When to Choose DAIR :

Evidence-Based Approaches for Infection Resolution

NICOLAAS C. BUDHIPARAMA Jr., MD., PhD (LUMC, NL), PhD (UGM, ID), Prof

Faculty of Medicine Airlangga University – Indonesia
Leiden University Medical Centre - The Netherlands
Nicolaas Institute of Constructive Orthopaedics
Research & Education Foundation for Arthroplasty & Sports Medicine Indonesia - The Netherlands

Treatment Options
For PJI

- Antibiotics Suppression Alone
- Debridement, Antibiotics, & Implant Retention (DAIR)
- Single Stage Revision
- Two Stage Revision

Resection Arthroplasty

Arthrodesis

Amputation

One Stage Revision
in Appropriate Patients

Social and economic advantages :

- Only one operation
- Shorter hospitalization
- Earlier return to activity
- Higher satisfaction rates
- Better early function
- No price to pay in terms of reinfection thus far

Eradication rate : 83-93%

If patients are given the odds, they will choose to have a single procedure

Mostly popular in Europe

One Stage
Exchange Arthroplasty

Indications

- **Effective antibiotics**
- **No sepsis**

Relative Contraindications

- **No identified organisms**
- **Presence of sinus tract**
- **Severe soft tissue involvement which needs flap coverage**

■ ARTHROPLASTY

One-stage revision is as effective as two-stage revision for chronic culture-negative periprosthetic joint infection after total hip and knee arthroplasty

A RETROSPECTIVE COHORT STUDY

J. van den Kieboom,
V. Tirumala,
H. Box,
R. Oganesyan,
C. Klemt,
Y-M. Kwon

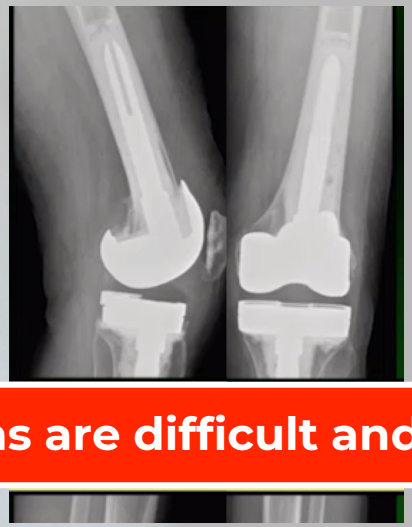
Conclusion:

One-stage revision arthroplasty demonstrated **similar outcomes including reinfection, re-revision & readmission** rates for the treatment of chronic culture-negative PJI after TKA and THA compared to two-stage revision

Culture negativity may not be a contraindication to one-stage revision

One Stage Exchange
Pitfalls

- **How radical a debridement is necessary ?**
- **Are fully cemented stems required ?**



Fully cemented stems are difficult and destructive to remove

One Stage vs Two Stage Revision

Complications - Infection

Is 2-Stage Septic Revision Worth the Money? A Cost-Utility Analysis of a 1-Stage Versus 2-Stage Septic Revision of Total Knee Arthroplasty

Charles E. Okafor, MPharm [a, b, *], Son Nghiem, PhD [c], Joshua Byrnes, PhD [a, b]

[a] Centre for Applied Health Economics, School of Medicine and Dentistry, Griffith University, Queensland, Australia
[b] Menzies Health Institute, Griffith University, Queensland, Australia
[c] Department of Health Services, Research and Policy, Australian National University, Canberra, Australia

J Arthroplasty, 2022

Single vs 2-Stage Revision for the Treatment of Periprosthetic Joint Infection

Beau J. Kildow, MD [a], Craig J. Della-Valle, MD [b], Bryan D. Springer, MD [a, *]

[a] OrthoCarolina Hip and Knee Center, Charlotte, North Carolina
[b] Department of Orthopaedic Surgery, Rush University, Chicago, Illinois

