



Programme and abstracts

35<sup>th</sup> annual meeting of the  
**European  
Bone and Joint  
Infection Society**

---

1-3 September 2016  
Oxford · United Kingdom



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## **EBJIS Conference Secretariat**

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# Welcome

**Dear colleagues,**

It is a great honour to host and organise the 35th Annual Meeting of the European Bone and Joint Infection Society in Oxford, United Kingdom, 1-3 September 2016.

The conference will be held in the historic Examination Schools in the centre of Oxford which we believe will give you a great opportunity to enjoy the city while also experiencing an interesting and stimulating conference. You will be able to visit many of the famous attractions in Oxford and we have arranged social events in prestigious venues around the city and University.

This year the conference will focus on patient management and particularly on how we can improve treatment and outcomes for these unfortunate people. The programme will be provided with keynote lectures, free paper sessions, industry symposia and posters. We hope the scientific programme will be of value to increase your knowledge, improve your future clinical work and build your friendships in the Society.

And last, but not least we would like to send a special thank you to all our industry partners and exhibitors for sponsoring the meeting. Without them this conference would not have been possible.

On behalf of the local organising committee and the EBJIS board,

**Klaus Kirketerp-Møller**, President of EBJIS

**Martin McNally**, Local Chair and Vice President of EBJIS





# Committees

## EBJIS Executive Committee

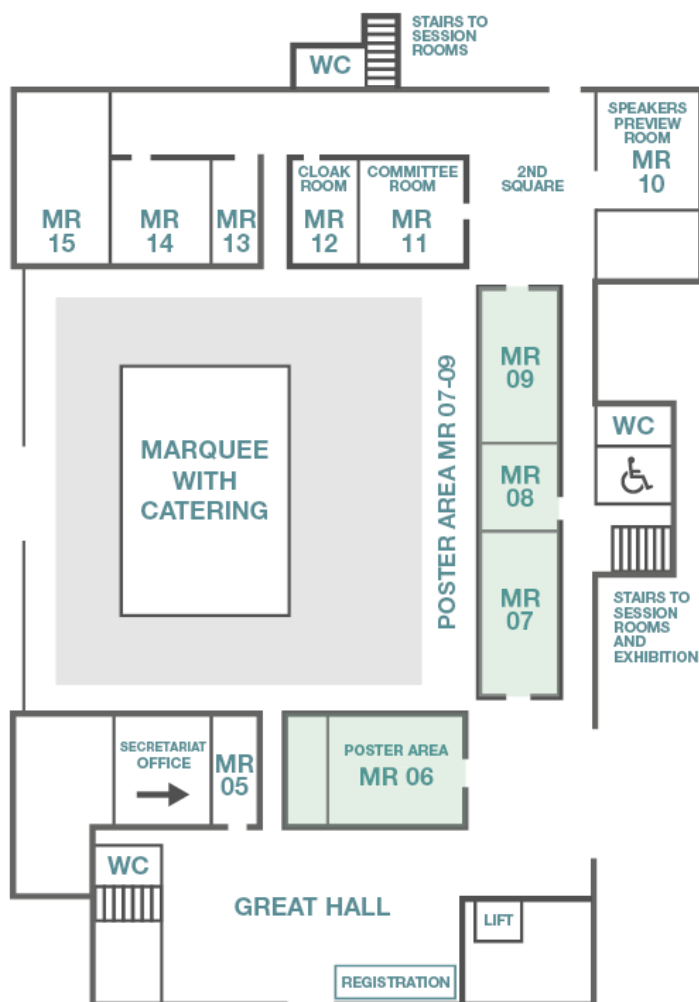
|                          |   |
|--------------------------|---|
| <b>President</b>         | Klaus Kirketerp-Møller                                  |
| <b>Vice President</b>    | Martin McNally  |
| <b>Past President</b>    | Heinz Winkler   |
| <b>General Secretary</b> | Charles Vogely  |
| <b>Treasurer</b>         | Olivier Borens  |
| <b>Members</b>           | Alex Soriano<br>Lorenzo Drago                           |
| <b>Associate Members</b> | Carlo Romano<br>Konstantinos Malizos<br>Christof Wagner |

## Local Organising Committee

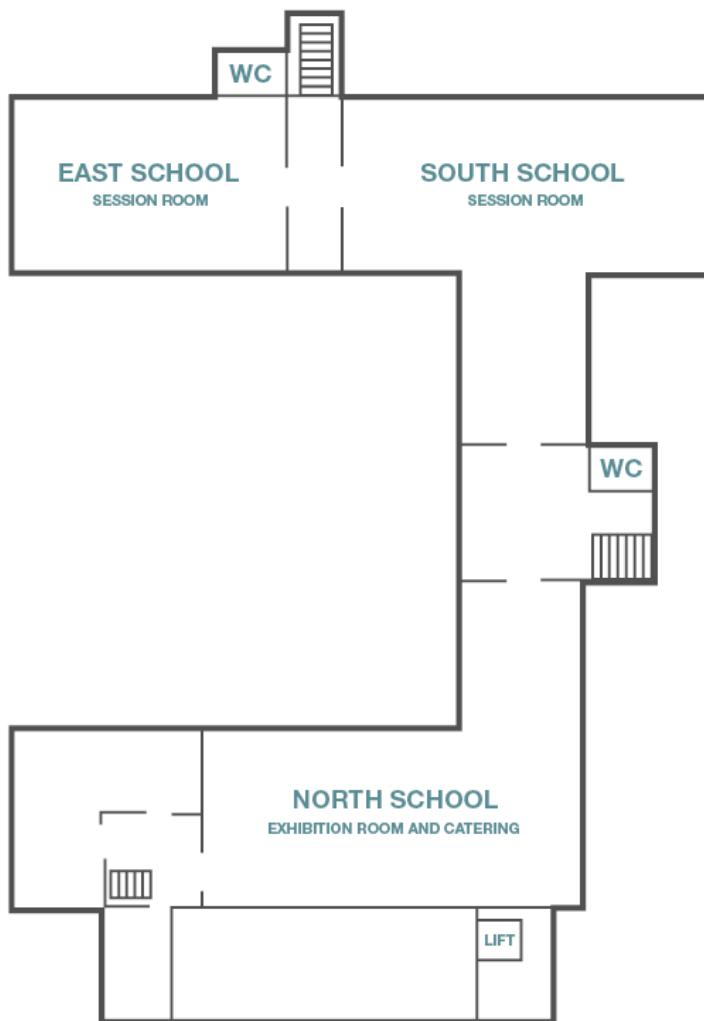
|                |   |
|----------------|---|
| <b>Chair</b>   | Martin McNally  |
| <b>Members</b> | Bridget Atkins<br>Andrew Brent<br>Fares Haddad<br>Elham Khatamzas<br>Jose Lomascabeza<br>Rhidian Morgan-Jones<br>Alex Ramsden<br>Matthew Scarborough<br>Adrian Taylor |

# Floor plan of venue

## GROUND FLOOR



## FIRST FLOOR



# General information

## Conference venue

### Examination Schools

University of Oxford  
75-81 High Street  
Oxford, OX1 4BG  
United Kingdom

### Badges

The conference name badges must be worn at all times during the conference. Access to the conference venue will not be granted without the name badge issued by the conference organisers.

### Entitlements for participants

Admission to all scientific sessions and industry symposia, admission to exhibition, conference bags with final programme and abstract book, CME credits, coffee breaks and lunch, Welcome reception Thursday 1/9, and Farewell high tea Saturday 3/9.

### CME credits

The conference has been granted 15 European CME credits (ECMEC) by the European Accreditation Council for Continuing Medical Education (EACCME). Participants who wish to apply for CME credits should go to the registration desk to confirm their attendance each day. The certificate will be issued after the conference.

### Conference app

Download the conference app to your mobile device. Search for “EBJIS 2016” in your app store. You will be able to view the day-by-day programme, select sessions, and make your own agenda. All accepted abstracts will be published in the app.

### Cloak room and storage

A cloak room and storage deposit located on the ground floor (Room 12) will be available throughout the conference.

## Conference language

English.

## Information for Speakers

Please bring your presentation to the technician in the auditorium in due time before your presentation. Please bring your presentation on a USB stick. At the end of the conference, all presentations will be deleted in order to secure that no copyright issues will arise.

## Social events

### Welcome reception on 1 September 2016

The welcome reception will take place at the Museum of Natural History in Oxford at 18.15-19.45.

Oxford University Museum of Natural History  
Parks Road  
Oxford, OX1 3PW

### Gala dinner on 2 September 2016

The gala dinner will take place at the charming Balliol College in the Balliol Hall at 19.30-23.00. NB: There are no more tickets available for the gala dinner.

Balliol College  
Broad Street  
Oxford, OX1 3BJ





## About Oxford

- Oxford is the city where Penicillin was discovered and first used
- It has one of the oldest Universities in Europe, starting in the 11th Century
- Oxford was one of the sites for the filming of the Harry Potter Films

There are many beautiful sights to explore while in Oxford. But we would recommend you to visit The Bodleian Library with its beautiful Gothic architecture, the Botanic Garden which is situated on the banks of the River Cherwell and The Ashmolean Museum which is one of the finest and oldest museums within Great Britain. Admission to the museum is free.



### The Examination Schools

Built between 1876 and 1882 and designed by Sir Thomas Jackson, this historical Grade II listed venue was created to house the University of Oxford's examinations. The venue was not only intended to be used for examinations, but the site played host to the first of many ceremonial events to be held there; a grand concert in the presence of the Prince of Wales.

The Examination Schools, however, have seen more than just the grandeur of royal concerts: during both the second and first World Wars the Schools served as a military hospital. Proof of this lies in the basement of the building where signs reading "resuscitation room" may still be seen.

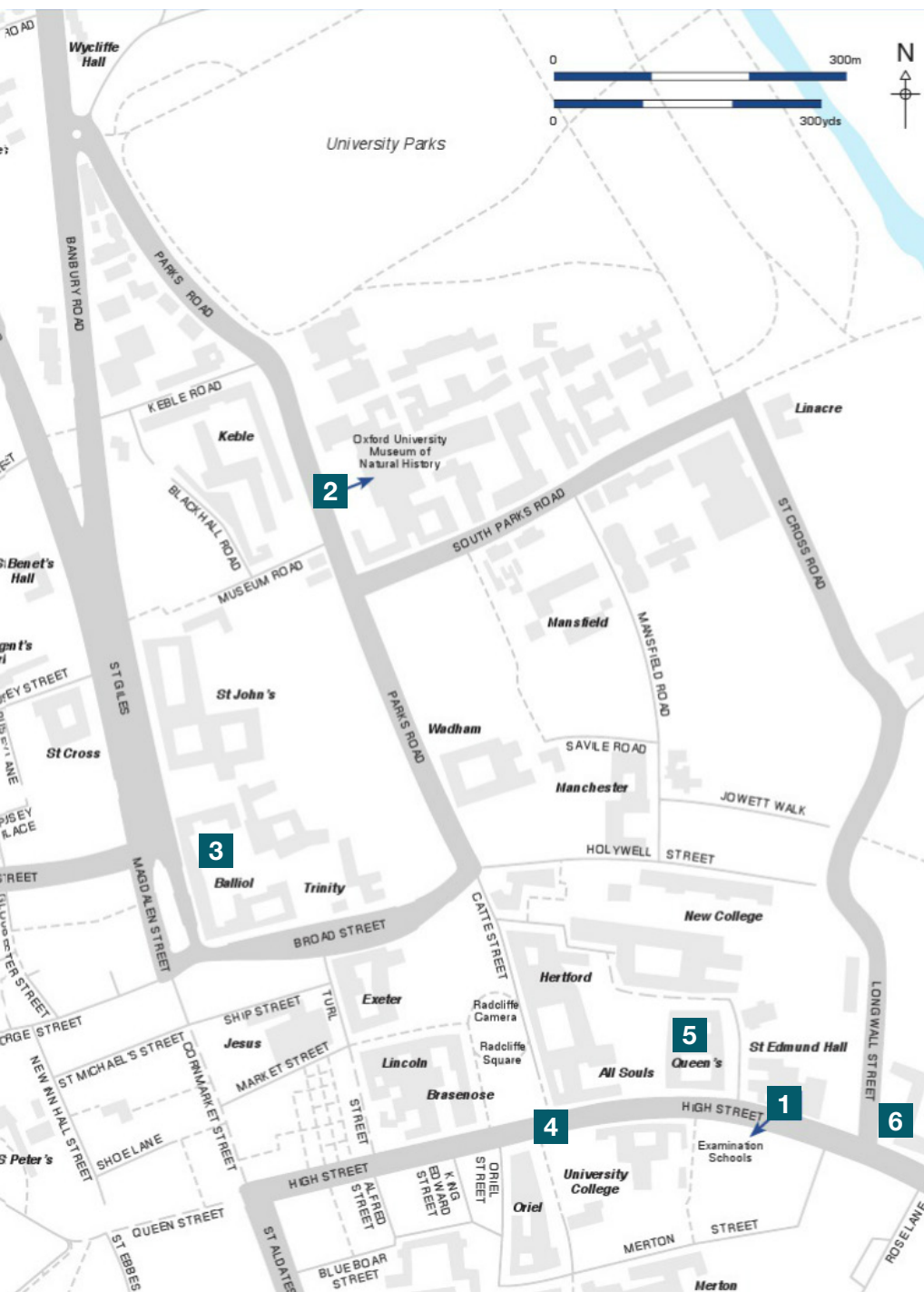
Today the Examination Schools fulfil their primary purpose as an examination centre for the University and each year in June, almost twelve hundred undergraduates every day sit their exams in one of the grand exam halls. During the rest of term, the Schools house several lectures for subjects as well as being rented out for conferences and exhibitions.



# Map of Oxford

- 1 Conference Venue**  
Examination Schools  
75-81 High Street  
Oxford, OX1 4BG
- 2 Welcome Reception**  
Museum of Natural History  
Parks Road,  
Oxford, OX1 3PW
- 3 Gala Dinner**  
Balliol College  
Broad Street  
Oxford, OX1 3BJ
- 4 Old Bank Hotel**  
92-94 High Street  
Oxford OX1 4BJ  
United Kingdom
- 5 Queen's College**  
High Street  
Oxford OX1 4AW
- 6 Magdalen College**  
Oxford OX1 4AU





| Time | Abs. | Title | Speaker |
|------|------|-------|---------|
|------|------|-------|---------|

## Room: South School

## 7.00 Registration

|             |  |         |  |
|-------------|--|---------|--|
| 08:15-08:30 |  | Welcome |  |
|-------------|--|---------|--|

Opening Ceremony

Martin McNally (Local Chair)  
Klaus Kirketerp-Møller  
(President, EBJIS)

|             |  |   |   |
|-------------|--|---|---|
| 08:30-09:30 |  | <b>Key session 1: Where are we in Bone and Joint Infection?<br/>Society Supported Session, Supported by the British Infection Association</b> | <b>Chairs:</b><br>Bridget Atkins & Charles Vogely |
|-------------|--|---|---|

|    |   |                  |
|----|---|------------------|
| 01 | Experimental studies on infection after osteosynthesis  | Fintan Moriarty  |
| 02 | Prospects for whole genome sequencing for diagnostics   | David Eyre       |
| 03 | Interactions between staphylococci, osteoblasts and osteoclasts<br>– what do we know in 2016? | Frédéric Laurent |

|             |  |  |   |
|-------------|--|--|---|
| 09:30-10:40 |  | <b>Key session 2: Prosthetic Joint Infection<br/>Society Supported Session, Supported by the British Hip Society</b> | <b>Chairs:</b><br>Fares Haddad (President BHS) &<br>Matthew Scarborough |
|-------------|--|--|---|

|    |   |                  |
|----|---|------------------|
| 04 | Introduction to the scale and cost of the problem and direction of travel | Fares Haddad     |
| 05 | Biofilm biology and novel therapies in PJI                                | Jason Webb       |
| 06 | Antibiotic delivery in cementless revision                                | Edward McPherson |
| 07 | DAIR – role and limitations   | Roger Gundle     |

