Enterobacter: An Early-Onset Pathogen of Prosthetic Hip and Knee Infections with Poor Prognoses

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Background

- *Enterobacter sp.* is a gram-negative bacillus known for producing especially recalcitrant infections due to high antibiotic resistance.[1,2]
- The proportion of prosthetic joint infections (PJIs) due to gram-negative organisms is significantly increasing, mainly attributable to multidrug resistance.[3]
- Our primary objective is to characterize the clinical presentation, treatment, and outcomes of an emerging pathogen, *Enterobacter sp.*, in PJI.

Methods

- This is a retrospective, single-center cohort of *Enterobacter* PJI including subjects treated between 2014 and 2021.
- Demographic factors included age, sex, race, BMI, Elixhauser comorbidity score, and follow-up time.
- Clinical factors included symptoms, lab values, time to onset, microbial sensitivity, and PJI history.
- Treatment factors included index procedure, antibiotic regimen, and surgical course.
- The primary outcome is infection clearance, defined as clearance and off antibiotics for at least one year.
- Secondary outcomes included repeat infection, survival (as defined by without further antibiotics or additional surgery), and surgical course.

References
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2. Bouige A, Fourcade C, Bicart-See A, et al. Characteristics of Enterobacter cloacae prosthetic joint infections. *Med Mal Infect.* 2019;49(7):511-518.
3. Benito N, Franco M, Ribera A, et al. Time trends in the aetiology of prosthetic joint infections: a multicentre cohort study. *Clin Microbiol Infect.* 2016;22(8):732 e731-738.
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Results

- The final cohort included 23 subjects with a mean age of 65.8 years (SD: 12.5 years), mean BMI of 31.8 (SD: 6.6), and mean Elixhauser score of 8.4 (SD: 4.0).
- Median follow-up time is 2.85 years [IQR: 1.96, 3.52].
- **Demographic factors:**
  - 11 knees and 12 hips due to 76% degenerative joint disease (n=16).
- **Clinical factors:**
  - 65% acute (n=15), 17% acute hematogenous (n=4), 17% chronic (n=4).
  - Mean time to PJI diagnosis is 21 days [IQR: 17.50, 48.50].
  - 61% polymicrobial (n=14), 40% prior PJI (n=9), 83% multiple prior surgeries (n=19).
- **Treatment factors:**
  - Antibiotic regimens included 13% independent IV (n=3), 13% independent oral (n=3), 17% oral + IV (n=4), 26% oral + IV + post IV tail (n=6), 30% post IV tail (n=7).
  - 69% received oral ciprofloxacin (n=11).
  - 40% received chronic suppression (n=9).

Treatment Factor	Total N = 23	Infection Clearance, n (column %)		p-value
		Yes n = 8	No n = 15	
Index Procedure				0.400
DAIR	11 (47.80)	5 (62.50)	6 (40.00)	
2-Stage	12 (52.20)	3 (37.50)	9 (60.00)	

Table 1. Index Procedure by Infection Clearance.

Outcome	Total n=23	Index Procedure, n (column %)		p-value
		DAIR n=11	2-Stage n=12	
Reinfection	14 (60.87)	6 (54.55)	8 (66.67)	0.193
Time to Reinfection in days, median [IQR]	54.50 [21.00, 128.50]	22.00 [12.50, 40.50]	122.00 [56.00, 174.75]	0.028*

Table 2. Repeat Infection by Infection Clearance.

Outcome	Total N=23	Index Procedure, n (column %)		p-value
		DAIR n=11	2-Stage n=12	
Final Joint Outcome				<0.01*
Retained Prosthetic	5 (21.70)	5 (45.50)	0 (0.00)	
Reimplanted Prosthetic	6 (26.10)	2 (18.20)	4 (33.30)	
Destination Spacer	4 (17.40)	0 (0.00)	4 (33.30)	
Arthrodesis	2 (8.70)	0 (0.00)	2 (16.70)	
Resection Arthroplasty	4 (17.40)	4 (36.40)	0 (0.00)	
Above-Knee Amputation	2 (8.70)	0 (0.00)	2 (16.70)	
Death	6 (26.10)	2 (18.20)	4 (33.30)	0.640
Time to Death in years, median [IQR]	2.12 [1.44, 2.68]	2.51 [2.34, 2.68]	1.65 [0.95, 2.95]	0.355

Table 3. Final Outcomes by Index Procedure.