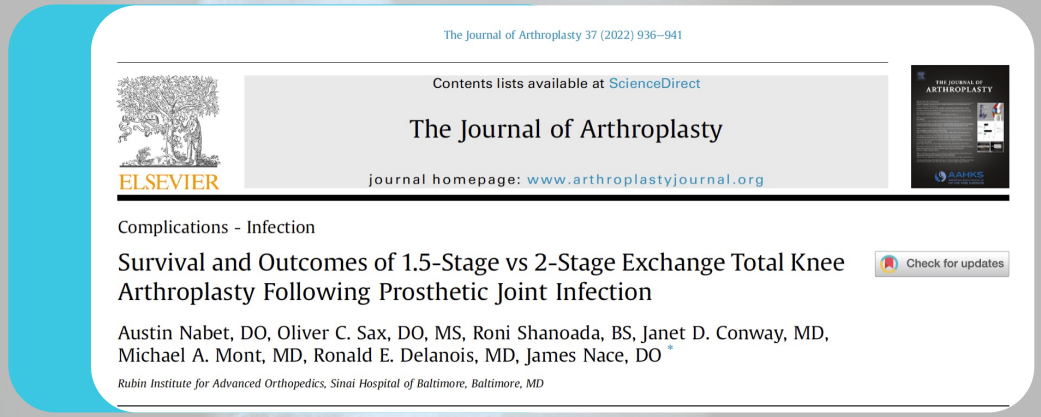
J Arthroplasty, 2020

Conclusions

The adoption of one-stage septic knee revision is the optimal choice for patients who have a PJI and who do not have a compelling need for a two-stage exchange arthroplasty

One-stage exchange for PJI should be advocated

One Stage Exchange Arthroplasty
Gaining Popularity in US



The Journal of Arthroplasty 37 (2022) 936–941

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

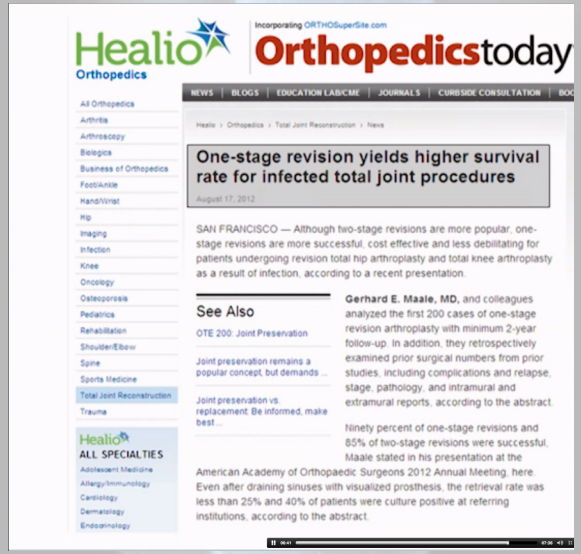
Complications - Infection

Survival and Outcomes of 1.5-Stage vs 2-Stage Exchange Total Knee Arthroplasty Following Prosthetic Joint Infection

Check for updates

Austin Nabet, DO, Oliver C. Sax, DO, MS, Roni Shanoada, BS, Janet D. Conway, MD, Michael A. Mont, MD, Ronald E. Delanois, MD, James Nace, DO *

Rubin Institute for Advanced Orthopedics, Sinai Hospital of Baltimore, Baltimore, MD



Healio Orthopedics — Orthopedicstoday

One-stage revision yields higher survival rate for infected total joint procedures

August 17, 2012

SAN FRANCISCO — Although two-stage revisions are more popular, one-stage revisions are more successful, cost effective and less debilitating for patients undergoing revision total hip arthroplasty and total knee arthroplasty as a result of infection, according to a recent presentation.

Gerhard E. Maale, MD, and colleagues analyzed the first 200 cases of one-stage revision arthroplasty with minimum 2-year follow-up. In addition, they retrospectively examined prior surgical numbers from prior studies, including complications and relapse, stage, pathology, and intramural and extramural reports, according to the abstract.

Ninety percent of one-stage revisions and 85% of two-stage revisions were successful, Maale stated in his presentation at the American Academy of Orthopaedic Surgeons 2012 Annual Meeting, here. Even after draining sinuses with visualized prosthesis, the retrieval rate was less than 25% and 40% of patients were culture positive at referring institutions, according to the abstract.

See Also

OTE 200: Joint Preservation

Joint preservation remains a popular concept, but demands ...

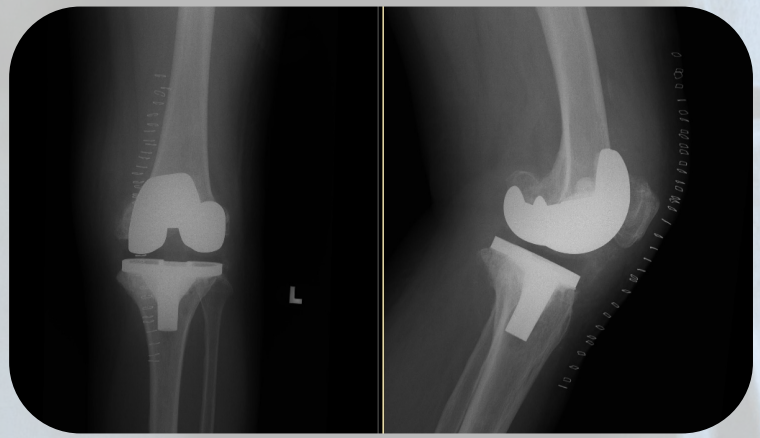
Joint preservation vs. replacement: Be informed, make best ...