## 10:40-11:15 Coffee break, posters and exhibition

|             |  |   |  |
|-------------|--|---|--|
| 11:15-12:45 |  | <b>Free Papers A</b><br>(6 min + 2 min) | <b>Chairs:</b><br>Heinz Winkler & Roger Gundle |
|-------------|--|---|--|

|     |  |                         |
|-----|--|-------------------------|
| 08  | Early surgical debridement in patients with suspected acute infection after hip or knee arthroplasty – safe, effective and without negative functional impact          | Luís Barros             |
| 09  | Early prosthetic joint infection after total hip arthroplasty  | Kjersti Kaul Jenssen    |
| 010 | The unsuspected prosthetic joint infection: the incidence and consequences of positive intraoperative cultures in presumed aseptic knee and hip revisions              | Anouk Jacobs            |
| 011 | Survivorship and function of massive endoprostheses used in the management of peri-prosthetic joint infections around the hip and knee                                 | Abtin Alvand            |
| 012 | Normalization of inflammatory parameters between two stage revision of infected prosthesis are not predictive of success – is it still reasonable to continue to wait? | Pedro Barreira          |
| 013 | Alpha-defensin test* for evaluation of periprosthetic joint infection  | Irene Katharina Sigmund |
| 014 | Alpha Defensin immunoassay for diagnosing PJI. A prospective study   | Akos Zahar              |
| 015 | Agreement between preoperative joint aspiration results and causative pathogens in patients with prosthetic hip and knee infections treated with a two-stage revision  | Peter Declercq          |
| 016 | Is there a relationship between perioperative positive cultures or positive leukocyte counting during exchange arthroplasty and postoperative infections?              | Marta Ginesta Serrano   |
| 017 | Commercially pure dissolvable antibiotic beads: a clinical review of 756 cases of periprosthetic joint infection and aseptic revision arthroplasty                     | Edward McPherson        |
| 018 | Multidrug resistant bacteria: an independent predictor of failure in periprosthetic joint infection  | Scott Evans             |





| Time                      | Abs. | Title   | Speaker   |
|---------------------------|------|---|---|
| <b>Room: South School</b> |      |   |   |
| <b>12:45-14:00</b>        |      | <b>Lunch<br/>Industry Symposium A, 12:50-13:50</b>  | <i>More information on pp. 22-23</i>              |
| <b>14:00-15:10</b>        |      | <b>Key session 3:<br/>Infection Networks and Registries</b>   | <b>Chairs:</b> Rhidian Morgan-Jones & Guenter Lob |
|                           | 030  | What can the registers tell us about infection and what can they not tell us?   | Lars Engaeseter                                   |
|                           | 031  | The UK perspective on regional infection networks and the fledgling Bone and Joint Infection Registry   | Mike Reed   |
|                           | 032  | Certification Process of MSI Units in Europe - key-factors - corner-stones - limits   | Andreas Tiemann                                   |
|                           | 033  | How can we learn from own mistakes? The urgent need for standardized diagnostic criteria and outcome definition of prosthetic joint infection                           | Andrej Trampuz                                    |
| <b>15:15-15:50</b>        |      | <b>Rapid Fire Papers 1</b><br>(3 min + 2 min)   | <b>Chairs:</b> Simon Warren & David Stubbs        |
|                           | 034  | Synovial calprotectin; a rapid test to diagnose a prosthetic joint infection  | Marjan Wouthuyzen-Bakker                          |
|                           | 035  | Prospective, randomized comparison of one- versus two-stage bursectomy for moderate to severe septic bursitis   | Benjamin Lipsky                                   |
|                           | 036  | Comparison of knee arthrodesis with Knee Arthrodesis Nail System and Femoro-Tibial Nail combined with ALAC spacer as salvage therapy for infected knee with bone defect | Ireneusz Babiak                                   |
|                           | 037  | A calcium sulphate / hydroxyapatite bone graft substitute eluting gentamicin in the treatment of diabetic foot osteomyelitis: a mid-term follow-up                      | Christine Whisstock                               |
|                           | 038  | Risk reduction on PJI with S. Aureus eradication therapy in THA   | Adriaan Thomas                                    |
|                           | 039  | Evaluation of the current trends and management of spinal infection   | Stefanie Andrew                                   |
|                           | 040  | Results of treatment of septic arthritis of the hip with an antibiotic-loaded cement spacer   | Ernesto Muñoz-Mahamud                             |
| <b>15:50-16:20</b>        |      | <b>Coffee break, posters and exhibition</b>   |   |
| <b>16:20-17:20</b>        |      | <b>Key Session 4:<br/>Perioperative Care of the Infected Patient</b>  | <b>Chairs:</b> Mike Reed & Matthew Scarborough    |
|                           | 048  | Optimisation of the infected patient prior to surgery   | Alex Soriano                                      |
|                           | 049  | Anaesthesia for complex bone infection patients: keep it simple   | Svetlana Galitzine                                |
|                           | 050  | Good mental health for good physical outcomes: how we can help  | Matthew Hotopf                                    |
| <b>17:20-17:45</b>        |      | <b>Ciorny &amp; Mader Lecture</b>   | <b>Chair:</b> Martin McNally                      |
|                           | 051  | Crossing Borders in Bone and Joint Infection Management   | Carlo Romano                                      |
| <b>18:15-19:45</b>        |      | <b>Welcome Drinks, Natural History Museum</b>   |   |
| <b>20:00</b>              |      | <b>Industry Sponsored Dinners, Free Evening</b>   |   |

| Abs. | Title  | Speaker  |
|------|--|--|
|      | <b>Room: East School</b>   |  |
|      | <b>Lunch<br/>Industry Symposium B, 12.50-13.50</b>   | <i>More information on pp. 24-25</i>                     |
|      | <b>Linked to South School</b>  |  |
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|      |  |  |
|      | <b>Rapid Fire Papers 2</b><br>(3 min + 2 min)  | <b>Chairs:</b> Frederic Laurent & Klaus Kirketerp-Møller |
| 041  | Theatre door opening as a marker of theatre discipline and infection control: are standards slipping?  | Scott Parker   |
| 042  | Influence of delay and temporary preservation conditions of bacteriological tissue samples on the diagnosis of bone infection: an experimental model       | Olivier Cornu  |
| 043  | The influence of titanium and steel fracture fixation plates with different surface topographies on infection rates in a rabbit fracture model             | Willem-Jan Metsemakers                                   |
| 044  | Application of next generation sequencing for the diagnosis of orthopaedic infection; an evaluation of four DNA extraction techniques                      | Leanne Cleaver   |
| 045  | Cost-to-benefit evaluation of antibiofilm microbiological diagnostic techniques in orthopaedics  | Maria Teresa Trentinaglia                                |
| 046  | Varying degrees of biofilm inhibition by gentamicin, vancomycin and daptomycin loaded acrylic cement: an in vitro model of cement periprosthetic infection | Herbert Gbejuade   |
| 047  | Can we rely on histopathological results for the diagnosis of prosthetic joint infection?  | Camille Fourcade   |
|      | <b>Coffee break, posters and exhibition</b>  |  |
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| Time                      | Abs. | Title   | Speaker   |
|---------------------------|------|---|---|
| <b>Room: South School</b> |      |   |   |
| <b>7.45</b>               |      | <b>Registration</b>   |   |
| <b>08:15-09:15</b>        |      | <b>Key Session 5:<br/>Soft-tissue Management in MSK Infections<br/>Society Supported Session, Supported by British Association of Plastic,<br/>Reconstructive and Aesthetic Surgeons (BAPRAS)</b> | <b>Chairs:</b><br>Alex Ramsden & Umraz Kahn           |
|                           | 052  | Improving outcomes in open fractures  | Umraz Kahn  |
|                           | 053  | Using perforator flaps to cover defects with Chronic Osteomyelitis  | Joon Pio Hong   |
|                           | 054  | Role of Plastic Surgeon in prosthetic joint infection   | Alex Ramsden  |
| <b>09:20-10:20</b>        |      | <b>Key Session 6:<br/>Optimizing Outcomes in Osteomyelitis</b>  | <b>Chairs:</b> Andrew Brent & Geert Walenkamp         |
|                           | 055  | Preoperative assessment and planning in the management of post-traumatic osteomyelitis  | Charalampos Zalavras                                  |
|                           | 056  | Patient-friendly surgery in Osteomyelitis   | Martin McNally  |
|                           | 057  | From diagnostics to discharge planning: Getting It Right First Time   | Bridget Atkins  |
| <b>10:20-10:30</b>        |      | <b>2015 Travelling Fellowship Report</b>  | Martins Malzubris                                     |
| <b>10:30-11:00</b>        |      | <b>Coffee break, posters and exhibition</b>   |   |
| <b>11:00-12:30</b>        |      | <b>Free Papers C<br/>(6 min + 2 min)</b>  | <b>Chairs:</b> Charalampos Zalavras & Christof Wagner |
|                           | 058  | Costs and remuneration of osteomyelitis treatment involving free flaps: implications of return to theatre   | Janka Fazekas   |
|                           | 059  | Antibiotic resistance profiles of surgical site infections in hip hemiarthroplasty; comparing low dose single antibiotic versus high dose dual antibiotic impregnated cement                      | Ben Tyas  |
|                           | 060  | Prophylactic effect of an injectable hydroxyapatite / calcium sulphate biocomposite eluting antibiotic in the treatment of open fractures with plate  | Damiano Papadia                                       |
|                           | 061  | Treatment of chronic osteomyelitis of the lower limb with a new injectable, vancomycin-loaded, calcium sulfate / hydroxyapatite composite   | Martin Glombitza                                      |
|                           | 062  | Radiographic and histological analysis of a synthetic bone graft substitute eluting gentamicin in the treatment of chronic osteomyelitis: a retrospective study in humans                         | Michael Diefenbeck                                    |
|                           | 063  | AB-cemented interlocking in infected non-unions of lower extremity: 5 years follow-up   | Oleg Bondarev   |
|                           | 064  | External fixation using a locking plate: a reliable way in treating distal tibial post-traumatic osteomyelitis  | Zhao Xie  |
|                           | 065  | Novel calcium phosphate antibiotic carrier for bone healing with slow release properties  | Siddhesh Angle  |
|                           | 066  | Is an antibiotic-loaded hydrogel coating able to reduce early post-surgical infection after internal osteosynthesis?  | Carlo Romanò  |
|                           | 067  | Efficacy of negative pressure wound treatment (NPWT) in the management of septic trauma cases   | Laszlo Gergely Nöt                                    |
|                           | 068  | Management of infectious fractures with "cement-plate complex" (CPC) method   | Zhao Xie  |



| Time                      | Abs. | Title   | Speaker   |
|---------------------------|------|---|---|
| <b>Room: South School</b> |      |   |   |
| <b>12:30-13:45</b>        |      | <b>Lunch<br/>Industry Symposium C, 12.35-13.35</b>  | More information on pp. 26-27                     |
| <b>13:45-14:45</b>        |      | <b>Key Session 7:<br/>Treatment Approaches to PJI</b>   | <b>Chairs:</b> Adrian Taylor & Simon Warren       |
|                           | 080  | Treatment strategies in PJI of the Hip  | Jason Webb  |
|                           | 081  | The role of the ID Physician in treatment of PJI  | Parham Sendi                                      |
|                           | 082  | Patient-adapted treatment of an infected TKA: a Swiss Algorithm   | Olivier Borens                                    |
| <b>14:45-15:20</b>        |      | <b>Free Papers E<br/>(6mins+2mins)</b>  | <b>Chairs:</b> Jason Webb & Olivier Borens        |
|                           | 086  | Antibiotic prophylaxis not indicated for dental procedures in patients with joint prostheses: a new Dutch guideline   | Geert Walenkamp<br>(9 mins +2 mins)               |
|                           | 087  | Functional Outcome of Debridement, Antibiotics and Implant Retention (DAIR) in hip peri-prosthetic joint infection - a case – control study                                   | Marie-Ève Bolduc                                  |
|                           | 088  | Incise draping* is protective against surgical site contamination during hip surgery: a prospective, randomized trial   | Antonia Chen                                      |
|                           | 089  | Prosthetic joint infections in Australia and New Zealand: the first 275 patients from the PIANO (Prosthetic joint Infection in Australia and New Zealand Observational) study | Joshua Davis                                      |
| <b>14:45-17:15</b>        |      | <b>Country Delegates Meeting, Room 11</b>   | Christof Wagner                                   |
| <b>15:20-16:10</b>        |      | <b>Coffee break, posters and exhibition</b>   |   |
| <b>16:10-17:25</b>        |      | <b>Free Papers G<br/>(6mins+2mins)</b>  | <b>Chairs:</b> Charles Vogely & Chema Lomascabeza |
|                           | 094  | Inpatient systemic sepsis alert systems do not demonstrate utility after joint arthroplasty   | Antonia Chen                                      |
|                           | 095  | Diagnosis of persistent infection in prosthetic two-stage exchange: PCR analysis of sonication fluid from bone cement spacers   | Sandrine Mariaux                                  |
|                           | 096  | Intraoperative microbiological investigation in prosthetic joint infections – sonication brings added value but is not a substitute for traditional sampling                  | Pedro Neves                                       |
|                           | 097  | Stability over 6 weeks of antibiotics in aqueous solution at body temperature with and without initial heat treatment mimicking curing bone cement                            | Peter Wahl  |
|                           | 098  | Hydrogel impregnation of bone chips allows prolonged cefazolin release  | Guy Putzeys                                       |
|                           | 099  | Radiographic remodeling patterns of a gentamicin-eluting hydroxyapatite / calcium sulfate biocomposite. Preliminary results from a large animal model                         | Werner Hettwer                                    |
|                           | 0100 | Postoperative infections after arthroscopic rotator cuff repair. Treatment and results in a prospectively registered cohort   | Kjersti Kaul Jenssen                              |
|                           | 0101 | Internalization of Propionibacterium acnes by osteoblasts depends on P. acnes genetic background  | Guillaume Aubin                                   |
| <b>17:20-18:45</b>        |      |   |   |
| <b>19:30-23:00</b>        |      | <b>EBJIS Gala Dinner in Balliol College<br/>(welcome drinks at 19.30, dinner at 20.00)</b>  |   |



| Abs. | Title  | Speaker  |
|------|--|--|
|      | <b>Room: East School</b>   |  |
|      | <b>Lunch<br/>Industry Symposium D, 12.40-13.40</b>   | More information on pp. 28-29                  |
|      | <b>Key Session 8:<br/>Infection in the Foot &amp; Ankle</b>  | <b>Chairs:</b> Mark Rogers & Elham Khatamzas   |
| 083  | Diagnosing diabetic foot osteomyelitis: contentious or consensus?  | Benjamin Lipsky                                |
| 084  | The management of diabetic foot chronic osteomyelitis with flaps   | Joon Pio Hong                                  |
| 085  | Internal Pedal Amputations   | Armin Koller                                   |
|      | <b>Free Papers F<br/>(6mins+2mins)</b>   | <b>Chairs:</b> Armin Koller & Ben Lipsky       |
| 090  | Photodynamic therapy as an antimicrobial technique targeting bacterial strains common to orthopaedic infections  | Simon Hislop                                   |
| 091  | Audiovisual distraction as an adjunct to epidural anaesthesia in "awake" patients undergoing complex surgery for osteomyelitis                                 | Martin McNally                                 |
| 092  | Periprosthetic fungal infections, outcomes and predictive factors  | Manpreet Sidhu                                 |
| 093  | Can sonication challenge aseptic vs PJI barrier  | Boštjan Kocjancic                              |
|      |  |  |
|      | <b>Coffee break, posters and exhibition</b>  |  |
|      | <b>Free Papers H<br/>(6mins+2mins)</b>   | <b>Chairs:</b> Lorenzo Drago & Geertje Govaert |
| 0102 | Calcium sulfate induced membrane in a rat femur critical-sized defect model: characteristics and differences from PMMA induced membrane in Masquelet technique | Yun-fei Ma                                     |
| 0103 | The role of preoperative asymptomatic bacteriuria in the development of periprosthetic joint infection of the hip  | Gábor Skaliczki                                |
| 0104 | Indium -111 white-cell SPECT CT scan: an emerging imaging modality with great potential in bone and joint infection  | D'jon Lopez                                    |
| 0105 | Rifampin combination therapy in early staphylococcal prosthetic joint infections: a randomized controlled trial  | Øystein Espeland Karlsen                       |
| 0106 | Post traumatic osteomyelitis of the femur or tibia: an evaluation of the clinical outcome, functional outcome, and quality of life                             | Khairul Rizal Zayzan                           |
| 0107 | Monitoring the incidence of prosthetic joint infections in a complication registry   | Tina Strømndal Wik                             |
| 0108 | Activity of a gentamicin-loaded bone graft substitute against different bacterial biofilm by microcalorimetry  | Maria Eugenia Butini                           |
| 0109 | Utility of gene expression pattern of Toll-like receptors and IL-1/IL1R family for assessment of periprosthetic joint infection in total joint arthroplasty    | Jiri Gallo                                     |
|      | <b>General Assembly</b>  |  |
|      |  |  |

| Time               | Abs. | Title  | Speaker  |
|--------------------|------|--|--|
| Room: South School |      |  |  |
| 09:00-10:15        |      | <b>Key Session 9:<br/>Diagnosis and Imaging in Bone &amp; Joint Infection</b>  | <b>Chairs:</b> Andrew Brent & Christof Wagner                          |
|                    | 0110 | Post traumatic osteomyelitis, pitfalls and best practices in nuclear medical imaging   | Geertje Govaert  |
|                    | 0111 | Ultrasound and MRI in the diagnosis of paediatric osteomyelitis  | James Teh  |
|                    | 0112 | Orthopaedic device related infection: time for a culture change?   | Andrew Brent   |
|                    | 0113 | The most reliable laboratory tests for PJIs: have we achieved a golden standard?   | Lorenzo Drago  |
| 10:15-10:45        |      | <b>Coffee</b>  | <b>Posters/Exhibition</b>  |
| 10:45-12:25        |      | <b>12 Best Papers</b><br>(6 min + 2 min)<br><b>Judges:</b> Klaus Kirketerp-Møller, Charles Vogely, Bridget Atkins, Christof Wagner   | <b>Poster Judges:</b><br>David Stubbs, Mike Reed, Konstantinos Malizos |
|                    | 0114 | Infected bone tissue decreases the penetration of cefuroxime   | Louise Kruse Jensen  |
|                    | 0115 | Infection after fracture fixation of the tibia: analysis of healthcare utilization and related costs   | Willem-Jan Metsemakers   |
|                    | 0116 | Post-operative blood glucose levels predicts PJI after primary total joint arthroplasty  | Antonia Chen   |
|                    | 0117 | Antibiotic-loaded hydrogel coating to prevent early post-surgical infection after joint arthroplasty. Results from a multi-center European trial   | Carlo Romano   |
|                    | 0118 | Patient-reported quality of life and hip function after revision of total hip arthroplasty due to chronic periprosthetic joint infection - an analysis of one-stage and two-stage revision | Ninna Rysholt Poulsen  |
|                    | 0119 | Low incidence of P.acnes on the skin of patients undergoing primary shoulder arthroplasty  | Lluís Puig Verdie  |
|                    | 0120 | Single-stage treatment of chronic osteomyelitis with a gentamicin-loaded, calcium sulphate / hydroxyapatite biocomposite: a prospective series of 100 cases                                | Martin McNally   |
|                    | 0121 | Vancomycin displays time dependent eradication of mature Staphylococcus aureus biofilms  | Peter Wahl   |
|                    | 0122 | Adaptation of vancomycin-intermediate Staphylococcus aureus to intracellular compartment leading to bacterial reservoir responsible for chronic infection                                  | Frédéric Laurent   |
|                    | 0123 | Synovial fluid testing for the diagnosis of prosthetic joint infection – improving its diagnostic accuracy with simple and inexpensive biomarkers  | Pedro Serrano  |
|                    | 0124 | Operating room ventilation and risk of revision due to infection after primary total hip arthroplasty  | Håkon Langvatn   |
|                    | 0125 | Treatment concept and complication management in spinal infections with and without acute spinal cord injury (aSCI)  | Martin Kreutzträger  |
| 12:25-12:40        |      | <b>Closing Remarks &amp; Prizes</b>  | Martin McNally<br>Klaus Kirketerp-Møller                               |
| 12:40-14:00        |      | <b>Farewell High Tea</b>   |  |



Poster overview

Oral abstracts

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Welcome



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<sup>1</sup>Mirano et al. Osteotomy of Distal Radius Fracture Malunion Using a Fast Remodeling Bone Substitute Consisting of Calcium Sulfate and Calcium Phosphate. J Biomed Mater Res Part B: Appl Biomater 93B: 281–286, 2010  
Bark et al. Case Report: Arthroscopic-Assisted Treatment of a Reversed Hill-Sachs Lesion: Description of a New Technique Using Cerament. Case Reports in Orthopedics, Volume 2015, Article ID 789203, 5 pages.  
Kaczmarczyk et al. Complete twelve month bone remodeling with a bi-phasic injectable bone substitute in benign bone tumors: a prospective pilot study. BMC Musculoskeletal Disorders (2015) 16:369.