Survival Outcomes:

- One-year survival is 45.5% index DAIR, 41.7% index 2-Stage
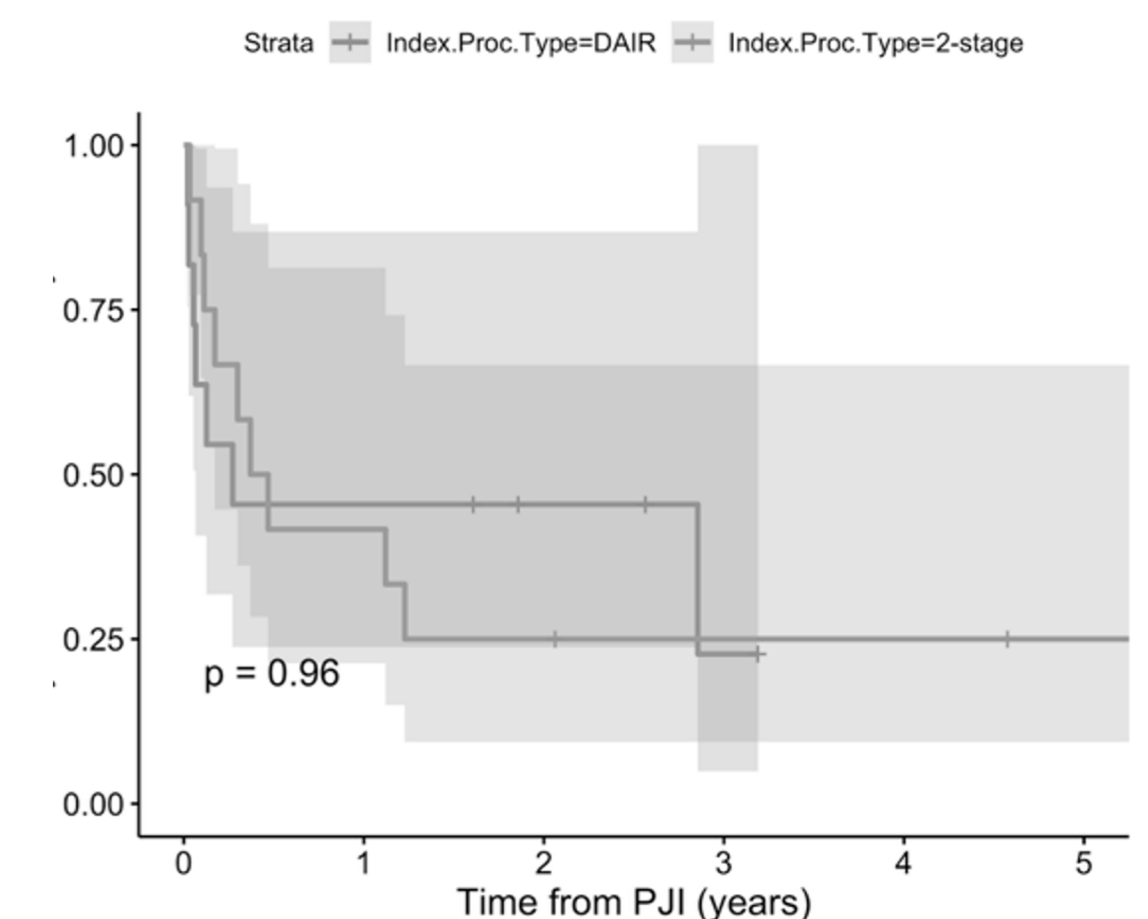- Two-year survival is 45.5% index DAIR, 25.0% index 2-Stage

Figure 1. Survival by Index Procedure.

Conclusions

- High rates of treatment failure (70%), consistent with prior studies, demonstrate the poor prognosis of *Enterobacter* PJI.[2,4]
- Patients with an index DAIR had significantly shorter time to reinfection, compared to those with an index 2-Stage.
- Final outcomes were significantly different: 64% of those with index DAIR had a final prosthetic compared to 33% of those with index 2-Stage.
- Two-year survival was 45.5% for index DAIR and 25% for index 2-Stage.