A 1.5-stage exchange TKA is an effective alternative to the traditional 2-stage protocols with noninferior infection eradication and absence of radiographic complications

Question :
What Will You Do?

Two weeks post op primary TKR

- **Female, 65 years old**
- **Swollen knee, redness & warmth**
- **CRP 106, ESR 120**
- **Leukocyte 12.000**



Single Stage Revision

VS

Debridement, Antibiotics & Implant Retention (DAIR)

Timing is very important

Revision Arthroplasty **for PJI**

Significant challenge to both surgeons & patients

- **Reduce mobility & significant anesthetic**
- **Surgical risk**

Challenges for the surgeons :

- **Removing a well-fixed prosthesis**
- **Potentially compromise soft tissue envelope**
- **Difficult reconstruction**
- **Increase risk of peri / postoperative complication**

Implant retention without infection is the ideal end result of PJI treatment

Is DAIR **The Solution ?**

Clin Orthop Relat Res (2011) 469:3043–3048
DOI 10.1007/s11999-011-1910-2

SYMPOSIUM: PAPERS PRESENTED AT THE 2010 MEETING OF THE MUSCULOSKELETAL INFECTION SOCIETY

Infection Control Rate of Irrigation and Débridement for Periprosthetic Joint Infection

Loukas Koyonos MD, Benjamin Zmistowski BS,
Craig J. Della Valle MD, Javad Parvizi MD, FRCS

… performed at relatively high rates despite an inability to consistently control infection

*… the use of I&D for PJI is **still a source of controversy***

"… should be performed for acute post-op & acute delayed infections …"

Is DAIR **The Solution ?**

Why surgeons prefer DAIR?

1. **Lower morbidity**
2. **Bone preserving procedure**
3. **Reduce hospital LOS**
4. **Less technical demand than one stage / two stage**
5. **Significant decrease in economic burden**

Irrigation & Debridement **(DAIR)**

Must **decrease burden of biofilm** so perioperative antimicrobial therapy can eradicate all remaining infection

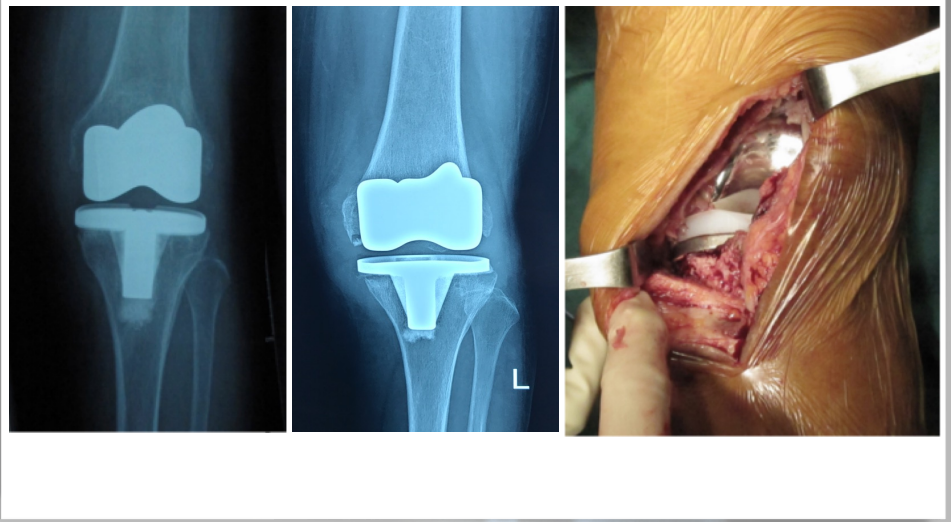
Crucial to **identify culprit agent** through aspiration prior to surgery

Antibiotics withheld until representative samples identified

Imaging Investigation
Is Very Important !!!