<sup>2</sup>McNally et al. A comparative study of three bioabsorbable antibiotic carriers in chronic osteomyelitis: 313 patients with minimum one-year follow-up. 34th European Bone and Joint Infection Society (EBJIS) Annual Meeting 2015. Free paper #135 podium presentation.



# Industry sponsored symposium A

Thursday 1 September 2016

Room: South School

## BONESUPPORT Industry Symposium

**12.50 - 13.50**     *Meet the Experts:*  
*Challenging cases in bone infections*

**Expert Panel**     Martin McNally, UK  
                              Armin Koller, Germany  
                              Mark Rogers, UK  
                              Martin Glombitza, Germany





# Imaginative solutions that improve outcomes for patients whilst conserving resources for healthcare providers

## Achieving predictable outcomes following hip and knee arthroplasty

1st September | 12.50 - 13.50 | Meeting room: East School |  
Examination Schools, University of Oxford

| Timing        | Topic  | Speaker          |
|---------------|--|------------------|
| 12.50 - 13.20 | Mode of action of Negative Pressure Wound Therapy (NPWT) in closed incision management following surgery                                 | Robin Martin     |
| 13.20 - 13.50 | Primary joint arthroplasty and closed incisional wounds: results of 220 patient RCT on primary hips and knees with or without PICO® NPWT | Sudheer Karlakki |

Smith & Nephew sponsored symposium at EBJIS congress 2016



# Industry sponsored symposium B

Thursday 1 September 2016

Room: East School

## Smith & Nephew Industry Symposium

12.50 - 13.50     *Achieving predictable outcomes following hip and knee arthroplasty*

**Robin Martin:**

*Mode of action of Negative Pressure Wound Therapy (NPWT) in closed incision management following surgery*

**Sudheer Karlakki:**

*Primary joint arthroplasty and closed incisional wounds: results of 220 patient RCT on primary hips and knees with or without PICO™ NPWT*



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# Industry sponsored symposium C

Friday 2 September 2016

Room: South School

## Biocomposites Industry Symposium

**12.35 - 13.35** *Improving outcomes in infected cases; surgical tips, tricks and lessons learnt from over 1,000 cases*

- Improving outcomes in infected revision cases
- Managing risks in comorbid patients undergoing primary joint replacement
- Salvaging limbs in extreme cases

Chair: Rhidian Morgan-Jones, (Cardiff)  
Edward McPherson (Los Angeles)  
Adrian Taylor (Oxford)





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Prof. Dr. C. L. Romanò, Prof. Dr. L. Drago, M. R. Reed  
02.09.2016 · 12:40–13:40 · Room: East School

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# Industry sponsored symposium D

Friday 2 September 2016

Room: East School

## Heraeus Industry Symposium

12.40 - 13.40     *Anti-biofilm strategies - what is effective?*

**Prof. Dr. Carlo L. Romanò**

Istituto Ortopedico Galeazzi IRCCS, Milano, Italy

**Prof. Dr. Lorenzo Drago**










Istituto Ortopedico Galeazzi IRCCS, Milano, Italy

**Mike R. Reed**

Northumbria NHS Trust, Newcastle University, UK

# Heraeus

## Exhibitor directory

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| E 15          | <b>Synimed</b>                                      | Tel: + 33 5 55 98 31 38<br>synimed@synimed.com<br>www.synimed.com                        |     |
| E 08          | <b>Tecres S.p.a.</b>                                | Tel: +39 045 9217311<br>info@tecres.it<br>www.tecres.it                                  |   |
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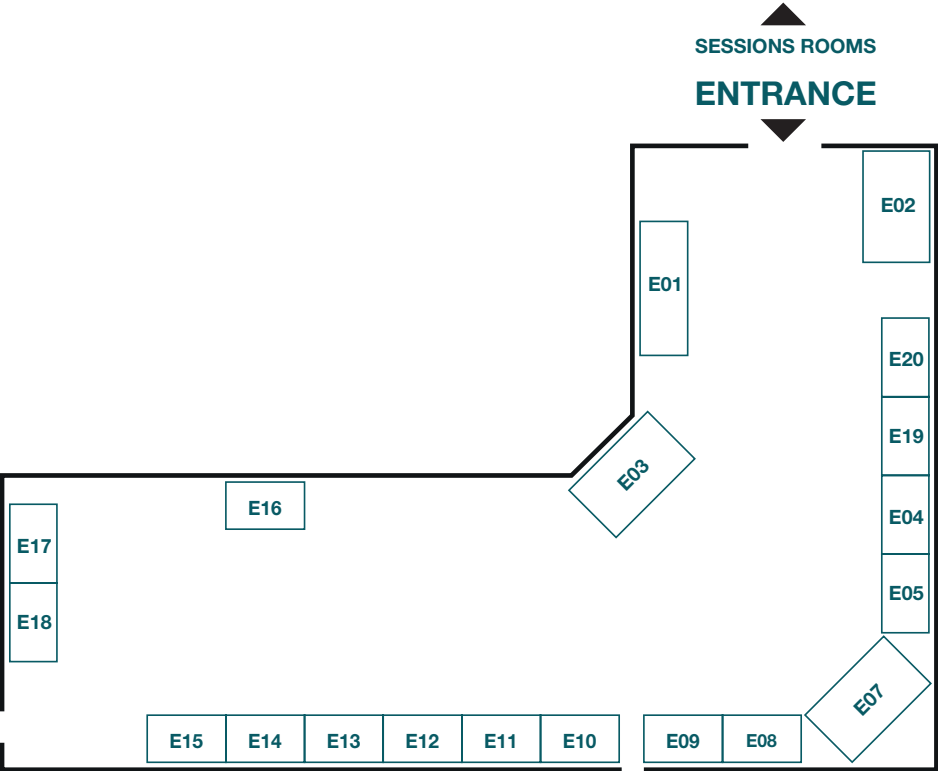
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# Oral Abstracts



### Key Session 1

#### [O1] EXPERIMENTAL STUDIES ON INFECTION AFTER OSTEOSYNTHESIS

T Fintan Moriarty<sup>1</sup>

<sup>1</sup>AO Research Institute Davos, Davos, Switzerland

Device-related bone infection is one of the most distressing complications of the surgical fixation of fractures. Despite best practice in medical and surgical interventions, the rate of infection remains stubbornly persistent, and current estimates indicate that treatment failure rates are also significant. The problem is recognized not only by the clinical community tasked with preventing and treating these infections, but also by the scientific and industrial sectors tasked with providing innovations that will improve the care of these patients.

As we approach the limit of the effectiveness of current techniques, novel approaches to infection management assume great importance. Preclinical *in vivo* models offer the possibility of reproducible, controlled conditions in which to study this problem and test novel interventions. In order to do so effectively however, certain critical features must be accurately recapitulated in the chosen preclinical model. In the case of orthopaedic device-related bone infection, these critical features include the implant constructs used and resultant biomechanical stability, the duration of the infection, the inclusion of device exchange in treatment protocols, as well as local antibiotic depots as traditionally used in staged exchange protocols.

In this talk, the opportunities provided by experimental preclinical *in vivo* studies will be described as they pertain to device-related bone infection. These include: the ability to control immunological responses in murine models; the importance of biomechanics in fracture models of infection; the ability to perform high-resolution CT imaging in living infected bone; a newly developed model for two-stage exchange of infected hardware; and finally a series of experiments deciphering the role played by local (bone cements and hydrogels) and systemic antibiotics alone and in combination in the treatment of infection. Extrapolation to the clinic is a challenge for such studies, but the aforementioned studies highlight what can be achieved with appropriate model selection.

## Key Session 1

# [O2] PROSPECTS FOR WHOLE GENOME SEQUENCING FOR DIAGNOSTICS

David Eyre<sup>1</sup>

<sup>1</sup>University of Oxford, Oxford, United Kingdom

Bacterial whole genome sequencing has the potential to replace much of routine laboratory microbiology, including in the investigation of potential bone and joint infection.

Approaches using whole genome sequencing to reliably identify bacteria and determine antimicrobial susceptibilities will be discussed. Most proof of principal studies to date have relied on prior culture of bacteria before sequencing, however methods in development to allow the presence of bacteria, species and susceptibilities to be determined directly from clinical samples will also be presented. Specific challenges include selective identification of limited amounts of bacterial DNA in the presence of large amounts of human DNA, and determining diagnostic thresholds for the amount of bacterial DNA associated with clinically significant infection.

Novel sequencing technology, such as Oxford Nanopore sequencing, is likely to significantly enhance diagnostics with clinical samples sequenced directly within hours using a device the size of a USB-drive connected to a laptop. Emerging 'read-until' technology offers the prospect of selectively sequencing pathogen DNA, while rejecting human DNA from the sequencing pore. In contrast to the short reads generated by current technology, the longer reads produced potentially enable improved matching of species identification and resistance prediction in polymicrobial infections.

Whole genome sequencing offers the potential for rapid culture-free diagnostics in bone and joint infection. Where distinguishing contamination from true infection is important, sequences from multiple samples can be compared directly rather than having to rely on proxies such antimicrobial susceptibilities. Additionally, whole genome sequencing has the potential to enhance our understanding of the aetiology of bone and joint infection; data collected for routine diagnostic purposes may concurrently yield insights into pathogenicity and virulence determinants. Comparison of patient and environmental flora with sequences from infections may also reveal sources of infection and allow their better control.

### Key Session 1

### [O3] INTERACTIONS BETWEEN STAPHYLOCOCCI, OSTEOBLASTS AND OSTEOCLASTS – WHAT DO WE KNOW IN 2016?

Frédéric Laurent<sup>1</sup>

<sup>1</sup>Centre International de Recherche En Infectiologie - Hospices Civils de Lyon, Inserm U1111, Lyon, France

Bone is a mineralized hard tissue that is constantly remodeled under the coordinated action of the bone matrix-forming osteoblasts and the bone matrix-resorbing osteoclasts. This balance is impaired when infection occurred, mostly caused by *Staphylococcus aureus* that is able to induce chronic forms characterized by inflammation and progressive bone destruction. We investigated the cellular mechanisms of staphylococcal-induced bone destruction and the switching from acute BJI to chronic BJI using ex-vivo infection models of osteoblasts and osteoclasts.

Our most recent results suggest that two complementary mechanisms are involved in bone loss during bone infections: i) staphylococcal invasion of osteoclast precursors induce their diversion from osteoclastogenesis and their differentiation into activated macrophages that actively secrete pro-inflammatory cytokines, which are able to enhance the bone resorption capacity of uninfected, mature osteoclasts and promote the migration as well as osteoclastogenesis of the uninfected precursors to the site of infection; and ii) infection of mature osteoclasts by *S. aureus* directly enhance their ability to resorb bone by promoting cellular spreading and fusion. In addition, using recombinant staphylococcal toxins, we demonstrated the ability of Panton Valentine leukocidin, a pore-forming toxin, to kill directly mature human osteoclasts while superantigenic toxins, such as TSST-1, are able to enhance bone resorption capacity of these cells.

Moreover, comparing isolates recovered from initial and recurrent BJI episode from the same patient with persisting or relapse of BJI, we showed that recurrent isolates tend to be less cytotoxic, to induce a lower inflammatory response, to persist longer in intracellular compartment of osteoblasts and to induce a lower mortality in mice infection model than initial isolates, despite no significant change at genomic level. These findings suggests that *S.aureus* BJI chronicization is associated with an in vivo bacterial phenotypical adaptation during the course of infection, leading to higher intraosteoblastic persistence, lower virulence as well as host immune escape.

Put together these data demonstrate that some physiopathological traits and clinical signs of BJIs are likely related to the intracellular life, the toxin profiles and the adaptative processes of clinical *S. aureus* isolates, which may open perspectives for innovative targeted therapeutics and bacteriological predictive tools of clinical outcomes in the setting of BJIs.

## Key Session 2

### [O4] INTRODUCTION TO THE SCALE AND COST OF THE PROBLEM AND DIRECTION OF TRAVEL

Fares S Haddad<sup>1</sup>

<sup>1</sup>Professor of Orthopaedic and Sports Surgery, UCLH and UCL, London, United Kingdom

Prosthetic joint infection is a devastating complication of arthroplasty surgery that can lead to debilitating morbidity for the patient and significant expense for the healthcare system.

With the continual rise in the number of arthroplasty cases worldwide every year, the revision burden for infection is becoming a greater financial strain on healthcare budgets.

The prevention of infection has to be the key to reducing this burden. For treatment, it is critical for us to collect quality data that can guide future management strategies to minimise morbidity / mortality for patients but that also considers healthcare costs.

There has been a management shift in many countries to a less expensive 1-stage strategy and in selected cases to the use of debridement, antibiotics and implant retention. These appear very attractive options on many levels, not least cost.

However, with a consensus on the definition of joint infection only clarified in 2011, there is still the need for high quality cost analysis data to be collected on how the use of these different methods could impact the healthcare expenditure of countries around the world. With a projected spend on revision for infection at US\$1.62 billion in the US alone, this data is vital and urgently needed.

Data collection in this area is still poor and requires a clear strategy that goes well beyond current registry aspirations.

## Oral Abstracts

### Key Session 2

#### [O5] BIOFILM BIOLOGY AND NOVEL THERAPIES IN PJI

Jason C J Webb<sup>1</sup>

<sup>1</sup>Avon Orthopaedic Centre, Bristol, United Kingdom

Prosthetic joint infection (PJI) remains one of the most feared complications of total hip arthroplasty. The Biofilm is central to the pathogenesis of PJI - without a sound understanding of its biology one cannot hope to prevent and treat PJI in our clinical practice. The collaboration of biofilm biologists, microbiologists and orthopaedic surgeons only started in the 1980's but since then there has been a vast amount of valuable research. In an era where healthcare and surgery is increasingly threatened by multi-resistant bacteria we would benefit from studying the molecular behaviour of bacteria in the biofilm. This lecture will provide an update for the orthopaedic surgeon of the current biofilm literature and the novel therapies that may be helpful in the prevention and treatment of PJI.

**Key Session 2**  
**[O6] ANTIBIOTIC DELIVERY IN CEMENTLESS REVISION**

**Edward McPherson<sup>1</sup>**

<sup>1</sup>L.A. Orthopedic Institute, Los Angeles, United States

**ABSTRACT NOT AVAILABLE AT PRINT**

## Oral Abstracts

### Key Session 2

#### [O7] DAIR – ROLE AND LIMITATIONS

**Roger Gundle**<sup>1</sup>

<sup>1</sup>Nuffield Orthopaedic Centre, Oxford, United Kingdom

**ABSTRACT NOT AVAILABLE AT PRINT**



## Free Papers A

### [O8] EARLY SURGICAL DEBRIDEMENT IN PATIENTS WITH SUSPECTED ACUTE INFECTION AFTER HIP OR KNEE ARTHROPLASTY – SAFE, EFFECTIVE AND WITHOUT NEGATIVE FUNCTIONAL IMPACT

**Luís Barros<sup>1</sup>**, João Esteves<sup>1</sup>, Marta Silva<sup>1</sup>, Pedro Serrano<sup>2</sup>, Nuno Esteves<sup>1</sup>, Ricardo Sousa<sup>3</sup>

<sup>1</sup>Centro Hospitalar Do Porto, Porto, Portugal

<sup>2</sup>Department of Orthopaedics, Centro Hospitalar Do Porto – Hospital de Santo António, Porto, Portugal

<sup>3</sup>Department of Orthopaedics, Centro Hospitalar Do Porto – Hospital de Santo António, Hospital Privado de Alfena, Porto, Portugal

**Aim:** The purpose of this study is to evaluate the safety profile and impact on functional results of surgical debridement performed in the early postoperative by comparing them with patients that undergone uncomplicated total joint arthroplasty.

**Method:** This is a retrospective case-control study. Patients that underwent debridement with prosthesis preservation for suspected acute postoperative infection of total hip or knee arthroplasty between 2010-2014 were included. Controls were randomly selected (1:2 ratio) from a list of primary arthroplasty patients in the same time period matching for articulation, age, gender, ASA score, BMI and follow-up time.

Infection status, success of treatment and medical-surgical complications were investigated and all patients were assessed using Hip disability and Osteoarthritis Outcome Score(HOOS) or Knee injury and Osteoarthritis Outcome Score(KOOS).

**Results:** Twenty-nine patients were included at a mean follow-up of 42.3 (18-66) months. Infection was confirmed in all but one patient. There was one related death (multiorgan failure) and three cases progressed to chronic infection requiring further two-stage revision – overall success rate was 86.2%. No other medical-surgical complications related to the procedure were noted.

Of the 25 that achieved infection eradication, only 19 were available to functional evaluation. Two had unrelated complications that preclude functional evaluation (one periprosthetic fracture and one contralateral amputation) and four patients died from unrelated causes (all of them without evidence of infection relapse after at least two years follow-up).

Comparing functional result of the 19 patients available with 38 uncomplicated controls, there were no significant differences between groups: Pain–91.7±86.5 vs. 87.5±14.2; Other symptoms–90.6±7.7 vs. 88.6±9.2; Activities of day living– 85.7±8.6 vs. 82.7±15.3; Sport– 62.3±13.2 vs. 56.6±16.1; Quality of life– 78.4±16.3 vs. 77±14.6.

**Conclusions:** Early diagnosis of acute periprosthetic infection can be extremely difficult because clinical manifestations can be very subtle. On one hand, waiting for obvious findings may delay proper therapeutic intervention leading to chronicity. On the other hand, fear of adding morbidity frequently delays decision.

The results of this study demonstrate that early surgical debridement is safe, effective and brings no long-term deleterious implications on functional results. The authors believe that when facing a complicated wound healing in early postoperative period, a low threshold to assume a possible infection diagnosis is beneficial.

### Free Papers A

#### [O9] EARLY PROSTHETIC JOINT INFECTION AFTER TOTAL HIP ARTHROPLASTY

Bjorn Brandsaeter<sup>1</sup>, **Kjersti Kaul Jenssen<sup>1</sup>**, Øystein Høvik<sup>1</sup>, Einar Amlie<sup>1</sup>, Arild Aamodt<sup>1</sup>

<sup>1</sup>Lovisenberg Diaconal Hospital, Oslo, Norway

**Aim:** Early prosthetic joint infection (PJI) is a feared complication of hip arthroplasty. Debridement, antibiotics and implant retention (DAIR) is attempted to avoid removal of the implant. The aim of this retrospective cohort study was to evaluate the success rate of DAIR in early PJI.

