confounding calculation for 2013.

The 2015 infection burden for TKA varied from 0.88% in AOANJRR to 1.28% in the SKAR. The unweighted average was 1.03%. In 2012, 2013, and 2014, the knee infection burden (unweighted average) was 1.04%, 1.11%, and 1.02%, respectively. These numbers were higher than the preceding 2 years (0.88% and 0.92%). Each of the 5 registries with 6-year data demonstrated an increase in the infection burden reported for TKA over the period of the study.

### Discussion

PJI remains a leading cause of failure in THA and TKA [5,6]. The treatment of PJI is associated with substantial morbidity and
They used the term mon reason for revision TKA (25%) and third most common reason few studies have looked at burden of infection in total joint system rather than a mathematical formula. The “burden from the data presented over the 5-year span of the study burden because all reasons for revisions were listed. The infection occurred in patients with the highest severity of illness was associated with the longest hospital stay, and was the costliest of orthopaedic surgery [16]. Kurtz et al. [10] has projected that rate of PJI will continue to rise over the next 15 years and may account for up to 60% of all revisions.

Much of the focus and clinical research related to infected arthroplasty over the last decade has looked at ways to identify those patients at risk for the development of PJI and at ways to reduce the incidence by altering modifiable risk factors, improving the intraoperative environment, and defining appropriate use of prophylactic antibiotics in the perioperative period [11,12]. Despite these efforts, it is difficult to document a reduced incidence and burden of arthroplasty-related infection.

Our present study surveyed 6 international registries to determine the contemporary burden of revision performed for a diagnosis of infection. The infection burden was defined as the number of revisions performed for a diagnosis of PJI over all primary and revision total joint performed in a given year for each of the specific registries surveyed and for the overall combined total. The defined infection burden would include both early (less than 1 year) and late (beyond 1 year) infections performed on implants inserted in preceding years.

Several studies have looked at the overall incidence of PJI as a mode of failure in total joint arthroplasty [17-20]. However, very few studies have looked at burden of infection in total joint arthroplasty. Kamath et al., using the US National Impatient Sample (NIS) from 2005-2010, demonstrated that PJI was the most common reason for revision TKA (25%) and third most common reason for revision THA (15.4%) [21]. They used the term “burden”, however, as the strain placed on the surgeon, patients, and healthcare system rather than a mathematical formula. The “burden” of infection occurred in patients with the highest severity of illness was associated with the longest hospital stay, and was the costliest to the hospital system. Bozic et al. [22], using the same NIS data set as Kamath, more precisely defined a revision burden for THA and TKA as the number of revisions over the total number of primaries and revisions. From this, we were able to calculate the infection burden because all reasons for revisions were listed. The infection burden from the data presented over the 5-year span of the study (2005-2010) was 2.3% for THA and 2.4% for TKA.

We are not certain why this calculation is higher than the AJRR result from 2014 and 2015 (2014 hip—0.99, 2015 hip—0.91; 2014 knee—0.95, 2015 knee—0.85), but hypothesize that the NIS data set may include all revisions for infection, rather than only one revision per deep infection episode. If the NIS data set reports each operative procedure for the same infection episode, it would tend to explain the disparity between these two data sets because in the United States, 2-stage treatment remains common for deep PJI.

There are several limitations to reporting combined data from multiple national registries, particularly with regard to attempted comparisons between registries. There can be varying definitions of infection and related factors among the different registries (Table 2). There is a strong potential for reporting bias between registries. AJRR, using a convenience sample and with data capture from less than 50% of annual procedures nationally, has relatively few “linked revisions” in its database. A linked revision refers to a revision surgery with details of the original primary surgery also available and reported to the registry. Although the number of linked revisions reported to the AJRR has grown, it remains a fraction of all revisions recorded and thus our ability to report longitudinal data regarding the entire course of care for infected patients is limited. International registries, where reporting of data is in many cases mandatory, and greater than 90% of all arthroplasty procedures are captured, will give a much more accurate picture of the overall course of treatment. In addition, we used any revision surgery that was submitted with an International Classification of Diseases, Ninth Revision diagnosis code of infection as a presumed true infection. Although we assumed that the inclusion of an infection code would take precedence over any other diagnosis code, this could lead to relative over or under reporting of the diagnosis of PJI from some centers because of variations in coding practices. We also had no way to apply a standardized definition of PJI (from either the Musculoskeletal Infection Society or Centers for Disease Control and Prevention) to these cases so it is possible that many cases coded as PJI could have been “false positives” and thus over-reported or alternatively were not called infection when in fact they met criteria, as sometimes seen with patients referred with negative cultures, on antibiotics but with draining sinuses. Despite these limitations, we believe the concordance of data on relative rates of the infection burden across registries validate the benefits of this information for longitudinal tracking over time within a specific registry as well as between registries.

Conclusions

The infection burden is defined as the number of joint replacement revisions performed for a diagnosis of infection divided by all revision and primary total joint arthroplasties in a given period (1 year in our analysis). For both revision THA and revision TKA, the burden of infection has increased over a 6-year period. Despite efforts to optimize patients and improve preventative measures, we have not seen a decline in the infection burden across 6 international registries and periprosthetic infection remains one of the most frequent modes of failure in total joint arthroplasty worldwide.

Table 2

| Component of infection burden equation | Factors affecting component of equation |
|----------------------------------------|-----------------------------------------|
| Numerator — deep infection in joint replacement in a given period | - Population with prior primary joint surgery |
| - Population with prior revision joint surgery |
| - Criteria for surgery for infection |
| - Availability (surgeons and/or hospital) to offer revision joint surgery for infection |
| - Population life expectancy and mortality |
| - Definition of deep infection of joint replacement |
| - Numerator |
| - Criteria used for primary and revision joint surgeries (definition of surgical arthritis and failed total joint within a health system) |
| - Population with surgical arthritis and failed total joint replacement |
| - Availability (surgeons and/or hospital) to offer primary and revision joint surgeries |
| Denominator — revision and primary joint replacements in the same period | - Population life expectancy and mortality |
| - Criteria for surgery for infection |
| - Availability (surgeons and/or hospital) to offer revision joint surgery for infection |
| - Population with prior primary joint surgery |
| - Population with prior revision joint surgery |
| - Criteria for surgery for infection |
| - Availability (surgeons and/or hospital) to offer revision joint surgery for infection |
| - Population life expectancy and mortality |

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