Rarely show evidence of infection

- **Periosteal reaction**
- **Loose implants**
- **Bone resorption may indicate compromised prosthetic stability**



DAIR on **Early PJI**

Journal of ISAKOS xxx (xxxx) xxx

Contents lists available at ScienceDirect

Journal of ISAKOS

journal homepage: www.elsevier.com/locate/jisakos

Systematic Review

Debridement, antibiotics, and implant retention (DAIR) for the early prosthetic joint infection of total knee and hip arthroplasties: a systematic review

Umile Giuseppe Longo [a,b,*], Sergio De Salvatore [a,b], Benedetta Bandini [a,b], Alberto Lalli [a,b], Bruno Barillà [a,b], Nicolaas Cyrillus Budhiparama [c], Sebastien Lustig [d]

CONCLUSIONS:

- DAIR is still considered **an effective option for early post-operative or acute hematogenous PJI**
- **Success rates** for the DAIR treatments **ranged from 55.5% up to a maximum of 90% (mean value of 71%)**
- **There are only few studies, especially RCTs, comparing DAIR with one- and two-stage revisions for early PJIs, showing a need for more high-quality research**

DAIR **Success Rate**

Highly variable due to :

- **Lack of consistency for definition of acute infection**
- **No consecutive series**
- **Multiple surgeons in a single study**

Author	Number of infected joints	Weeks to irrigation	Polyexchange performed	Retention rate
Brandt et al., 1999 [3]	33	23 pts > 4, 10 pts < 4		12 (36%)
Burger et al., 1991 [5]	39	14.3 (0.14–114.4)		7 (18%)
Chiu and Chen, 2007 [6]	40	73.7 (1.29–311.76)	40	12 (30%)
Deirmengian et al., 2003 [9]	31	104 (2.28–364)	10	11 (35%)
Mont et al., 1997 [19]	24	10 pts < 4, 14 pts 26–307	21	20 (83%) [10(100%) early infx, 10(71%) late infx]
Morrey et al., 1989 [21]	10			8 (80%)
Rasul et al., 1991 [22]	15 (6 superficial, 9 deep)	21.3 (1–156)		9 (60%) [6(100%) superficial, 3(33%) deep]
Segawa et al., 1999 [26]	41	30 pts < 4, 11 pts > 4	41	24 (59%) [23(77%) early, 1 (9%) late]
Tsukayama et al., 1996 [29]	41	< 4	41	28 (68%)

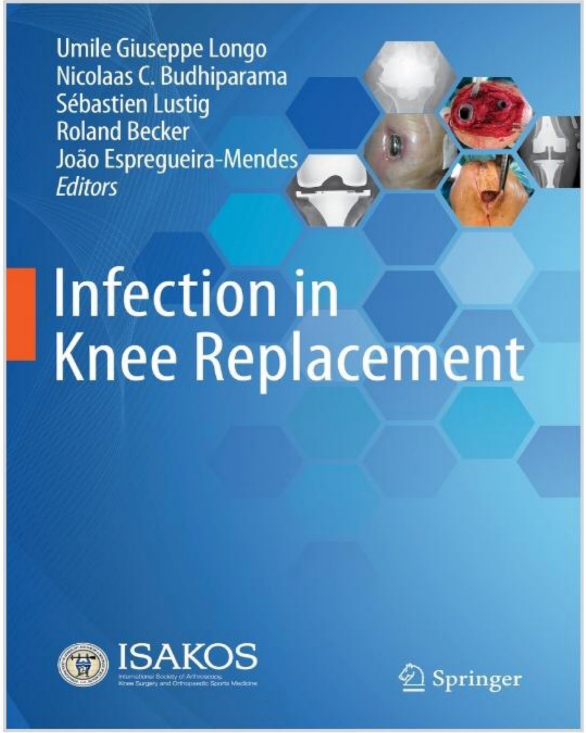
Decision to **Retain Implant**

Depends on :

- **Not immunocompromised**
- **PJI caused by low virulent organism**
- **Biofilm containment**

Crucial to eradicate biofilm within a short time frame before it attaches to the implant

Predictor of DAIR Success



Infection in Knee Replacement pp 159–170 | Cite as

DAIR (Debridement, Antibiotics, and Implant Retention) for the Treatment of Periprosthetic Joint Infection of Knee