**Method:** All patients who were diagnosed with early PJI and treated with DAIR at our center from 2003 to 2013 were included in the study. During the time period, 5176 primary hip arthroplasties and 555 revision hip arthroplasties were performed. Early PJI was diagnosed in 54 patients (43 primary and 11 revisions). Median follow-up was 5.6 years (range 2.0-12.1). Standard postoperative antibiotic treatment at our centre is vancomycin and rifampicin.

**Results:** Median patient age was 74 years and 29 patients were women. Mean C-reactive protein at time of diagnosis was 119 mg/L (range 4-546). In 41 patients the infection was eradicated with one DAIR median 17.6 days (range 5-44) after index surgery. Twelve patients underwent a second DAIR and two patients needed DAIR 3 times. Eight primary arthroplasties and two revision arthroplasties proceeded to 2-stage revision after index surgery. Two patients (revisions) were left with a spacer only and one patient was put on lifelong antibiotic suppression therapy. The most frequently isolated microorganisms were *Staphylococcus aureus* in 19 patients (35%) and Coagulase negative *Staphylococcus* in ten patients (19%) of which five were MRSE. There were no infections with MRSA in our material. Among the ten patients that proceeded to 2-stage revision, five had *Staphylococcus aureus*, three had polymicrobial flora, one Coagulase negative *Staphylococci* and one *Propionibacterium acnes* infection. The most frequently used post-operative parenteral antibiotic treatment was vancomycin in 35 patients and cloxacillin in 15 patients. The subsequent oral treatment was predominantly dicloxacillin in 25 patients and ciprofloxacin in ten patients. Twenty-four patients received rifampicin in addition. These were mainly patients operated after 2009. Intravenous antibiotics were given for median 15.7 days (range 0-60) and continued orally for median 8.1 weeks (range 0-72).

**Conclusions:** In our cohort of 54 patients, 81.4% of primary prosthesis and 63.6% of the revision prosthesis were treated successfully with DAIR. This is in accordance with previous studies.

## Free Papers A

### [O10] THE UNSUSPECTED PROSTHETIC JOINT INFECTION: THE INCIDENCE AND CONSEQUENCES OF POSITIVE INTRAOPERATIVE CULTURES IN PRESUMED ASEPTIC KNEE AND HIP REVISIONS

Anouk Jacobs<sup>1</sup>, Benard Menno<sup>1</sup>, Jacques F. Meis<sup>2</sup>, Gijs Van Hellemond<sup>1</sup>, Jon Goosen<sup>1</sup>

<sup>1</sup>Sint Maartenskliniek, Nijmegen, Netherlands

<sup>2</sup>Canisius-Wilhelmina Hospital, Medical Microbiology & Infectious Diseases, Nijmegen, Netherlands

**Aim:** Despite a preoperative workup with no evidence to suspect a prosthetic joint infection (PJI) before revision surgery, routinely obtained intraoperative cultures still can be unexpectedly positive. The purpose of this study was (1) to assess the incidence of unexpected positive intraoperative cultures in presumed aseptic knee and hip revisions and (2) to determine whether a difference exists between the infection-free implant survival rate of patients with and without unexpected positive intraoperative cultures.

**Method:** We selected patients who underwent a one-stage revision total knee arthroplasty (TKA) or total hip arthroplasty (THA) for different reasons. Three or more separate intraoperative cultures were obtained during each procedure. A negative result was defined as less than two positive cultures with the same microorganism. An unsuspected PJI was defined as having two or more positive cultures with the same microorganism. Patients' medical records were reviewed to collect demographics, preoperative laboratory results, culture results, and the occurrence of infection during follow-up.

**Results:** A total of 340 and 339 patients with a presumed aseptic knee and hip revision, respectively, were analyzed. The incidence of unsuspected PJIs was 7.9% and 12.1% in the knees and hips, respectively. Of these unsuspected PJIs, the infection-free prosthetic survival rate at 2 year follow-up was 88% (95%CI 59-97) and 92% (95%CI 73-98) in knees and hips, respectively. In the knee group, the infection-free prosthetic survival rate of patients with an unsuspected PJI was significantly lower compared to that of patients with negative intraoperative culture results (88% (95%CI 59-97) versus 97% (95%CI 93-99) with  $p=0.01$ ). In the hip group, there was no such a difference (92% (95%CI 73-98) versus 93% (95%CI 88-96) with  $p=0.41$ ).

**Conclusions:** We found incidences of unsuspected PJI and infection-free prosthetic survival rates that are comparable with previous studies.<sup>1-6</sup> During follow-up after one-stage revision TKA, a higher incidence of infection was observed in patients with an unsuspected PJI. This difference was not observed in the hip revisions.

#### References:

1. Moojen DJ et al. Acta Orthop. 2010;81(6):667-73.
2. Ribera A et al. J Infect. 2014;69(3):235-43.
3. Fernandez-Sampedro M et al. BMC Infect Dis. 2015;15:232.
5. Barrack RL et al. J Arthroplasty. 2007;22(6 Suppl 2):94-9.
6. Boot W et al. Acta Orthop. 2015;86(6):678-83.

### Free Papers A

#### [O11] SURVIVORSHIP AND FUNCTION OF MASSIVE ENDOPROSTHESES USED IN THE MANAGEMENT OF PERI-PROSTHETIC JOINT INFECTIONS AROUND THE HIP AND KNEE

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**Introduction:** The burden of peri-prosthetic joint infection (PJI) following hip and knee surgery is increasing. Endoprosthetic replacement (EPR) is an option for management of massive bone loss resulting from infection around failed lower limb implants.

**Aims:** To determine clinical outcome of EPRs for treatment of PJI around the hip and knee joint.

**Methods:** This was a retrospective consecutive case-series of hip and knee EPRs between 2007-2014 in our tertiary unit for the treatment of PJI following complex arthroplasty or fracture fixation. Data recorded included indication for EPR (infected primary/revision arthroplasty, infected non-union/failed osteosynthesis, gross bone loss following native joint infection), number of previous surgeries, and organism identified. Outcome measures included PJI eradication rate (with failure defined as EPR revision, amputation, or being on life-long suppressive antibiotics), complications, implant survival, mortality, and functional outcome (Oxford Hip/Knee Score; OHS/OKS).

**Results:** 58 EPRs (32 knee and 26 hip) were performed with a mean age of 68 years (range: 35-92). The mean number of previous surgeries prior to EPR was 3.4 (range: 1-10). At mean follow-up of 3.5 years, 11 (19%) patients were deceased. EPR was implanted as a two-stage procedure in 76% of cases. Plastic surgical involvement and flap coverage was necessary in 11 cases. Polymicrobial growth was detected in 40% of cases, followed by Coagulase-negative staphylococci (26%). The overall complication rate was 40%. Recurrence of infection post-EPR occurred in 14 patients (24%); 5 were treated with Debridement, Antibiotics and Implant Retention (DAIR), 3 with revision, 1 with above-knee amputation and the remaining 6 remained on long-term suppressive antibiotics. PJI eradication was achieved in 44 (76%) cases (69% knees and 85% hips). Of the remaining 14 cases, 9 remain on long-term antibiotics. The complication rate was similar in knees (41%) and hips (38%). PJI eradication was more successful in hips (85%) compared to knees (69%). To date, 6 EPRs have been revised (10%). The overall 5-year implant survivorship was 83% (95% CI: 68-98%). The mean OHS was 25 (range 7-39.) and the mean OKS was 20 (range 6-43), the best possible score being 48.

**Conclusions:** This mid-term study provides further support for the use of massive endoprostheses in the eradication of PJI in complex, previously multiply revised cases with subsequent limb salvage (in all but one case). We describe PJI eradication rate of 76% with acceptable functional outcomes. This eradication rate is comparable to that following treatment of PJI associated with standard arthroplasty.

## Free Papers A

### [O12] NORMALIZATION OF INFLAMMATORY PARAMETERS BETWEEN TWO STAGE REVISION OF INFECTED PROSTHESIS ARE NOT PREDICTIVE OF SUCCESS – IS IT STILL REASONABLE TO CONTINUE TO WAIT?

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**Aim:** The aim of this study is to evaluate the value of inflammatory parameters normalization and/or increased time between stages necessary in predicting healing and preventing infection recurrence.

**Method:** We retrospectively studied all cases of total hip and knee arthroplasty that underwent revision for infection in our institution between 2011 and 2014. We revised the clinical and laboratory information from 55 patients (27 hips: 28 knees) with a mean age of 68 years. The average values before the first stage were 88.6 mm/h (15-134) and 59.1 mg/L (2-279) for the erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) serum respectively. In 10 cases (18.2%) it was not possible to perform the second stage. Moreover, in the other 45 cases of re-arthroplasty, the mean follow-up was 32 months (1 year).

**Results:** Among the 45 cases in which the two stages were completed, only 3 (6.7%) had recurrence of infection. No significant differences between the two groups regarding the absolute values of ESR and/or CRP before the second stage or variation between the first and second stage of revision were seen. Interestingly, in the group of cases where there was recurrence of infection, the average values of CRP and ESR before the second stage were even lower: 6.0 *vs.* 11.8 mg/L and 19.3 *vs.* 28.7 mm/h respectively. Analysing the temporal influence on the recurrence rate, we find that the 17 cases in which the second stage was performed in less than 90 days, there were no recurrences. The three recurrences occurred in the group of patients with an interval > 90 days (3/28 - 11%).

**Conclusions:** Knowing when to perform the second stage safely is one of the most difficult decision in two-stage procedures. Tradition mandates waiting for complete normalization of inflammatory parameters sometimes for a long period of time in order to identify cases at risk. However, this approach involves an increased disability time and significant quality of life decrease for patients and lacks adequate scientific support. This study confirms that this traditional approach does not increase the chances of success. The authors argue that there is no advantage in waiting for the normalization of inflammatory parameters before advancing to the second stage time and this practice should be definitively abandoned.

### Free Papers A

#### [O13] ALPHA-DEFENSIN TEST\* FOR EVALUATION OF PERIPROSTHETIC JOINT INFECTION

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**Aim:** Quantitative assessment of alpha-Defensin offers a promising approach for diagnosing a periprosthetic joint infection (PJI) with sensitivities and specificities ranging from 97% to 100% and 95% to 100%, respectively. However, to the best of our knowledge and after due inquiry little information exists concerning qualitative measurements of alpha-Defensin. The aim of this study was to assess the diagnostic accuracy of the alpha-Defensin test, a lateral flow test for the qualitative detection of alpha-Defensin.

**Method:** In this study, 50 patient with indicated revision surgery met the inclusion criteria due to septic or aseptic loosening. In addition to clinical standard diagnostics of PJI, the alpha-Defensin test\* for the assessment of the qualitative alpha-Defensin in the synovial fluid was performed. The results were compared with the sensitivity and specificity of currently available clinical tests, specifically C-reactive protein (CRP), frozen section, definitive histology, bacteriology and sonication.

**Results:** Based on the Musculoskeletal Infection Society's (MSIS) definition of PJI, 36 cases were categorized as aseptic and 13 as septic revisions. Due to the lack of an indicated control line ("C"), one alpha-Defensin test\* was inconclusive. Qualitative alpha-Defensin had an area under the curve, sensitivity, specificity, and positive and negative likelihood ratios of 0.82, 69%, 94%, 12.46, and 0.33, respectively. Adjusted p-values using the method of Hochberg showed that the alpha-Defensin test\* is significantly at least as good when diagnosing PJI as histology ( $p=0,0042$ ) and bacteriology with at least one positive culture ( $p=0,0327$ ).

**Conclusions:** Qualitative alpha-Defensin tests could be an effective supplement in diagnosing PJI with a diagnostic accuracy comparable to histology and bacteriology ( $\geq 1$  positive culture).

\*Synovasure™



## Free Papers A

### [O14] ALPHA DEFENSIN IMMUNOASSAY FOR DIAGNOSING PJI. A PROSPECTIVE STUDY

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**Aim:** A key of success in the treatment of prosthetic joint infection (PJI) is the proper diagnosis. There is a lack of diagnostic tools able to diagnose a PJI with high accuracy. Alpha-defensin has been proposed as possible solution but the available literature is still limited. This prospective study was carried out in order to determine (1) what is the sensitivity, the specificity, the positive and the negative predictive value of the Alpha-defensin immunoassay test in diagnosing PJI; (2) which clinical features may be responsible for false positive and false negative results?

**Method:** Preoperative aspiration was performed in patients presenting with a painful hip/knee arthroplasty. Metallosis, other inflammatory comorbidities and previous/concomitant antibiotic therapy were not considered as exclusion criteria. Patients with inadequate amount of synovial fluid for culture were excluded. At time of revision synovial fluid samples were taken in the OR in order to perform Alpha-defensin assay. During surgical debridement tissue samples for cultures were obtained. Prospectively, 156 patients (65 knees and 91 hips) were included. A diagnosis of PJI was confirmed in 29 patients.

**Results:** The sensitivity of the Alpha-defensin immunoassay was 97% (95% CI, 92% - 99%), the specificity was 97% (95% CI, 92% - 99%), the positive predictive value was 88% (95% CI, 81% - 92%) and the negative predictive value was 99% (95% CI, 96% - 99%). Among four false positive patients two had a metallosis and one had a polyethylene wear. The false negative case presented with a draining sinus, and intraoperative cultures were also negative.

**Conclusions:** Alpha-defensin assay may have a significant role in PJI diagnosis. Negative tests may exclude the diagnosis of PJI. Positive tests are very much likely to confirm PJI, but other conditions (metallosis, poly wear) should be excluded.

### Free Papers A

#### [O15] AGREEMENT BETWEEN PREOPERATIVE JOINT ASPIRATION RESULTS AND CAUSATIVE PATHOGENS IN PATIENTS WITH PROSTHETIC HIP AND KNEE INFECTIONS TREATED WITH A TWO-STAGE REVISION

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**Aim:** Preoperative joint aspiration cultures (PJACs) are of great value in diagnosing prosthetic joint infections (PJIs). Studies investigating the predictive value of PJACs to identify causative pathogens in PJI, which is off course relevant for the correct initiation of antimicrobial treatment, are limited. The objective of this study was to investigate whether the PJACs are in agreement with causative pathogens in PJIs.

**Method:** A retrospective monocentric study was conducted at the 40-bed orthopedics department of a tertiary centre. Medical files of patients with proven prosthetic knee or hip infection with PJACs from maximum 6 months prior to the first stage of a two-stage revision admitted between March 2010 and December 2014 were evaluated. A proven PJI was defined as at least two positive preoperative or intraoperative cultures, the presence of purulent synovial fluid or purulence at the implant site or surrounding the prosthesis without other identifiable causes, the presence of acute inflammation upon histopathological examination of the periprosthetic tissue at the time of surgery or the presence of a sinus tract communicating with the prosthesis. In order to identify the causative pathogen(s) per patient, a multidisciplinary team, consisting out of a microbiologist, a septic orthopedic surgeon, two infectious diseases specialists and two clinical pharmacists, assessed the relevance of pathogens cultured in the PJACs and intraoperative deep samples based on the current 2012 IDSA guidelines. Per patient, agreement of PJACs corresponding to the retained causative pathogen(s) was investigated in two ways: 1) on species level and 2) on Gram stain or fungi level.

**Results:** Forty six patients (66 ± 10 years; 26 males; 23 knee and 23 hip; 25 first revisions and 21 with multiple revisions) were included. PJACs remained sterile in seven patients. In 25 of 46 patients (54%) there was agreement in terms of causative pathogen species. In 39 of 46 patients (85%), there was agreement in terms of Gram staining or fungi results. In the other 7 patients, PJACs remained sterile, but with positive intraoperative culture results.

**Conclusions:** Only half of PJAC results corresponded to the retained causative pathogens. Therefore, PJACs should not be used to initiate directed antimicrobial therapy; directed therapy should only be instituted when also intraoperative cultures are known. Initially, a (combination of) broad spectrum agent(s) should be preferred. Also preliminary narrowing of the spectrum can be implemented based on the Gram staining or fungi results of PJACs, as was seen in our study.

## Free Papers A

### [O16] IS THERE A RELATIONSHIP BETWEEN PERIOPERATIVE POSITIVE CULTURES OR POSITIVE LEUKOCYTE COUNTING DURING EXCHANGE ARTHROPLASTY AND POSTOPERATIVE INFECTIONS?

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**Aim:** The purpose of this work is to study whether there is or not, in the case of an aseptic arthroplasty exchange, a relationship between positive cultures and an early periprosthetic joint infection.

**Method:** We carried out a retrospective review of our cases of aseptic exchange arthroplasties of hip, knee and shoulder performed between January 2007 and December 2015.

The follow-up period was, in average, from 1 to 9 years, and in all the cases perioperative cultures were evaluated.

**Results:** The number of arthroplasties reviewed was 183, corresponding to 180 patients.

Seventy-six cultures were positive for one or more microorganisms. *Staphylococcus epidermidis* was the microorganism most isolated followed by other Coagulase Negative *Staphylococci*.

Five cases (6.58%) were followed by an acute infection. In three of these cases (60%) the previous culture were positive, but only in one single case, one of the microorganisms isolated after the infection was the same as the isolated previously.

**Conclusions:** Perioperative cultures in aseptic exchange arthroplasties seems not to have any value as infection predictor.

Neither the previous isolated microorganisms, in case of postoperative infection, have any value as a predictor of the etiological agent.

Free Papers A

[O17] COMMERCIALLY PURE DISSOLVABLE ANTIBIOTIC BEADS: A CLINICAL REVIEW OF 756 CASES OF PERIPROSTHETIC JOINT INFECTION AND ASEPTIC REVISION ARTHROPLASTY

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**Aim:** Dissolvable antibiotic-loaded calcium sulfate beads have been utilized for management of periprosthetic joint infection (PJI) and for aseptic revision arthroplasty. However, wound drainage and toxic reactive synovitis have been substantial problems in prior studies. Currently a commercially pure, physiologic product has been introduced that may reduce complications associated with this treatment modality. We aim to answer the question: does a commercially pure, physiologic version of antibiotic-loaded calcium sulfate beads reduce wound drainage and provide efficacious treatment for PJI and aseptic revision arthroplasty?

**Method:** Starting January 2010, 756 consecutive procedures were performed utilizing a set protocol of Vancomycin and Tobramycin antibiotics in commercially pure dissolvable antibiotic beads. There were 8 designated study groups:

|                                     |         |                                     |
|-------------------------------------|---------|-------------------------------------|
| Aseptic Revision TKA                | N = 216 | Aseptic Revision THA                |
| N = 185                             |         |                                     |
| DECRA* TKA                          | N = 44  | DECRA* THA                          |
| N = 16                              |         |                                     |
| 1 <sup>st</sup> Stage Resection TKA | N = 103 | 1 <sup>st</sup> Stage Resection THA |
| N = 62                              |         |                                     |
| Reimplant TKA                       | N = 81  | Reimplant THA                       |
| N = 49                              |         |                                     |

\*DECRA = Debridement, modular Exchange, Component Retention, iv Antibiotics for acute PJI

**Results:** Wound drainage in the entire series was 4.2%. Wound drainage was generally seen in cases using higher bead volumes (≥30cc). The rate of heterotopic ossification was 1.6%. With bead volumes of ≥30cc, we did notice transient hypercalcemia in 12% of the study group (14% hips, 10% knees). The overall rate of infection failure was 2.5%. In the DECRA groups, reinfection failure rate was encouraging, measuring 9.1% in knees and 6.3% in hips. The non-DECRA group with the highest infection rate was Reimplant TKA (6.2%).

**Conclusions:** We utilized a large series of commercially pure dissolvable antibiotic-loaded beads in a wide variety of clinical scenarios in patients with substantial comorbidities. Our rate of wound drainage, compared to prior studies utilizing gypsum products, was reasonably good. Additionally, our infection failure rates were encouraging. Over-stuffing knee joints with too many beads, in our clinical review, does affect wound drainage rates. By removing impurities from calcium sulfate, we do not see the substantial toxic synovial reaction compared to the traditional gypsum-washed products. We feel that commercially pure, physiologic antibiotic-loaded dissolvable beads are an acceptable delivery tool for local antibiotic delivery in aseptic and septic revision joint arthroplasty of the hip and knee. In our opinion, further study is warranted. We advocate future randomized studies to examine the potential of improving outcomes of PJI and aseptic revision arthroplasty.

## Free Papers A

### [O18] MULTIDRUG RESISTANT BACTERIA: AN INDEPENDENT PREDICTOR OF FAILURE IN PERIPROSTHETIC JOINT INFECTION

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**Aim:** Compare clinical outcomes following staged revision arthroplasty for periprosthetic joint infection (PJI) secondary to either multidrug resistant (MDR) bacteria or non-MDR (NMDR) bacteria.

**Method:** Retrospective analysis of a prospectively collected bone infection database. Adult patients diagnosed and treated for hip or knee PJI, between January 2011 and December 2014, with minimum one-year follow-up, were included in the study. Patients were divided into two groups:

1. MDR group (defined as resistance to 3 or more classes)
2. N-MDR group (defined as acquired resistance to two classes of antibiotic or less).

The Charlson Comorbidity Index was used to stratify patients into low, medium and high risk.

The diagnosis of PJI, and any recurrence following treatment, was made in accordance with the Musculoskeletal Infection Society criteria. Failure was defined as recurrence of infection necessitating implant removal, excision arthroplasty, arthrodesis or amputation.

**Results:** The study population comprised 240 patients. 74 (31%) had an MDR infection. 14 patients were deceased at the time of data capture. All infections were treated by staged revision with interval antibiotic space and targeted systemic antibiotics under the supervision of a multidisciplinary team. Total number of failures in both groups was 39 (16%), 15 hips (12%) and 24 knees (21%). There were significantly more failures in the MDR group (n=24, 32%) than the non-MDR group (n=15, 9%) (p<0.0001).

Using the Charlson Comorbidity Index within the N-MDR group there was no significant difference in outcomes between the low and medium groups (p=0.352), the low and high risk groups (p=1.000) and the high and medium risk groups (p=1.000). There was no statistically significant association discerned within the MDR group based on co-morbidity also. (p values = 0.1702, 0.665 and 0.1096 respectively).

When comparing all cases, there was a statistically significantly higher rate of failure in patients with polymicrobial infection versus single organism infection (P<0.0001).

When stratifying by the presence of an MDR organism versus an N-MDR organism, both polymicrobial sub groups showed a greater rate of failure than their single organism counterparts, however this was only significant in the MDR group and not the N-MDR group (p=0.0007 vs p=0.123). Furthermore the polymicrobial MDR group showed a statistically significant higher rate of failure versus the polymicrobial N-MDR group (p=0.002).

**Conclusions:** The study suggests that the presence of an MDR organism may be a predictor of failure, independent of patient co-morbidity, in staged revision hip and knee arthroplasty for PJI.

### Free Papers B

#### [O19] RISK FACTORS FOR THE DEVELOPMENT OF DEEP INFECTION FOLLOWING HIP FRACTURE SURGERY: ANALYSIS OF 2,822 CONSECUTIVE PATIENTS

**Richard Holleyman**<sup>1</sup>, Sameer Khan<sup>1</sup>, Martin Marsh<sup>2</sup>, Ben Tyas<sup>2</sup>, Nick Kalson<sup>1</sup>, Paul Baker<sup>1</sup>, Kate Martin<sup>1</sup>, Dominic Inman<sup>1</sup>, Tamsin Oswald<sup>1</sup>, Mike Reed<sup>2</sup>

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**Aim:** This study aimed to identify risk factors for development of deep periprosthetic joint infection (PJI) in patients following surgical treatment of neck of femur fracture.

**Method:** This study identified a consecutive series of 2,822 (2,052 female, 73%) patients who underwent either hemiarthroplasty (n=1,825, 65%) or fixation (DHS) (n=997, 35%) for fractured neck of femur performed between January 2009 and June 2015 at our institution. Full patient demographics, co-morbidity and peri-operative complication data were determined. The majority of patients were either ASA 2 (n=663, 23%) or ASA 3 (n=1,521, 54%), mean age = 81.3 years (SD 10.3). All patients were followed up post-operatively by a dedicated surgical site infection (SSI) monitoring team in order to identify patients who developed a PJI within 1 year. A stepwise multivariable logistic regression model was used to identify patient and surgical factors associated with increased risk of infection. Predictors with a p-value of <0.20 in the univariate analysis were included in the multivariate analysis.

**Results:** Thirty-nine (39) cases of deep periprosthetic infection were identified (hemiarthroplasty n=35, DHS n=4) representing an overall deep infection rate of 1.4% (hemiarthroplasty 1.9%, DHS 0.4%). The most common infecting pathogen was a pure growth of coagulase negative Staphylococcus (n=9, 23%) followed by a pure growth of Staphylococcus aureus (n=7, 18%). An increased risk of PJI was observed in patients who underwent hemiarthroplasty compared to those treated by fixation (odds ratio (OR) 6.50, 95%CI 2.26 - 18.7, p=0.001). Of patient factors, only blood transfusion within 30 days (OR 3.51, 95%CI 1.72 - 7.13, p=0.001) and the presence or development of pressure sores on or during admission (OR 2.99, 95%CI 1.24 - 7.19, p=0.015) were significantly associated with an increased risk of development of PJI. Use of high-dose dual antibiotic cement (gentamicin and clindamycin) was associated with a two-fold reduction in the risk of PJI (OR 0.39, 95%CI 0.20 - 0.76, p=0.005) vs standard dose gentamicin antibiotic cement.

**Conclusions:** This study found: 1) a deep infection rate similar to that reported earlier from large number studies from the UK, 2) a six-fold higher deep infection rate in hemiarthroplasties, compared to internal fixations, and 3) a three-fold higher infection rate in patients who suffer concomitant pressure sores or receive a blood transfusion up to 30 days post-operatively.

## Free Papers B

### [O20] LOW-GRADE-INFECTION IN THE PATHOGENESIS OF PRIMARILY ASEPTICALLY CLASSIFIED NONUNION OF THE LOWER EXTREMITY – BASED ON TIBIAL-SHAFT-NONUNION

Simon Hackl<sup>1</sup>, Lena Hellinger<sup>1</sup>, Christian Von Rüden<sup>1</sup>, Jan Friederichs<sup>1</sup>, Volker Bühren<sup>1</sup>, Mario Perl<sup>1</sup>, Christian Hierholzer<sup>2</sup>

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**Aim:** The pathogenesis of nonunion is multifactorial. Pathobiological factors, mechanical factors, and low-grade-infection contribute to impaired bone healing. Aim of this study was to determine the rate of low-grade-infection in patients with long bone nonunion of the lower extremity without signs of acute infection, the influence of CRP (C-reactive protein), and the outcome.

**Method:** In a retrospective study (2003-2013), all patients who underwent surgery for treatment of tibial- or femoral-shaft-nonunion without any clinical evidence of infection were assessed. Bacterial cultures harvested during nonunion revision, the CRP and WBC (white blood cells) values at hospital admission, the outcome, and epidemiological data were analyzed.

**Results:** In 88 patients with tibial-shaft-nonunion without any clinical signs of infection, bacterial samples remained negative in 51 patients (46 yr; 33% open fracture; 33% nicotine abuse; 8% diabetes mellitus; revision of nonunion 10.9 months following primary osteosynthesis). In 37 patients (46 yr; 54% open fracture; 42% nicotine abuse; 11% diabetes mellitus; revision of nonunion 15.2 months) microbiological diagnostic studies after long-term-culturing demonstrated positive bacterial cultures whereas after short-term-culturing for 2 days only 17 positive cultures were observed. Among patients with negative bacterial cultures bone healing was achieved after 13.2 months, whereas in 29% additional surgical interventions (1.3 procedures) were necessary. Nonunion with positive bacterial cultures required 22.9 months (p-value<0.01) until bone healing, and even 57% of these patients required additional operations (2.9 procedures; p-value<0.01). Hematological studies performed at hospital admission demonstrated no significant difference regarding CRP (negative vs. positive culture: 0.8 mg/dl vs. 1.9 mg/dl) and WBC (negative vs. positive culture: 7.6/nl vs. 7.8/nl). Comparable results were observed in 86 patients with femoral-shaft-nonunion (38 patients with positive bacterial cultures after long-term-culturing and 18 patients after short-term-culturing) with an increased number of required operations (0.8 vs. 1.6 procedures; p-value<0.05) and a longer time period until bone healing (18.2 months vs. 27.2 months; p-value<0.05) in the group with positive bacterial cultures. In contrast to tibial-shaft-nonunion, a significant difference of the CRP level was observed (negative vs. positive culture: 0.8 mg/dl vs. 2.7 mg/dl; p-value<0.01).

**Conclusions:** The pathogenesis of nonunion may originate from low-grade-infection even in patients without any signs of infection and may result in increased number of required surgical interventions. Therefore, during any nonunion revision surgery, multiple bacterial samples should be harvested for long-term-culturing. Possibly, increased CRP levels may be a predictor for low-grade-infection in femoral - but not in tibial-shaft-nonunion.



### Free Papers B

#### [O21] INDICATIONS FOR AND PROBLEMS WITH BONE-DEFECT-RECONSTRUCTION WITH THE MASQUELET-TECHNIQUE

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**Aim:** Which patients is bone-defect-reconstruction with the Masquelet-technique suitable and which problems did we see?

**Method:** From 11/2011 to 4/2016 we treated 49 Patients (12f/37m) with bone-defects up to 150mm after septic complications with the Masquelet-technique. We had infected-non-unions of upper and lower extremity, chronic osteomyelitis, infected knee-arthrodesis and upper-ankle-empyema. On average the patients were 48 (8-74) years old. The mean bone-defect-size was 60 mm (25-150). From other hospitals came 47 of the 49 patient, where they had up to 20 (mean 4,9) operations caused by the infection. The time before transfer to our hospital was on average 177days (6-720). 40 patients received flaps because of soft tissue-defects (12 free flaps, 28 local flaps). 21 patients suffered a polytrauma. In 8 cases the femur, in 4 cases a knee-arthrodesis, in 34 cases tibia, in 2 cases humerus and in 1 case the ulna were infected resulting in bone defects. Indication for the Masquelet-technique was low-/incompliance in 35 cases due to higher grade of traumatic brain injury and polytrauma and difficult soft-tissue conditions, in 9 times problems with segment-transport and in 5 cases as dead space management. Positive microbial detection succeeded in 32 patients at the first operation. Mainly we found difficult to treat bacteria. After treating the infection with radical sequestrectomy, removal of foreign bodies and filling the defect with antibiotic loaded cementspacer and external fixation we removed the spacer 6-8 weeks later and filled the defect with bonegraft. In 23 cases we stabilized the defect then with an internal anglestable plate. All patients were examined clinically and radiologically every 4-6 weeks in our outpatient-department until full weight bearing, later every 3 months .

**Results:** In 41 of 49 cases the infection was clinically treated successfully. 21 patients are allowed for full weight bearing (all with secondary internal plates). There were 8 recurrences of infection, 22 instabilities needing internal stabilization and further bonegraft. We saw "Plate-breaks" in 4 cases. 2 patients underwent amputation.

**Conclusions:** For patients with low-/incompliance for various reasons and for those with difficult soft tissue conditions following flaps the Masquelet technique is a valuable alternative to the normal bonegraft and to the segmenttransport. The stiffness of the new Masquelet bone like a rod is a problem. Internal fixation is often necessary.

## Free Papers B

### [O22] MASQUELET TECHNIQUE: A SYSTEMATIC REVIEW THIRTY YEARS AFTER ITS INTRODUCTION

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**Aim:** The induced membrane technique (IMT) or Masquelet technique, is a two-step surgical procedure used to treat bony defects (traumatic or resulting from tumoral resections) and pseudoarthroses, even caused by infections. The relatively small case series reported, sometimes with variants to the original technique, make it difficult to assess the real value of the technique. Aim of this study was then to undertake a systematic review of the literature with a particular focus on bone union, infection eradication and complication rates.

**Method:** A systematic review was carried out following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Individual Patient Data (PRISMA-IPD) guidelines. PubMed and other medical databases were searched using “Masquelet technique” and “induced membrane technique” keywords. English, French or Italian written articles were included if dealing with IMT employed to long bones in adults and reporting at least 5 cases with a 12 months minimum follow-up. Clinical and bone defect features, aetiology, surgical data, complications, reinterventions, union and infection eradication rates were recorded into a database. Fischer’s exact test and unpaired t-test were used for the statistical analysis on the individual patients data.

**Results:** Ten papers met the inclusion criteria (312 patients), but only 5 reported individual patients data (65 cases). IMT was used for acute bone loss (53%), septic (47%) and aseptic (7%) pseudoarthroses and tumour resections (2%). Bone defect length ranged from 0.6 to 26 cm. Overall, union rate was achieved in 88% of the cases and infection cured in 93%. Complication rate was 53%. Surgical variants included the use of antibiotic-loaded spacers (59.9%), internal fixation during the first step (62.1%), use of Reamer-Irrigator-Aspirator technique (40.1%) instead of iliac crest (63.1%) grafting, bone substitutes (18.3%) and growth factors addition (41%). No statistical differences were found comparing patient-related factors or surgical variants in achieving the two outcomes.

**Conclusions:** IMT is effective to achieve bone union and infection eradication, but is associated with a high rate of complications and reinterventions. This should be taken into consideration by the surgeons and be a part of the informed consent. This systematic review was limited by the few studies meeting the inclusion criteria and their high variability in data reporting, making a meta-analysis impossible to undertake. Further studies are needed to demonstrate the role the patients’ clinical features and IMT variants with respect to bone union and infection eradication.

### Free Papers B

#### [O23] IN VITRO EVALUATION OF LYTIC BACTERIOPHAGE ACTIVITY AGAINST METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (MRSA) BIOFILM

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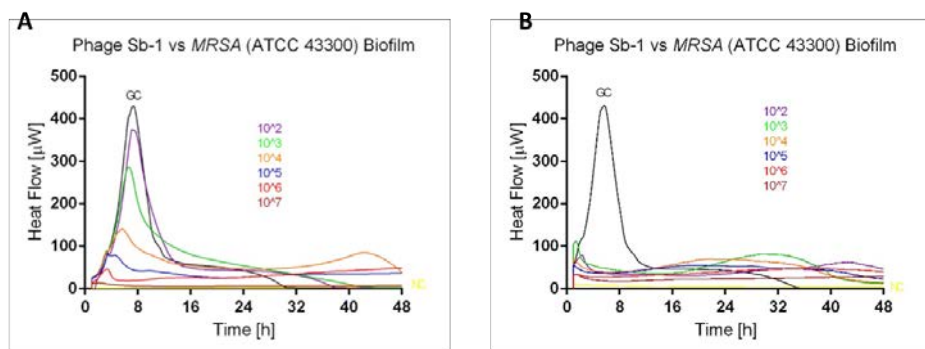
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**Aim:** To evaluate antimicrobial activity of Sb-1 and Pyo-bacteriophage in preventing and eradicating MRSA biofilm in vitro using isothermal microcalorimetry.

**Method:** Two *S. aureus* specific bacteriophages, Sb-1 and Pyo-bacteriophage cocktail, were tested against *S. aureus* MRSA (ATCC 43300). MRSA biofilm was formed on porous glass beads and incubated for 24 h at 37° C in BHI, washed 3 times and exposed to different concentrations of bacteriophages. For biofilm prevention, MRSA ( $5 \times 10^6$  CFUs/ml) was incubated with different phage titers. Glass beads were placed in the calorimeter and heat flow ( $\mu$ W) and total heat (J) were measured in real-time for 48h (eradication) or 24h (prevention).

**Results:** Both tested bacteriophages rapidly inhibited the heat production of MRSA biofilm in a concentration-dependent manner during the first 24h, as shown for Sb-1 in Figure 1 A. After 48h-exposition all the titers of bacteriophages show a strong reduction of biofilm viability (Figure 1B). MRSA biofilm was eradicate only by co-incubation with the highest Sb-1 phage titer ( $10^7$  PFUs/ml) (Figure 1A-B). In prevention experiments, significant reduction of MRSA heat production was already achieved at a lower titer ( $10^2$  PFUs/ml) of both Sb-1 and Pyo-bacteriophage and in the presence of  $10^4$  PFUs/ml the heat production was completely abolished.

**Conclusions:** Sb-1 and Pyo-bacteriophage are promising phages for treatment MRSA biofilms, as well as for preventing device colonization and controlling biofilms on surface. Their potential activity combined with antibiotics should be further investigated.



**Figure 1.** Activity of Sb-1 against MRSA biofilm measured by microcalorimetry. Heat production of MRSA biofilm co-incubated (A) and after 24h exposition (B) to different Sb-1 titers.

## Free Papers B

### [O24] GENTAMICIN CONTAINING BONE SUBSTITUTE TO PREVENT INFECTIONS DURING BONE RECONSTRUCTION SURGERY

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**Aim:** The demand for a synthetic bone substitute that can build bone and at the same time kill bacteria is high. The aim of this study was to compare the elution of gentamicin from a new synthetic bone substitute in vitro with the performance in clinical applications.