Nicolaas C. Budhiparama, Asep Santoso, Hendy Hidayat & Nadia N. Ifran

Chapter | First Online: 14 November 2021

435 Accesses

Abstract

Prosthetic joint infection (PJI) is one of the most devastating complications following joint replacement. The primary goal of treatment is eradication of the infection. Maintenance of a pain-free, functional joint is the secondary goal, which is also important. The surgical options include irrigation, debridement, antibiotics, and implant retention with or without polyethylene exchange (DAIR), one-stage or two-stage revision, resection arthroplasty, arthrodesis, and amputation. When patients are contraindicated to undergo DAIR treatment, either one stage or multiple stages revision surgery is the preferred option. The fundamental aspects for a successful DAIR are related to tissue, stability of the prosthesis, and susceptibility of the organism. Resection arthroplasty (without reimplantation), arthrodesis, and amputation remain valid options for difficult to treat and chronic PJI, and these treatment options very rarely have a role in acute PJI cases. Non-surgical medical treatment such as antibiotic suppression therapy should be reserved for patients who are unfit or contraindicated for surgery.

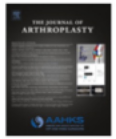
International Consensus Meeting **2018**

The Journal of Arthroplasty xxx (2018) 1–21

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org



Hip and Knee Section, Treatment, Debridement and Retention of Implant: Proceedings of International Consensus on Orthopedic Infections

Jean Noël Argenson [1], Marius Arndt [12], George Babis [1], Andrew Battenberg [2], Nicolaas Budhiparama [2], Fabio Catani [3], Foster Chen [4], Brian de Beaubien [5], Ayman Ebied [6], Silvano Esposito [7], Christopher Ferry [5], Henry Flores [3], Andrea Giorgini [3], Erik Hansen [8], K.D. Hernugrahanto [2], Choe Hyonmin [6], Tae-Kyun Kim [9], In Jun Koh [9], Georgios Komnos [10], Christian Lausmann [12], Jeremy Loloi [5], Jaime Lora-Tamayo [11,12], I. Lumban-Gaol [2], F. Mahyudin [2], Mikel Mancheno-Losa [11,12], Camelia Marculescu [9], Sameh Marei [6], Kimberly E. Martin [5], Prashant Meshram [9], Wayne G. Paprosky [4], Lazaros Poultsides [3], Arjun Saxena [3], Evan Schwechter [4], Jay Shah [8], Noam Shohat [6], Rafael J. Sierra [1], Alex Soriano [13], Anna Stefánsdóttir [10], Linda I. Suleiman [4], Adrian Taylor [9], Georgios K. Triantafyllopoulos [3], Dwikora Novembri Utomo [2], David Warren [12], Leo Whiteside [5], Marjan Wouthuyzen-Bakker [6,13,14], Jean Yombi [14], Benjamin Zmistowski [11]

Proceedings of the Second International Consensus Meeting on Musculoskeletal Infection

Chairmen:
Javad Parvizi, MD, FRCS
Thorsten Gehrke, MD

Indications for DAIR

Patients with an acute infection (<3 weeks) or acute hematogenous infection of TKA <2 weeks of onset

Well fixed and well positioned prosthesis

Good soft tissue envelope

Patients with high risk of complication in more aggressive surgery

International Consensus Meeting 2018
Predictor of DAIR success rate

Delegates:
Wouthuyzen-Bakker, Marjan
Ebied, Ayman
Hyonmin, Choe
Shohat, Noam

Editor:
Parvizi, Javad

Co-Authors: Sameh Marei

HK-111 - DAIR INDICATIONS

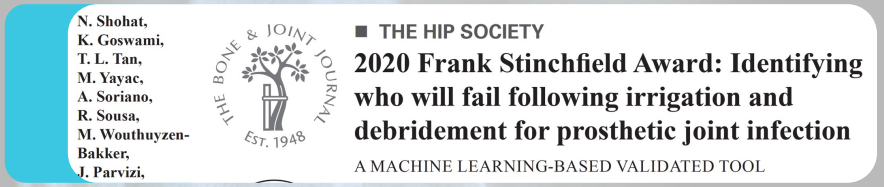
HK-111 - What are the indications and contraindications of using debridement, antibiotics, and implant retention with modular components for the management of PJI?

Rationale / Recommendation

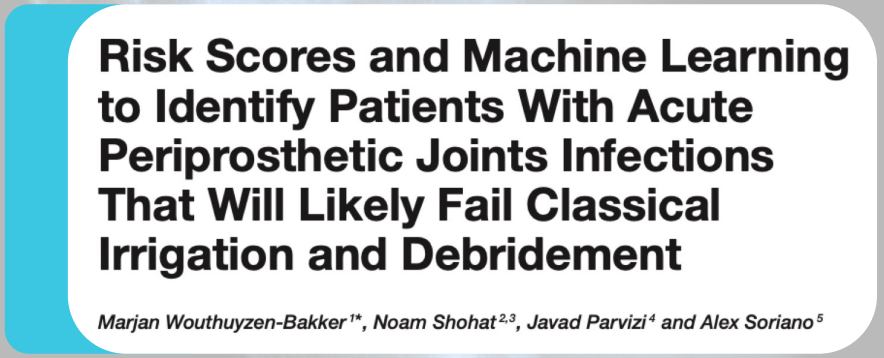
- DAIR only performed when acute PJI exists < 3 weeks
- **KLIC and CRIME80 scores may help in stratifying risk (only for DAIR patients)**
- Extending the antibiotic before debridement does not increase the chance for cure

Delegate vote : Agree 80%; Disagree 18%; Abstain 2%

AI as Predictor of DAIR Success Rate



2020



Frontiers, 2021

Conclusions

The developed algorithm provides the medical profession with a tool that can be employed in clinical decision-making and improve patient care

The use of machine learning as a tool for predicting outcomes following I&D surgery is beneficial

International Consensus Meeting **2018**

Delegates:
Koh, In Jun
Taylor, Adrian
Kim, Tae-Kyun

Editor:
Parvizi, Javad

Coauthors: Prashant Meshram

HK-23 - MODULAR EXCH & DAIR SUCCESS

HK-23 - Does exchange of all modular components during debridement, antibiotic, and implant retention (DAIR) reduce the rate of SSI/PJI recurrence?

Rationale / Recommendation

- **86% success rate with modular component exchange** & 4x increase in eradication rate
- Better visualization in the posterior knee

Delegate vote : Agree 94%; Disagree 4%; Abstain 2%

M. Gerritsen,
A. Khawar,
H. Scheper,
R. van der Wal,
J. Schoones,
M. de Boer,
R. Nelissen,
B. Pijls

From Leiden University Medical Center, Leiden, the Netherlands

BJO

■ SYSTEMATIC REVIEW

Modular component exchange and outcome of DAIR for hip and knee periprosthetic joint infection

A SYSTEMATIC REVIEW AND META-REGRESSION ANALYSIS

BJO, 2021

Conclusion

- **Study found no benefit of modular component exchange on reduction of PJI failure**
- **This suggests the effect seen after 2004 may reflect a more rigorous, evidence-based, approach to the infected implant compared to the years before**

Controversies of DAIR

1. Failure in DAIR Effecting Subsequent Revision ?

2. Antibiotic Duration ?

International Consensus Meeting **2018**

Authors: Fabio Catani, Lazaros Poultsides, Henry Flores, Andrea Giorgini, Georgios K. Triantafyllopoulos, Arjun Saxena

QUESTION 11: How many debridement, antibiotics and implant retention (DAIR) procedure(s) are acceptable in management of patients with acute periprosthetic joint infection (PJI) of a primary arthroplasty before removal of components needs to be performed?

RECOMMENDATION: After one failed DAIR procedure, strong consideration should be given to removal of components.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 86%, Disagree: 13%, Abstain: 1% (Super Majority, Strong Consensus)

After one failed DAIR procedure

- Strong consideration should be given to **removal of components**

Second DAIR
Should be Considered

The Journal of Arthroplasty 35 (2020) 2204–2209

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Complications - Infection

A Second Surgical Debridement for Acute Periprosthetic Joint Infections Should Not Be Discarded

Marjan Wouthuyzen-Bakker, MD, PhD [a, *], Claudia A.M. Löwik, PhD [b], Joris J.W. Ploegmakers, MD, PhD [b], Bas A.S. Knobben, MD [c], Baukje Dijkstra [d], Astrid J. de Vries [c], Glen Mithoe, MD [e], Greetje Kampinga, MD, PhD [a], Wierd P. Zijlstra, MD, PhD [d], Paul C. Jutte, MD, PhD [b], on behalf of the Northern Infection Network Joint Arthroplasty (NINJA)

CONCLUSION

- 455 DAIR, 144 underwent 2nd debridement, 37/144 **(25.7%) failed**
- **A second DAIR had a low failure rate** therefore, a second DAIR should not be discarded in acute PJIs

Second DAIR
Should Be Considered

Complications - Infection
The Journal of Arthroplasty 34 (2019) 1214–1220

Failed Debridement and Implant Retention Does Not Compromise the Success of Subsequent Staged Revision in Infected Total Knee Arthroplasty