**Method:** Gentamicin release was measured from a synthetic bone graft substitute, comparing *in vitro* and *clinical* conditions:

1) elution in Ringers solution. The bone graft substitute contained 175mg gentamicin per 10mL. The material was introduced either as paste or as pre-set beads with a high or low surface areas, >100cm<sup>2</sup> and 24cm<sup>2</sup> respectively. The gentamycin release was measured by daily collection of samples.

2) elution in patients treated for trochanteric hip fractures(n=6) or uncemented hip revisions(n=5) 7,3±1,1mL of substitute was implanted and drainage was collected at 6h,12h,24h,30h,36h post-op. Blood serum was collected every hour for the first 6h and thereafter every 6h until 4 days post-op, urine - daily for the first 7 days post-op.

3) elution in patients treated after bone tumor resection(n=8), 12,1±5,5mL of substitute was implanted and both drainage and blood serum were collected daily until 2 days post-op. Gentamicin concentrations were analyzed using antibody technique.

**Results:** In the *in vitro* study, there was an initial peak in the gentamicin concentration (GC) for all the samples and at a level above 4mg/L, which is the MIC break point, during the whole test period of 28 days. All gentamicin was released during the test period and more than 95 % had been released after 2-4 days independently of the surface area of the material, or if it was pre-set or paste. In the clinical studies similar results were found. Gentamicin was detected in the drainage until 2 days post-op. and the hip patients 40% less GC - compared to the tumor patients. In the blood serum with higher GC in the tumor patients and non-detectable levels after 2 days post-op for the hip patients. The GC was significantly lower than maximum systemic level recommended of 12 mg/L. In the urine, GC was above the MIC of 4mg/L for the first seven days post-op.

**Conclusions:** A reliable *in vitro* test method has been identified for the future development of additional new and effective antibiotic containing bone substitutes. The new bone regenerating carrier gives very high local antibiotic release for a controlled short time after surgery and high systemic serum concentrations are avoided.

### Free Papers B

#### [O25] ASSOCIATION OF TNF- $\alpha$ AND LYMPHOTOXIN- $\alpha$ GENE POLYMORPHISMS AND SUSCEPTIBILITY OF EXTREMITY CHRONIC OSTEOMYELITIS IN CHINESE POPULATION

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**Aim:** Previous studies have indicated that TNF- $\alpha$  and lymphotoxin- $\alpha$  (LTA) gene polymorphisms are involved in the pathogenesis of inflammatory diseases. However, potential associations of TNF- $\alpha$  and LTA gene polymorphisms with extremity chronic osteomyelitis remain unclear. This study aimed to investigate association of TNFA gene polymorphisms (rs1800629, rs361525, rs1799964, rs1800630, rs1799724 and rs1800750) and LTA gene polymorphism (rs909253) with the susceptibility of extremity chronic osteomyelitis in Chinese population.

**Method:** A total of 233 patients with extremity chronic osteomyelitis and 200 healthy controls were genotyped for the above 7 single-nucleotide polymorphisms (SNPs) in TNFA and LTA genes using the SNaPshot genotyping method.

**Results:** Significant difference was found regarding the genotype distribution of rs909253 between patients and healthy controls ( $P = 0.002$ ). The mutant allele C frequency in rs909253 in patient group was significantly higher than that in control group ( $P = 0.001$ , OR = 1.57, 95% CI 1.200-2.054). In addition, significant associations were identified between rs909253 and the risk of developing chronic osteomyelitis by dominant model ( $P = 0.025$ , OR = 1.676, 95% CI 1.065-2.638), recessive model ( $P = 0.001$ , OR = 2.108, 95% CI 1.333-3.335) and homozygous model ( $P = 0.001$ , OR = 2.631, 95% CI 1.491-4.642) using the multiple logistic regression analysis. However, no significant associations were identified between TNFA gene polymorphisms (rs1800629, rs361525, rs1799964, rs1800630, rs1799724 and rs1800750) and the susceptibility of developing chronic osteomyelitis.

**Conclusions:** The present study suggests that LTA gene polymorphism rs909253 may participate in the pathogenesis of chronic osteomyelitis in Chinese population.

## Free Papers B

### [O26] ROLE OF PREOPERATIVE BONE BIOPSY IN THE MICROBIOLOGICAL DIAGNOSIS OF LOWER EXTREMITY CHRONIC OSTEOMYELITIS

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**Aim:** The ultimate diagnostic proof of chronic osteomyelitis (COM) is the association of a compatible clinical presentation with an unequivocal positive deep bone sample culture. Intraoperative deep bone samples cultures has been widely considered the gold standard in this setting but the preoperative identification of the infecting microorganism through a bone biopsy is of paramount importance in the diagnostic and treatment protocol of any COM. Unfortunately, preoperative bone biopsies have proven to have a broad range of sensitivity values and the most useful biopsy technique remains unknown. The correlation of the preoperative and intraoperative microbiological results is a matter of concern. The purpose of this study was to assess the diagnostic accuracy of a percutaneous bone biopsy (PBB) and an open bone biopsy (OBB) in isolating the infecting organism in cases of lower extremity chronic osteomyelitis.

**Methods:** A retrospective study was done involving 29 patients suspected of COM and where either a PBB or OBB was performed during the preoperative diagnostic workup. Culture results from PBB and OBB were compared with intraoperative tissue cultures at the time of surgery. Epidemiologic data was recorded, Cierny-Mader type, number of samples, susceptibility profile, and technique-related complications. Only tibia and femur osteomyelitis were considered.

**Results:** Finally 29 patients were included in the analysis, twenty were men, with a mean age of 45 years old. In 19 cases the tibia was the involved bone. Type-IV osteomyelitis was the most frequent type of infection. The procedure was made percutaneously in sixteen cases (55%) and open biopsy was performed in thirteen patients. The most common pathogen encountered in our series were the Gram-positive cocci (*Staphylococcus aureus* in 13.8% of the cases, Coagulase negative *Staphylococcus* (CoNS) in 27.6% and *Streptococcus viridans* in 3.45% of the cases). Overall, the preoperative bone biopsy sensitivity was 48.2% while the specificity was 52.2%. Positive and negative predictive values were 54.2% and 46.15% respectively. In the case of the drugs most frequently used how local antibiotics, 50% of all *Staph. aureus* were resistant to gentamicin, 37.5% among CoNS and 20% among Gram-Negative Bacilli. No gram-positive resistance against Vancomycin was founded.

**Conclusions:** According our data, routine bone biopsy does not add a relevant diagnostic value in the preoperative microbiological diagnosis of COM. Although our accuracy is higher than normally reported in the literature, the cost, invasive nature, and the possibility of complications makes necessary to identify which patients could benefit from this diagnostic technique.

### Free Papers B

#### [O27] RISK FACTORS FOR RECURRENCE OF CHRONIC POSTTRAUMATIC OSTEOMYELITIS

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**Aim:** The incidence of posttraumatic osteomyelitis (PTO) is increasing in spite of new surgical techniques and development of new antimicrobial therapies. It has been difficult to assess outcomes of PTO because of the numerous risk factors involving the patients, trauma characteristics, surgical conditions, diversity of etiologic agents and long period of follow-up required to determine the effects of any treatment. We aim to identify factors predisposing to develop recurrence of chronic PTO.

**Method:** Between August 2007 and August 2012, a single-center prospective cohort study was carried out among 193 patients with PTO following orthopedic surgery. Bone and soft tissues were collected for cultures and PTO was defined according to CDC/NHSN criteria. Patient, injury, surgery-associated variables and microbiological records were identified for potential risk factors associated to recurrence of PTO. Univariate and multivariable analyses using logistic regression were performed, and  $p < 0.05$  was considered significant.

**Results:** We analyzed 192 patients with PTO, of which 38 (19.8%) had recurrence. One hundred and thirty-two (68.8%) patients were men and 25.9% were over 60 years of age. High-energy trauma due to road traffic accidents occurred in 57% of our population and 29.7% suffering fall from height. Open fractures were diagnosed in 37.8% of patients and 39.9% underwent more than one surgical debridement. Factors associated to recurrence in the multivariable analysis were age 61-80 years and above 80 years [hazard ratio (HR) = 6.086, 95% confidence interval (CI) = 2.459;15.061,  $p = < 0.001$ ] and [HR = 9.975 (95% CI = 3.591;27.714),  $p = < 0.001$ ], need for intraoperative blood transfusion [HR = 2.239 (95% CI = 1.138;4.406),  $p = 0.020$ ], and bone and soft tissue positive culture for *Pseudomonas aeruginosa* [HR = 2.700 (95% CI = 1.370;5.319),  $p = 0.004$ ]. When *P. aeruginosa* was the recovered pathogen, disease-free survival was lower than of *Staphylococcus aureus* and *Enterococcus* spp,  $p = 0.002$ . In terms of age, disease-free survival was of 38 months for patients 61 to 80 years and of 17 months for more than 80 years;  $p < 0.001$ .

**Conclusions:** Risk factors associated with recurrence of the PTO are difficult to be measured e the present study revealed that elderly patients, the need for intraoperative blood transfusion and *P. aeruginosa* culture were independently associated with recurrence of PTO.

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## Free Papers B

### [O28] ANTIMICROBIAL STEWARDSHIP IN THE MANAGEMENT OF ACUTE OSTEOMYELITIS AND SEPTIC ARTHRITIS IN CHILDREN

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**Aim:** North America is facing a rising epidemic involving strains of methicillin-resistant *Staphylococcus aureus* (MRSA) that, instead of being found almost exclusively in hospitals, are community-associated (CA-MRSA). These strains are aggressive, associated with musculoskeletal manifestations including osteomyelitis (OM), and septic arthritis (SA).

We aimed to establish novel management algorithms for acute OM and SA in children. We investigated *S.aureus* susceptibilities to current first-line antimicrobials to determine their local efficacy.

**Method:** The project was conducted at Nemours General Children Hospital in Florida, USA, following approval by the internal review board. A literature review was conducted. An audit of *S.aureus* antimicrobial sensitivities was completed over three years and compared against national standards. Susceptibilities of clindamycin, trimethoprim/sulfamethoxazole (TMP/SMX) and vancomycin were studied using local resistance ranges.

**Results:** Two algorithms for acute OM and SA management were created adopting a multidisciplinary team approach from admission to discharge whilst differentiating higher risk patients within fast-track pathways. We analysed 532 microbiology results for antibiotic susceptibilities from 2012 to 2014. Overall, 51% of *S.aureus* infections were MRSA versus 49% methicillin-susceptible *S.aureus* (MSSA). Surprisingly, clindamycin resistance rates rose compared to 2005 (MRSA 7% in 2005 vs 39% currently, MSSA 20% vs 31% and total *S.aureus* resistance rate of 8% vs 35%, respectively). MRSA and MSSA isolates were near 100% sensitive to Vancomycin and TMP/SMX. No appropriate national standards existed.

**Conclusions:** Multidisciplinary based algorithms were created for acute OM and SA treatment in children. Possible therapeutic roles for ultrasound guided aspiration and corticosteroids were highlighted in SA. Our audit revealed equal incidence of MSSA to MRSA, supporting national figures on falling MRSA. Interestingly, increased resistance of MSSA and MRSA was found towards recommended first line clindamycin, raising concern over its efficacy.

### Free Papers B

#### [O29] BONE TRANSPORT FOR POST-INFECTIOUS SEGMENTAL DEFECTS IN CHILDREN

Antonio Loro<sup>1</sup>

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**Aim:** Untreated or improperly managed osteomyelitis can lead to several complications, bone loss being one of the most challenging to manage. Bone transport is just one of the surgical options available for filling the bone gaps and promote bone union. This presentations focuses on bone transport for long bones gaps in pediatric age group, highlighting its advantages and disadvantages, its indications and its complications.

**Method:** Between 2006 and 2014. 71 patients underwent a procedure of bone transport. Out of them, 39 were males and 32 females, with an average age at presentation of 8.7 years. The bone involved were tibia (27 right, 25 left), femur (4 right, 9 left), radius (1 right, 4 left) and ulna (1 right). Clinically speaking, the children presented with one of the following picture:

- a. Pathological fracture, with sequestration without or minimum involucrum formation
- b. Extensive, extruded diaphyseal sequestrum, with loss of soft tissues
- c. Post-surgical gap, with residual or quiescent infection.

Bone transport was preceded by one of the following procedure: sequestrectomy, sequestrectomy and external fixation, external fixation with sequestrum in situ. Monolateral fixator was used in 46 patients, ring fixator in 25. Bone transport started 7 days after the ostetomy, at the rhythm of 1 mm per day. Plastic surgery procedures were used in 3 kids

**Results:** Bone reconstruction was primarily obtained in 50 patients; non-union at the docking point was observed in 18. It required additional procedures of bone graft or site refreshing, associated with external fixation. Pins replacements and/or fixator adjustment were required in 24 patients. Several procedures were required during transport to overcome technical mistakes or to handle unexpected complications. All patients were able to walk unsupported. Reduced knee flexion was observed in 11 patients, knee fusion in 4, ankle fusion in 3, limb length discrepancy in 20, axial deformity in 6.

**Conclusions:** Bone transport has proved to be a reliable technique for managing segmental bone defects in children. It requires long time and it is prone to several complications. Strict medical supervision is necessary all along the process. Besides filling the gap, it can achieve limb equalization when needed. The presence of infection is not a contraindication to concurrent sequestrectomy and transport. The treatment is long, challenging, strenuous for the patient, the family and the medical staff but the results can be rewarding in terms of limb function.

## Key Session 3

### [O30] WHAT CAN THE REGISTERS TELL US ABOUT INFECTION AND WHAT CAN THEY NOT TELL US?

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The national arthroplasty registers function as a continuous post-marketing surveillance of arthroplasties. Rear events after joint replacements as infection, are suitable for studying in such huge databases. The interpretation of these data requires, however, some knowledge.

Reported revisions due to infection to the Norwegian Hip Arthroplasty Register (NAR) have increased continuously during the last 29 years; both for cemented and uncemented THA. For all groups the increase has been most pronounced the first postoperative year. Increased reported frequency of revisions to a national register is, however, not necessary the same as increased incidence of infected THA. Although a true increase in incidence of infection after THA has probably taken place, our findings are also influenced by improved diagnostics of infection, changed revision policy and improved reporting of revision due to deep infection.

National registers are suitable to study different variables (as gender, age, comorbidity, implants, theatre ventilation, antibiotic prophylaxis), and comparing different surgical procedures (as in revision of infected arthroplasties).

The reliability of the data in a register is dependent on sufficient coverage (how many of the hospitals in the country are reporting) and completeness (how many of the operations, both primary operations and reoperations, from each hospital are reported). The validity of the infection diagnosis in the registers has been questioned, since the diagnosis is depending on the assessment of the reporting surgeon immediately after surgery and before microbiological confirmation. Registers tend to underestimate the incidence of deep infection as revisions (i.e. reoperations with removal or exchange of part of or the whole implant) are record more reliable than soft tissue procedures for infections.

Register studies are for practical and economic reasons suitable if long term comparisons of several implants are to be done. And they show us how the treatment functions in real life (high external validity). Randomized controlled trials (RCT) have advantages as to prove a hypothesis, ability to control for known variables, and for clearly defined problem in a clearly defined patient group. We need both register and randomised studies, they provide different information. One is not better than the other - they are complementary.

### Key Session 3

#### [O31] THE UK PERSPECTIVE ON REGIONAL INFECTION NETWORKS AND THE FLEDGLING BONE AND JOINT INFECTION REGISTRY

**Mike Reed<sup>1</sup>**

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In line with other European countries and the draft NHS England service specification several regional bone and joint infection networks have evolved. There may be between 3 and 6 networks in England. One region has had specific NHS England funding to establish a network where a multidisciplinary team (MDT) decides treatment for all cases.

The outcomes and influence of these networks will be discussed and the likely future direction. In order to capture the results of such networks and the outcomes of bone and joint infection overall we need to establish National registry to allow individual MDTs to collect and analyse their results, and improve. Many questions about the risks and benefits of specific treatments can be answered. The Bone and Joint Infection Registry (BAJIR) has been developed to support these MDTs and gather data, and an initial 20 units will pilot data collection.

## Key Session 3

### [O32] CERTIFICATION PROCESS OF MSI UNITS IN EUROPE – KEY-FACTORS – CORNER-STONES – LIMITS

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Musculo-skeletal infections are one of the most critical diseases in orthopedic surgery. Problem oriented, rational treatment is a must.

In addition the topic gets more and more in the focus of politics and health care insurances. The call for clear determined rationales becomes louder. In some European countries politics already dictates the way, in others health care insurances press for certificated centers.

Nevertheless specific national and international accepted guidelines for the medical aspect are missing as well as regulations how to create MSI Units in hospitals.

Members of the EBJIS formed a “certification conference” in order to create an Europe-wide acceptable catalogue of basic requirements for

- a. MSI-units and
- b. (post-graduate) medical education

In this regard the most serious problem to overcome are the different medical-political and medical-educational systems in Europe. Facing this, the Conference defined three key-factors and came to the agreement, that these guidelines must

- a. strictly be focused on the medical requirements
  - a. education
  - b. hospital equipment
- b. exclude politics and
- c. create a system where participation is strictly voluntary

The specific demands on the way to this European solution, possible way of their implementation, corner-stones and limits are outlined in the lecture based on the German situation.

### Key Session 3

#### [O33] HOW CAN WE LEARN FROM OWN MISTAKES? THE URGENT NEED FOR STANDARDIZED DIAGNOSTIC CRITERIA AND OUTCOME DEFINITION OF PROSTHETIC JOINT INFECTION

**Andrej Trampuz<sup>1</sup>**

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Several definition criteria for the diagnosis of prosthetic joint infection (PJI) are used, but none of them is clinically validated and uniformly accepted. Particularly the definition of low-grade PJI cause great variability of epidemiological and outcome data between institutions and makes them difficult to compare. Therefore, establishment of a uniform database is proposed, using standardized diagnostic criteria, follow-up evaluation and outcome definition: the European PJI cohort study (EPJIC).

The first aim of EPJIC study is to improve the management of PJI and learn from own mistakes by systematic analysis of consecutively included patients with revision joint surgery. Factors associated with better outcome regarding infection (assessed by the infection-free interval), joint function (assessed by the degree of pain, mobility, range of motion) and quality of life will be analyzed. Patients with revision joint surgery of hip, knee and shoulder joints for PJI and aseptic reasons will be recruited in selected participating study centers. Clinical, radiological, pharmacological, laboratory, microbiological, treatment and outcome data will be systematically collected using a standardized electronic Case Report Form. Long-term follow-up will be implemented with clinical evaluation after 3 months and 1 year, followed by phone or mail contact after 2, 5 and 10 years after PJI diagnosis. In addition to the databank, a linked biobank of clinical strains will be established.

The second aim of EPJIC is to provide an accessible infrastructure for implementation of side-projects investigating specific research questions regarding diagnosis, antimicrobial or surgical treatment.

The third aim is to obtain objective, accurate and comparable data on PJI on a broad international level to raise public awareness and get important information for funding applications to European agencies.

## Rapid Fire Papers 1

### [O34] SYNOVIAL CALPROTECTIN; A RAPID TEST TO DIAGNOSE A PROSTHETIC JOINT INFECTION

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**Introduction:** In the last couple of years, several synovial biomarkers have been introduced in the diagnostic algorithm for a prosthetic joint infection (PJI). Alpha defensin-1 proved to be one of the most promising, with a high sensitivity and specificity. However, a major disadvantage of this biomarker are the high costs. Calprotectin is a protein that is present in the cytoplasm of neutrophils, and is released upon neutrophil activation. Its value has been established for decades as a (fecal) marker for inflammatory bowel disease.

**Aim:** To determine the efficacy of synovial calprotectin in the diagnosis of a prosthetic joint infection.

**Methods:** We prospectively collected synovial fluid (from hip, knee and shoulder) from patients with a proven PJI (n=15) and from patients that underwent a revision surgery without signs of a PJI (n=19). Patients with an active rheumatoid arthritis and/or gout were excluded from the study. Synovial fluid was centrifuged and the supernatant was used to measure calprotectin, by using a rapid, point of care test. This test was validated for synovial fluid analysis of calprotectin using an ELISA. A Mann-Whitney U test was used to calculate the difference between both patient groups.

**Results:** The median calprotectin level was 899 mg/L (range 28-2120) for PJI versus 22 mg/L (range 0-202) for controls ( $p < 0.0001$ ). With a cut-off value of 50 mg/L, synovial calprotectin has a high sensitivity of 93%, and a specificity of 84%. The positive and negative predictive values are 82% and 94%, respectively.

**Conclusions:** Synovial calprotectin is a potentially valuable biomarker in the diagnosis of a PJI. With a point of care test, a rapid quantitative diagnosis can be made within the operating room (results are obtained within 20 minutes), and could help in the decision making process to reimplant a prosthesis in an one stage procedure. In comparison to the currently available test (to measure alpha defensin-1), the measurement of calprotectin test is much cheaper (500 euro versus 20 euro per sample) and easily to implement in hospitals where this test is already available. Its diagnostic efficacy for exclusively low-grade PJI should be further elaborated.

### Rapid Fire Papers 1

#### [O35] PROSPECTIVE, RANDOMIZED COMPARISON OF ONE- VERSUS TWO-STAGE BURSECTOMY FOR MODERATE TO SEVERE SEPTIC BURSTITIS

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**Aim:** The optimal surgical approach for patients hospitalized for moderate to severe septic bursitis is not known, and there have been no randomized trials of a one-stage compared with a two-stage (i.e., bursectomy, followed by closure in a second procedure) approach. Thus, we performed a prospective, non-blinded, randomized study of adult patients hospitalized for an open bursectomy.

**Method:** Patients were randomized 1:1 to a one-stage vs. a two-stage surgical approach. All patients received postsurgical oral antibiotic therapy for 7 days. These are the final results of the prospective study registered at ClinicalTrials (NCT01406652).

**Results:** Among 164 enrolled patients, 130 had bursitis of the elbow and 34 of the patella. The surgical approach used was one-stage in 79 and two-stage in 85. The two groups were balanced with regards to sex, age, causative pathogens, levels of serum inflammatory markers, co-morbidities, and cause of bursitis. Overall, there were 22 treatment failures: 8/79 (10%) in the one-stage arm and 14/85 (16%) in the two-stage arm (Pearson- $\chi^2$ -test;  $p=0.23$ ). Recurrent infection was caused by the same pathogen a total of 7 patients (4%), and by a different pathogen in 5 episodes (3%). The incidence of infection recurrence was not significantly different between those in the one- vs. two-stage arms (6/79 vs. 8/85;  $\chi^2$ -test:  $p=0.68$ ). In contrast, outcomes were better in the one- vs. two-stage arm for wound dehiscence (2/79[3%] vs. 10/85[12%] ;  $p=0.02$ ), median length of hospital stay (4.5 vs. 6 days), nurses' workload (605 vs. 1055 points) and total costs (6,881 vs. 11,178 Swiss francs) (all  $p<0.01$ ).

**Conclusions:** For adult patients with moderate to severe septic bursitis requiring hospital admission, bursectomy with primary closure, together with 7 days of systemic antibiotic therapy, was safe, resource-saving and effective. Using a two-stage approach did not reduce the risk of infectious recurrence, and may be associated with a higher rate of wound dehiscence than the one-stage approach.



## Rapid Fire Papers 1

### [O36] COMPARISON OF KNEE ARTHRODESIS WITH KNEE ARTHRODESIS NAIL SYSTEM AND FEMORO-TIBIAL NAIL COMBINED WITH ALAC SPACER AS SALVAGE THERAPY FOR INFECTED KNEE WITH BONE DEFECT

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**Aim & introduction:** Infected knee with bone defect resulting from failed total knee arthroplasty (TKA) or destruction of native joint can necessitate restoration of segmental defect and arthrodesis for therapy of infection and maintenance of walking ability. In segmental knee defect external fixators or KAFO are not suitable, not comfortable and poor tolerated by elderly patients. Both custom-made Femoro-Tibial Nail (FTN) combined with acrylic cement spacer and Knee Arthrodesis Nail System (KANS) offer maintenance of supportive function of extremity and avoidance of leg length discrepancy after removal of TKA.

**Method:** The group consists of 13 patients. In 12 cases knee arthrodesis have been performed due to infection with bone defect after removal of infected TKA and in 1 case due to inflammatory destruction of native knee joint. In 7 cases FTN with ALAC spacer and in 6 cases KANS (5 cases Orthopedic Salvage System-OSS; 1 case Link KANS) was used. In cases treated with FTN the gap between distal femur and proximal tibia was filled with hand-made acrylic cement spacer loaded with selected antibiotic (2g per 40g cement) so that the spacer finally gained cylindrical shape.

**Results:** Stable knee was noted after 7 years in 4 of 7 knees treated with FTN with ALAC spacer and after 2 years in 6 of 6 after KANS. Infection free knee was gained after 7 years in 4 of 7 cases treated with FTN with ALAC spacer and after 2 years in 5 of 6 cases treated with KANS. Amputation was necessary after 6 years in 3 of 7 cases treated with FTN with ALAC spacer and after 2 years in none case treated with KANS. Complications occurred in 2 cases after FTN with ALAC spacer (1x: FTN breakage, 1x: stress fracture of femoral neck) and in 1 case after KANS (OSS implant failure). Replacement of FTN nail and cement spacer in 1 case and respectively revision of OSS KANS in 1 case was performed.

**Conclusions:** Compared with the KANS, custom-made FTN combined with ALAC spacer proved to be effective up to 6 years, but showed higher rate of complications and amputations after 6 years. It can be considered as a temporary low-cost salvage procedure for infected TKA with segmental bone defect as 1<sup>st</sup> stage in two-stage arthrodesis for infected knee prosthesis.

### Rapid Fire Papers 1

#### [037] A CALCIUM SULPHATE / HYDROXYAPATITE BONE GRAFT SUBSTITUTE ELUTING GENTAMICIN IN THE TREATMENT OF DIABETIC FOOT OSTEOMYELITIS: A MID-TERM FOLLOW-UP

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**Aim:** Since July 2013 our group has been using an antibiotic bone substitute, composed of calcium sulphate, hydroxyapatite and gentamicin sulphate (CSH + HA + GS), in the treatment of osteomyelitis (OM) in diabetic foot. The aim of this work was to evaluate the mid-term efficacy of this treatment regime on outcomes. A favorable outcome in diabetic foot includes no recurrence of OM, healed soft tissues and the ability to weight-bear.

**Method:** To date we have used the CSH + HA + GS bone substitute in 24 diabetic patients with OM. In this study we reviewed patients treated from July 2013 to December 2014, in which we used CSH + HA + GS to treat OM of the forefoot, midfoot and hindfoot, and evaluated how many patients are able to walk and fully weight-bear at present. We identified 11 pts treated during this time period; 1 with bilateral 1<sup>st</sup> metatarsal-head OM due to plantar ulcers, 5 with midfoot OM secondary to Charcot deformities and ulcers, 5 with hindfoot OM due to pressure ulcers or Charcot deformity. We continuously monitored the patients for recurrence of OM, ulcers and soft tissue inflammation in our outpatient department.

**Results:** Of the 11 patients, two died during follow up (both patients had calcaneal ulcers; one died in the 1<sup>st</sup> month and one in the 2<sup>nd</sup> month after treatment, both due to cardiovascular disease). For the remaining nine patients, we had an average of 25 (17–33) months follow-up. One patient did not heal, presenting with a persistent mid-foot lesion in a Charcot foot. Another patient with bilateral forefoot ulcers had a plantar ulcer recurrence under the left 1<sup>st</sup> metatarsal foot, 19 months after bone substitute application and primary healing. This patient is still weight-bearing on the right foot, as are the remaining 6 patients. In 7 patients (1 with bilateral forefoot, 4 with mid-foot and 3 with hindfoot OM) no recurrence of OM or ulcers was observed.

**Conclusions:** This study suggests that a CSH + HA + GS bone substitute can be used to treat diabetic foot OM. Our mid-term results show good clinical outcomes in terms of ulcer healing, no recurrence of OM and weight-bearing.

## Rapid Fire Papers 1

### [O38] RISK REDUCTION ON PJI WITH *S. AUREUS* ERADICATION THERAPY IN THA

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**Aim:** Prosthetic joint infection (PJI) is a major complication in THA. Nasal carriage with *S. aureus* is a well-defined risk factor for infection in hospitalized patients. Risk for infection is reduced up to 50% by eradication therapy. Since PJI rates are very low and only 25% of the population are carriers, significant differences are hard to show and reports on PJI have been inconclusive. We analyzed the effect of *S. aureus* eradication therapy in THA.

**Methods:** From 2011, patients receiving THA are screened for *S. aureus* carriage and carriers are treated. This group was retrospectively compared with a historical THA group in which no screening and eradication therapy was done. We assumed similar carrier rates in both groups and calculated the risk reduction of eradication therapy for PJI in comparison to the historical carriers without treatment. Fisher's Exact test was used to compare outcome.

**Results:** 2072 patients were screened and 478 patients were positive (23%). The historical control group consisted of 1248 patients, with 288 calculated carriers (23%). 15 PJI (0.72%) occurred vs 14 (1.12%) in the historical group ( $p=0.16$ ). A 52% reduction in *S. aureus* infections was found (0.33% vs 0.64%  $p=0.15$ ). Infection rates for PJI caused by *S. aureus* was similar in non-carriers and carriers after eradication therapy (0.3 vs 0.4%  $p=0.506$ ). The calculated infection rates in carriers in the historical group was reduced from 2.6% to 0.8% (RR 3,25,  $p=0.07$ ) by eradication therapy and from 1.7% to 0,4% (RR 4,25,  $p=0.07$ ) for *S. aureus* PJI.

**Conclusions:** A clear trend in reduction of PJI was demonstrated as a result of *S. aureus* screening and eradication therapy, reducing the rate of PJI for carriers to the same level as non-carriers.

### Rapid Fire Papers 1

#### [O39] EVALUATION OF THE CURRENT TRENDS AND MANAGEMENT OF SPINAL INFECTION

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**Aim:** Spondylodiscitis and vertebral osteomyelitis can lead to long-term sequelae if not diagnosed and treated promptly and appropriately. The Royal National Orthopaedic Hospital (RNOH) has devised a new spinal infection referral system within the UK that allows cases to be discussed in a specialist multi-disciplinary (MDT) forum. National guidelines were devised in 2013 to help guide treatment, which recommends both tissue biopsies from the affected region and a MRI of the entire spine. The aims of this study were to assess the current treatment and referral practices and compare them with the set guidelines. It is hypothesised that a high percentage of patients are started on antibiotics without a biopsy or a positive set of blood cultures, a low percentage of patients are referred without undergoing a MRI of the full spine and that there is a long delay in referral to the MDT.

**Method:** A retrospective case study analysis was carried out on all spinal infection referrals received by the Royal National Orthopaedic Hospital over a 2-year period (2014-16), using the standards set by the current national guidelines. Clinical features, haematology results, imaging, biopsy results, treatment and outcome were all reviewed. Three key areas were addressed; whether antibiotics were commenced before positive cultures or biopsy, whether a MRI of the entire spine was performed and the time taken for referral from the onset of symptoms.

**Results:** A total of 49 cases were identified, the average age was 56 years and the majority were male (67%). The most common organisms grown were staphylococcus aureus and mycobacterium tuberculosis. Lumbar (37%) and thoracic (31%) spine were the most predominant regions affected. As predicted only 42% of the patients were referred with a whole spine MRI, only 33% had a biopsy and 29% had positive blood cultures before starting antibiotics. The average time to referral was 62 days overall (10 days for acute referrals).

**Conclusions:** This multicentre study highlights a number of key concerns with both the referral and treatment of spinal infections. New national infection guidelines recommend a tissue sample prior to antibiotics; however this study showed that only 45% of patients had either a biopsy or positive blood culture before starting antibiotics. The time to referral was prolonged and the majority of patients did not receive a whole spine MRI. Overall this confirms the study's hypothesis and the need for better management of this complex and debilitating condition.

## Rapid Fire Papers 1

### [O40] RESULTS OF TREATMENT OF SEPTIC ARTHRITIS OF THE HIP WITH AN ANTIBIOTIC-LOADED CEMENT SPACER

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**Aim:** Septic arthritis of the hip is a rare entity among the adult population, but with a potential severe repercussion. The most accepted treatment is the hip debridement, even though a notorious proportion of the cases need further hip replacement owing to the cartilage destruction. The aim of this study is to analyse all our cases of septic arthritis of the hip treated with a 2-stage strategy using an antibiotic-loaded cement spacer.

**Method:** We present a retrospective review of all our cases of septic arthritis of the hip diagnosed between 2004 and 2016 that were treated with an antibiotic-loaded cement spacer. We analysed age, gender, comorbidities, aetiology, duration of symptoms, C-reactive protein values, erythrocyte sedimentation rate, initial treatment, cultures, definitive treatment and evolution.

**Results:** A total of 14 cases were included with a mean age of 47 years: 8 men and 6 women. The aetiology of the arthritis was: haematogenous in 8 cases, after osteosynthesis in 5 cases and after arthroscopy in 1 case. An initial debridement was performed in 6 cases whereas the spacer was directly implanted in 8 cases. The cultures were positive for: *Staphylococcus aureus* (4 cases), *Candida albicans* (2 cases), *Staphylococcus epidermidis* (1 case), *Pseudomonas aeruginosa* (1 case), *Enterococcus faecium* (1 case), *Serratia marcescens* (1 case), *Streptococcus dysgalactiae* (1 case), *Salmonella spp* (1 case) and negative in 2 cases. The evolution was: total hip arthroplasty in 10 cases, spacer preserved in 2 cases, pending of hip replacement in 1 case and exitus in 1 case. All cases presented negative cultures at the moment of implantation of the definitive prosthesis.

**Conclusions:** A 2-stage strategy using an antibiotic-loaded cement spacer prior to the definitive hip prosthesis is a good treatment for the septic arthritis of the hip in cases with important cartilage destruction.

### Rapid Fire Papers 2

#### [O41] THEATRE DOOR OPENING AS A MARKER OF THEATRE DISCIPLINE AND INFECTION CONTROL: ARE STANDARDS SLIPPING?

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**Aim:** Peri-prosthetic joint infection is a serious and expensive complication of joint arthroplasty. Theatre discipline has infection prevention at its core with multiple studies correlating increased door opening with surgical site infection. The WHO, NICE and Philadelphia Consensus all advocate minimal theatre traffic. The Dutch Health Inspectorate consider >5 door openings per procedure excessive.

**Method:** This prospective observational study over five weeks observed theatre door traffic during hip and knee arthroplasty within the eight laminar flow theatres at our institution. Two students attached to the department collected data. Half way through the study notices reminding people not to enter during arthroplasty were placed on the theatre doors.

**Results:** The students observed 59 knee or hip arthroplasty 32 prior to notice's being placed on the theatre doors. The average number of door openings per case was 67 (25-130) prior to intervention and 70 (34-158) after intervention, although opening rates reduced from 1/min to 0.9/min ( $p=0.053$ ). Reasons for door opening were drawing up medications, blood tests, delivery surgical equipment, general enquiries, staff breaks and "unknown" entries and exits.

**Conclusions:** The rate of door opening was excessive and remained so after reminders were displayed. This deterioration in theatre discipline potentially has a significant negative impact on theatre hygiene and infection control. Individually wrapped components and screws along with the increasing component choice may have played some role in 'legitimizing' door opening. It will be challenging to reverse this behavioural trend but must be achieved.

## Rapid Fire Papers 2

### [O42] INFLUENCE OF DELAY AND TEMPORARY PRESERVATION CONDITIONS OF BACTERIOLOGICAL TISSUE SAMPLES ON THE DIAGNOSIS OF BONE INFECTION: AN EXPERIMENTAL MODEL

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**Aim:** Bacterial identification in musculoskeletal infection is sometimes difficult and treatment strategy difficult facing unknown pathogen agent. We wonder if the delay of incubation and the preservation conditions of the samples between surgical procurement and subculture on plates have an influence.

**Method:** 25 cm<sup>3</sup> bone fragments were obtained from femoral heads retrieved during hip arthroplasty and excluded for bone transplant donation. Informed consent was obtained from the donor for research purpose. The study was approved by the Ethic Committee (N°B403201317725). Bone fragments were immersed for 30 minutes under gently agitation (140 RPM) at 35°C in a physiologic solution (negative control) or two solutions with two concentrations of staphylococcus epidermidis (0.5 Mc Farland or 1.5x 10<sup>8</sup> bacteria and 7.5x10<sup>2</sup> bacteria). Bone samples were separated and preserved at room temperature or at 4°C until seeded on Petri Plates to observe the influence of preservation conditions. Samples were plated after different delays (T0, T30min, T1H, T2H, T4H, T6H, T8H, T12H, T16H, T24H et T48H) to observe the influence of delay of culture. Experiments were repeated 5 times. When culture was positive, results were expressed with the number of colony.