Katy Kim, BSc [a], Mark Zhu, MBChB [b], Alana Cavadino, PhD [c], Jacob T. Munro, FRACS, PhD, MBChB [b], Simon W. Young, FRACS, MD, MBChB [a,*]

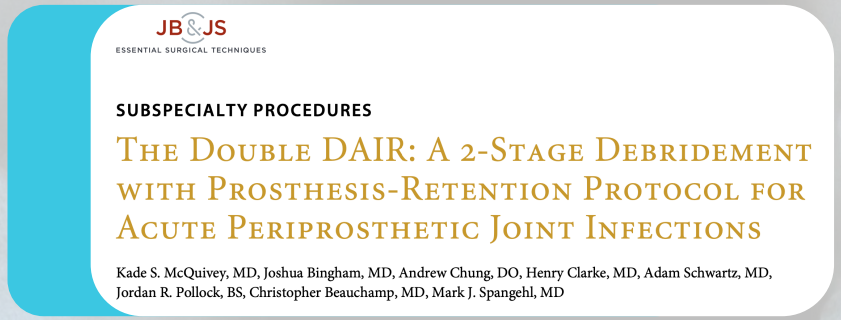
[a] Department of Orthopaedics, North Shore Hospital, Auckland, New Zealand
[b] Department of Orthopaedics, Auckland Hospital, Auckland, New Zealand
[c] Section of Epidemiology and Biostatistics, The University of Auckland, Auckland, New Zealand

- 75 patients with 2 stage rTKA, 228 with a prior I&D
- After 6.2 years, success rate 72% for I&D group vs 81% w/o I&D group

Conclusion :

Study suggested that a previously failed DAIR does not compromise the success rate of subsequent staged revision

Second DAIR
Success Rate ??



Conclusions :

Approximately 5 to 6 days later, a second debridement is performed, and the new modular, sterile components are implanted

Through debridement is key to successful infection control

International Consensus Meeting 2018

Delegates:
Lora-Tamayo, Jaime
Warren, David

Editor:
Citak, Mustafa
Frommelt, Lars

Co-Authors: Mikel Mancheno-Losa, Marius Arndt, Christian Lausmann

HK-138 - ABX AFTER DAIR

HK-138 - What is the optimal length of antibiotic treatment following debridement, antibiotics, and implant retention (DAIR) for acute PJI?

Rationale / Recommendation

6 - 8 weeks of antibiotic therapy seems to be sufficient in most PJI cases treated by DAIR

Delegate vote : Agree 91%; Disagree 9%; Abstain 1%

Antimicrobial Management
Post DAIR

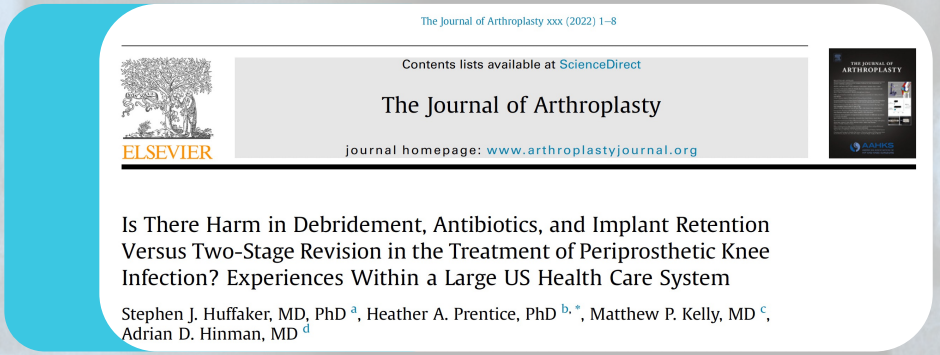
Staphylococcal Species

- 300-450 mg oral rifampicin twice daily + initial IV antibiotic
- Post IV: oral rifampicin + another antibiotics (ciprofloxacin / levofloxacin for 3-6 months for TKA

Antibiotic Duration

- **DAIR may require longer antibiotic use than in revision procedure**
- **Duration depends on the virulence of offending pathogen, the need for repeat procedures & host factors**

Experience in a
Large US Health Care System



The Journal of Arthroplasty xxx (2022) 1–8

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Is There Harm in Debridement, Antibiotics, and Implant Retention Versus Two-Stage Revision in the Treatment of Periprosthetic Knee Infection? Experiences Within a Large US Health Care System

Stephen J. Huffaker, MD, PhD [a], Heather A. Prentice, PhD [b, *], Matthew P. Kelly, MD [c], Adrian D. Hinman, MD [d]

Although DAIR had a higher risk of septic re-revision, ***they failed to observe a difference in risk following DAIR-F when compared to those who initially underwent 2-stage revision***

Do it for the right reason – NOT because it is easier

DAIR vs Two Stage Revision
in PJI Less Than 12 Weeks

A comparsion study between debridement, antibiotics, and implant retention and two-stage revision total knee arthroplasty for the management of periprosthetic joint infection occurring within 12 weeks from index total knee arthroplasty

Yanchao Zhang[1,2,3†], Zhisen Gao[2,3†], Ti Zhang[2,3,4], Yu Dong[2,3,4], Zhuoqi Sheng[1,2,3], Fei Zhang[1,2,3], Yonggang Zhou[2,3*] and Lingfei Guo[2,5*]

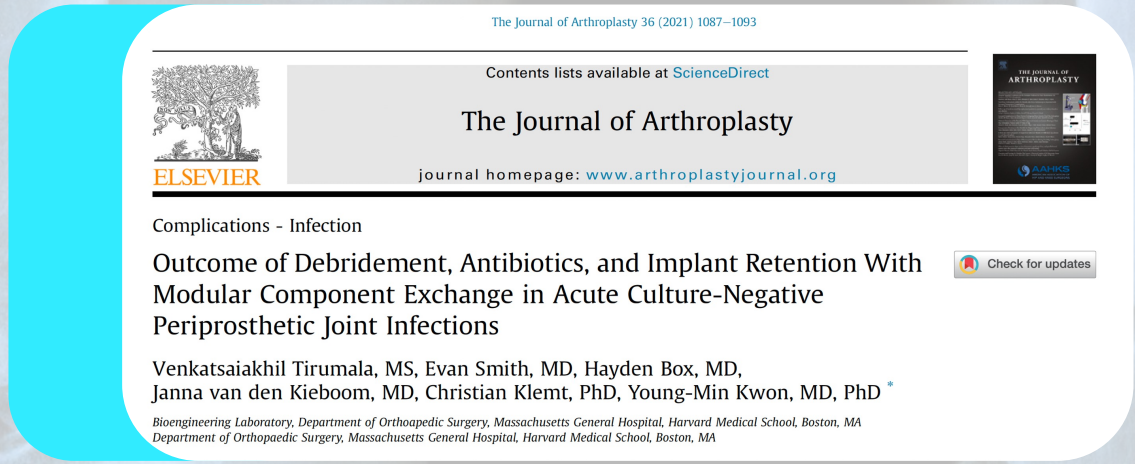
JOSR, 2022

DAIR demonstrated comparable effectiveness with two-stage rTKA

DAIR as a choice for patients with current infection within 12 weeks after primary TKA

For MRSA and fungal infections, two-stage rTKA might be preferred

DAIR in **Acute Culture Negative**



The Journal of Arthroplasty 36 (2021) 1087–1093

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Complications - Infection

Outcome of Debridement, Antibiotics, and Implant Retention With Modular Component Exchange in Acute Culture-Negative Periprosthetic Joint Infections

Venkatsaiakhil Tirumala, MS, Evan Smith, MD, Hayden Box, MD, Janna van den Kieboom, MD, Christian Klemt, PhD, Young-Min Kwon, MD, PhD *

Bioengineering Laboratory, Department of Orthoapedic Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, MA
Department of Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, MA

- **7% - 23% of PJIs have been reported to yield negative culture results**
- DAIR for acute culture-negative PJI was associated with similar reinfection rates compared to acute culture-positive PJI, **suggesting that culture negativity may not be a contraindication to DAIR in patients with acute PJI**

Take Home Message

Lack of International Consensus for DAIR

Comparing DAIR with one-stage and two-stage revision protocols in the setting of early PJIs, there is a lack of studies, in particular randomized control trials (RCTs), reflecting the necessity to conduct further high-quality studies to face the burden of early PJI

No international consensus has been reached regarding the best approach for early prosthetic knee and hip infections

Thank You For Your Attention

AAHKS AMERICAN ASSOCIATION OF HIP AND KNEE SURGEONS
APA ASIA PACIFIC ARTHROPLASTY SOCIETY
ASEAN Arthroplasty Association 2007
AAOS AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS
Asia Pacific Orthopaedic Association 1962
EFORT
Arthroplasty Society in Asia
ICJR
European Knee Society