**Results:** We observed a regular diminution of number of colonies with the delay of culture. The number of colony goes to zero after 40 hours when the samples have been preserved at room temperature. Differences were not significant between preservation at room temperature and at 4°C for delay inferior to 04 hours but become significant for higher delay of culture in favor of low temperature preservation. With a low bacterial bioburden, no colony was recovered after a delay of 06 hours. False positive results were observed in 4% of the negative control.

**Conclusions:** This experimental model demonstrates the negative influence of delay of culture and preservation at room temperature if the culture is delayed for more than 04 hours. The negative influence is more critical when facing low bacterial bioburden as it is generally the case in musculoskeletal infections. Our model do not included biofilm embedded bacteria and is limited to a staphylococcus epidermidis strain. The results could be worse with anaerobic bacteria. Some inhibition due to antibioprophyllaxis given to patient just before hip arthroplasty could have negatively influence the results. This study stresses the importance of a rapid seeding of bacterial samples to improve bacterial identification. Procedures should be in place to transfer rapidly samples to the lab and process them immediately.

### Rapid Fire Papers 2

#### [O43] THE INFLUENCE OF TITANIUM AND STEEL FRACTURE FIXATION PLATES WITH DIFFERENT SURFACE TOPOGRAPHIES ON INFECTION RATES IN A RABBIT FRACTURE MODEL

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**Aim:** The aim of this study was to define the role of implant material and surface topography on infection susceptibility in a preclinical in vivo model incorporating appropriate fracture biomechanics and bone healing.

**Method:** The implants included in this experimental study were composed of: standard Electropolished Stainless Steel (EPSS), standard titanium (Ti-S), roughened stainless steel (RSS) and surface polished titanium (Ti-P). In an in vivo study, a rabbit humeral fracture model was used. Each rabbit received one of three *Staphylococcus aureus* inocula, aimed at determining the infection rate at a low, medium and high dose of bacteria. Outcome measures were quantification of bacteria on the implant and in the surrounding tissues, and determination of the infectious dose 50 (ID50).

**Results:** Of the 72 rabbits eventually included in the in vivo study, 50 developed an infection. The ID50 was found to be: EPSS  $3.89 \times 10^3$  colony forming units (CFU); RSS  $8.23 \times 10^3$  CFU; Ti-S  $5.66 \times 10^3$  CFU; Ti-P  $3.41 \times 10^3$  CFU. Significantly lower bacterial counts were found on the Ti-S implants samples compared with RSS implants ( $p < 0.001$ ) at the high inoculum. Similarly, lower bacterial counts were found in the bone samples of animals in the Ti-S group in comparison with both RSS and EPSS groups, again at the high inoculation dose ( $p < 0.005$ ).

**Conclusions:** In a preclinical in vivo model incorporating fracture biomechanics through an osteotomy, we could not identify any significant differences in susceptibility to infection when comparing titanium and steel implants with conventional (as currently used in the clinics) or modified topographies. The finding that Ti-S has a lower bacterial burden compared to both EPSS and RSS, but only when using a high bacterial inoculum, is interesting and indicates that the material (or its surface) may not influence the infection risk, but rather the infection severity. Furthermore, polished titanium implants with potential to reduce complications associated with tissue adherence, are not expected to affect the infection rate, or influence implant stability as shown in this fracture model.



## Rapid Fire Papers 2

### [O44] APPLICATION OF NEXT GENERATION SEQUENCING FOR THE DIAGNOSIS OF ORTHOPAEDIC INFECTION; AN EVALUATION OF FOUR DNA EXTRACTION TECHNIQUES

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**Aim:** Diagnosing Orthopaedic infection is limited by the sensitivity of culture methods. Next generation sequencing (NGS) offers an alternative approach for detection of microorganisms from clinical specimens. However, the low ratio of pathogen DNA to human DNA often inhibits detection of microorganisms from specimens. Depletion of human DNA may enhance the detection of microbial DNA<sup>1</sup>. Our aim was to compare four DNA extraction methods for the recovery of microbial DNA from orthopaedic samples for NGS.

**Method:** Simulated samples; pooled culture negative sample matrix was spiked with known concentrations of microorganisms, each panel consisting of 7 samples. Broth culture was performed on simulated samples for comparison with NGS\*.

DNA Extraction; total nucleic acid extraction was performed on a automated extraction platform\*\* using the viral NA assay. Modifications included:

1. mechanical lysis (glass beads)
2. lysis of human cells (saponin 0.025%), turbo DNase treatment and mechanical lysis
3. addition of MspJI enzyme post-extraction for methylated DNA digestion

Detection of human and microbial DNA; human endogenous (HE) gene rtPCR\*\*\* was utilised following manufacturer's recommendations. Microbial DNA was detected using SYBR green 16s ribosomal RNA rtPCR with high resolution melt-curve analysis\*\*\*\*.

**Results:** Broth culture recovered 64% (9/14) of the microorganisms from simulated samples.

A significant increase ( $p < 0.01$ ) in the cycle threshold ( $C_T$ ) (median  $C_T$  **25.9 IQR 25.5, 26.1**) of the HE gene rtPCR was observed using extraction method b, indicating a significant reduction in human DNA. No significant change ( $p = 0.38$ ) in the  $C_T$  of the HE gene rtPCR was observed between the baseline method (median  $C_T$  19.2 IQR 18.5, 19.7) and modifications a (median  $C_T$  18.4 **IQR 18.2, 19.4**) and c (median  $C_T$  19.3 IQR 18.6, 19.4).

Detection of microbial DNA was successful using the base line extraction method and modification a. Microbial DNA was not detected using the 16s ribosomal RNA rtPCR for modifications b and c.

**Conclusions:** This study has demonstrated that modification of DNA extraction methods using selective enzymatic digestion of human DNA negatively impacts on the recovery of microbial DNA from simulated specimens. Total DNA extraction allows the successful recovery of microbial DNA alongside a significant amount of human DNA. The effect of the presence of human DNA will be subsequently assessed through NGS CosmosID analysis to establish if NGS is more sensitive than broth based culture.

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\*BD Bactec; Becton Dickinson, USA, \*\*IXT (DiaSorin, Italy), \*\*\*Fast-Track Diagnostics, Malta,

\*\*\*\*RotorGene 600

### Rapid Fire Papers 2

#### [O45] COST-TO-BENEFIT EVALUATION OF ANTIBIOFILM MICROBIOLOGICAL DIAGNOSTIC TECHNIQUES IN ORTHOPAEDICS

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**Aim:** Implant-related infections, including peri-prosthetic joint infection (PJI) and infected osteosynthesis, are biofilm-related. Intra-operative diagnosis and pathogen identification is currently considered the diagnostic benchmark, however the presence of bacterial biofilm(s) may have a detrimental effect on pathogen detection with traditional microbiological techniques. Sonication and chemical biofilm debonding have been proposed to overcome, at least partially, this issue, however little is known about their possible economical impact. Aim of this study was to examine direct and indirect hospital costs connected with the routine use of antibiofilm microbiological techniques applied to hip and knee PJIs.

**Method:** In a first part of the study, the “Turn Around Time (TAT)” and direct costs comparison between a system to find bacteria on removed prosthetic implants\*, a closed system for intra-operative tissue and implant sampling, transport and antibiofilm processing, versus sonication has been performed. An additional analysis of the estimated indirect hospital costs, resulting from the diagnostic accuracy of traditional and antibiofilm microbiological processing has been conducted.

**Results:** Considering an average 5 samples per patient, processed separately with the sonication or pooled together, using the device\*, the direct costs comparison shows a similar overall average estimated cost per patient when using sonication (€ 400.00) or the system to find bacteria on removed prosthetic implants\* (€ 391.70). Indirect hospital costs of false positive or negative intra-operative pathogen identification can be estimated as, respectively, € 65,000 and € 90,000, including possible inadequate treatments and/or surgeries and/or need for further hospital stay, risk of infection recurrence/persistence, possible medico-legal claims, etc. Considering 1 out of ten cases of false identification as generating indirect hospital costs (“mitigation factor”: 90%) and an accuracy of current intra-operative microbiological sampling and testing of approximately 80%, it is calculated that any antibiofilm procedure able to increase the microbiological diagnostic accuracy by 10%, at an average cost per patient of € 500.00, would induce an average hospital cost saving of approximately € 100,000 per 100 treated cases.

**Conclusions:** To our knowledge, this is the first study specifically focused on the potential economical impact of the routine clinical use of microbiological antibiofilm processing techniques in orthopedics. The several limitations of this study notwithstanding, including the variable Country-based value of the different direct costs and the assumptions made concerning indirect costs calculations, this analysis points out how more accurate pathogen identification procedures can lead to an improvement of the management of implant-related infections in orthopaedics, with a substantial economical balance.

\*microDTTect

## Rapid Fire Papers 2

### [O46] VARYING DEGREES OF BIOFILM INHIBITION BY GENTAMICIN, VANCOMYCIN AND DAPTOMYCIN LOADED ACRYLIC LOADED CEMENT: AN IN VITRO MODEL OF CEMENT PERIPROSTHETIC INFECTION

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**Aim:** To evaluate the ability of different combinations of antibiotic loaded cement to inhibit bacteria growth and biofilm formation.

**Method:** Cement beads were aseptically prepared using Palacos R (plain 40g PMMA cement) or Palacos R+G (40g PMMA cement containing industrially added 0.5g of gentamicin), with or without supplementary antibiotics as follows: Palacos R; Palacos R+G; Palacos R *plus* 1g / 2g daptomycin; Palacos R+G *plus* 1g / 2g of daptomycin; Palacos R *plus* 1g / 2g vancomycin; and Palacos R+G *plus* 1g / 2g vancomycin. After production, each antibiotic loaded acrylic cement (ALAC) combination was allocated into two groups (group 1 and 2).

The group 2 cement beads were initially eluted in broth at 37° C for 72hours then transferred to fresh broth containing a known concentration of bacteria. The group 1 samples were not eluted but directly immerse in culture broth containing bacteria. All samples were thereafter incubated at 37°C for 24 hours. After incubation, group 1 samples were visually assessed for bacterial growth, while for the group 2 samples, biofilm formation were quantified using ultrasonication and viable bacteria counting technique. Three proficient biofilm forming *Staphylococcus epidermidis* bacterial strains (1457, 1585-RA and 5179-R1) were used for all experiments and the bacteria counts were expressed as colony forming units / ml (CFU/ml).

**Results:** In the group 1 samples, all the ALAC combinations were able to inhibit growth of all the three biofilm bacteria strains assessed except the gentamicin only samples in which biofilm growth were observed within 24hours. Meanwhile, in group 2, bacterial growth and biofilm formation by all three bacterial strains were observed on all the ALAC combinations, with the least biofilm formation being on the Palacos R+G *plus* 2g daptomycin combinations (mean CFU/ml: 1.04E +06) and the greatest on the gentamicin only cement (mean CFU/ml: 2.3E +07).

**Conclusions:** Our study demonstrates that the highest antimicrobial activity of ALAC is seen in the first 24 hours. However, after 72 hours of antibiotic release, fresh bacterial exposure in fresh broth resulted in varying degrees of biofilm colonisation of all ALAC surfaces. Nonetheless, the overall biofilm formation was least on the gentamicin / daptomycin combinations and the results were statistically significant when compared to plain cement ( $p < 0.05$ , two tail t-test).

### Rapid Fire Papers 2

#### [O47] CAN WE RELY ON HISTOPATHOLOGICAL RESULTS FOR THE DIAGNOSIS OF PROSTHETIC JOINT INFECTION?

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**Aim:** When a prosthetic joint infection (PJI) is suspected, guidelines recommend performing periprosthetic samples, at least one for histopathological examination and 3 to 6 for microbiological culture. The diagnosis of infection is based on the presence of neutrophil granulocytes whose number and morphology can be variable, resulting in definition of “acute” inflammation. The acute inflammation of periprosthetic tissue is supportive of infection. Since 2007, in our hospital, for all patients with suspected PJI who underwent surgery, from each sample taken by the surgeon, one part has been sent to the pathologist and the other one to the microbiologist. Our aim was to compare histopathological to microbiological results from samples taken intraoperatively at the same site.

**Method:** We conducted a retrospective study including all surgeries for which at least one couple “histopathology-culture” was found. Exclusion criterion was a history of antimicrobial treatment 2 weeks prior the surgery.

**Results:** From July 2007 to April 2015, 309 surgeries for suspected PJI were performed in 181 patients. Median age of the study population was 70 years, 60% of patients were male, 45% had a history of joint infection. The location of arthroplasty was knee in 50% of cases and hip in 46%, ankle and shoulder in 4%. Surgery was performed within one month after the last prosthetic surgery in 15% of cases. According to the criteria from the Musculoskeletal Infection Society, 60% of cases should have been considered as having an infection. The median number of samples per surgery was 4 (IQR 3-5) for histopathological examination and 5 (IQR 4-6) for culture. Finally, 1247 couples “histopathology-culture” were available. Among them, histopathological examination showed acute inflammation in 292 cases (23%) and subacute inflammation in 327 cases (26%). Microorganisms considered to be pathogenic were found in 582 samples (47%). The presence of neutrophil granulocytes was well correlated with the presence of those microorganisms (OR=4.1; IC 95% 3.1-5.5). As expected, the highest correlation between acute inflammation and positive culture was observed for early infection (< 1 month) (OR = 9; 3.6-23.4) and *Staphylococcus aureus* infection (OR = 4.8; 3.3-7.0). There was no correlation between acute or low-grade inflammation and anaerobic or Candida infection.

**Conclusions:** Our results confirmed histopathological examination is better correlated with culture in acute infection and/or infection due to highly virulent bacteria but must be interpreted with caution in case of chronic infection or infections due to microorganisms with low virulence.

## Key Session 4

### [O48] OPTIMIZATION OF THE INFECTED PATIENT PRIOR TO SURGERY

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The incidence of orthopaedic implant infection ranges between 1% and 2.4% for primary joint arthroplasty but significantly increases in revision arthroplasty, open fractures, spinal instrumentation and different subpopulations including patients with rheumatoid arthritis, diabetes mellitus, obese or elderly. Once the patient is infected, in the majority of cases a re-intervention is necessary to obtain a relatively high success rate. These additional interventions have a higher re-infection rate and frequently by multi-drug resistant microorganisms. These infections often occur as a result of a microbial contamination during or immediately after surgery. The development of surgical infection is the result of an imbalance between the burden of contaminating organisms and the host ability to eradicate or control this contamination. According to these facts, it is very important to improve the immune system of the patient taking into account that the treatment of infections cannot be delayed. The lecture will cover those recommendations that have demonstrated a positive impact on the incidence of post-surgical complications. In brief, leukocyte function is essential for winning the battle after wound contamination. Hyperglycaemia, hypoxia and hypothermia are well-recognized factors that reduce the bactericidal activity of leukocytes, therefore, it is necessary to avoid these situations during surgery. To reduce the risk of hyperglycaemia a strict metabolic control in diabetic patients and the identification of potential diabetic patients is important. Stop smoking and treating anaemia with iron therapy or erythropoietin will reduce the risk of tissular hypoxia during surgery. Nutritional status will also impact on the immune system function and wound healing, therefore, methods for identification malnourished patients will be discussed as well as the prevalence among infected patients. A particular aspect in infected patients is that in many occasions they are under antibiotic treatment or have recently received antibiotics reducing the “immunity of colonization” an important concept that will be discussed.

### Key Session 4

#### [O49] ANAESTHESIA FOR COMPLEX BONE INFECTION PATIENTS: KEEP IT SIMPLE

Svetlana Galitzine<sup>1</sup>

<sup>1</sup>Nuffield Orthopaedic Centre, Oxford University Hospitals NHS Trust

Nuffield Orthopaedic Centre specialises in surgery for patients with bone infection such as lower limb osteomyelitis (LLOM). Anaesthesia for these complex and prolonged orthoplastic procedures plays a crucial role in ensuring successful outcome. For free flap surgery, in particular, specific anaesthetic objectives include avoiding situations such as vasoconstriction due to poor perioperative pain relief, surges of blood pressure, and/or hypoxaemia.

In our centre, epidural anaesthesia and analgesia (EA) are very much advocated for “free flap” operations, both by surgeons and anaesthetists. In the past EA was usually combined with general anaesthesia and artificial ventilation (EA+GA), due to perceived discomfort to the patient and possible surgical difficulties during prolonged “awake” surgery. However, since 2007 we have growing experience of successful prolonged operations in supine position under a “simple” technique of EA+Sed as opposed to EA+GA. In our series of ca. 70 patients with orthoplastic procedures of mean duration over nine hours, there were no postoperative ITU admissions and anaesthesia related complications. There were no free flap failures. One patient requiring a revision of the venous anastomosis within 24hrs of initial surgery had it done successfully under an epidural “top-up”.

The main observed benefits of EA+Sed include reliable effective neuraxial anaesthesia without risks associated with prolonged GA or incomplete postoperative epidural analgesia. Over the years, EA+Sed for LLOM surgery has received very positive informal feedback from surgeons, anaesthetists and nursing staff. Most importantly, a recently completed study showed overwhelming positive formal assessment of patients’ experiences and outcomes.

Our tips for the successful anaesthesia for this type of surgery will be discussed, including strategies to minimise sedation and discomfort of prolonged surgery. Based on our experience, we recommend EA+Sed as a “simple” technique of choice for complex LLOM surgery. Good teamwork between the anaesthetists, surgeons and the patient are the keys to success.

**Key Session 4**

**[O50] GOOD MENTAL HEALTH FOR GOOD PHYSICAL OUTCOMES:  
HOW WE CAN HELP**

**Matthew Hotopf<sup>1</sup>**

<sup>1</sup> South London and Maudsley NHS Foundation Trust National Institute of Health Research Biomedical Research Centre (BRC), The Institute of Psychiatry, Psychology and Neuroscience, King’s College London, United kingdom

**ABSTRACT NOT AVAILABLE AT PRINT**

### Cierny & Mader Lecture

#### [O51] CROSSING BORDERS IN BONE AND JOINT INFECTION MANAGEMENT

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Bone and joint infection has been a neglected field for years. Seemingly unpredictable results, anticipated bad prognosis, lack of standards, relatively low-incidence or even denial of septic complications, all contributed to relegate this condition in a largely unexplored territory. Adventuring here then required to a few pioneers in last decades to cross borders and frontiers, many of which still stand in front of us...

1. **There is a land out there...** A very first border is to acknowledge the problem, avoiding superficial or blaming attitudes and, thus changing the way physicians, institutions, industry, patients and mass media may think.
2. **.. an unexplored land.** The next frontier are our dogmas and beliefs, the challenge of which will eventually really lead us to knowledge.
3. **Looking for new pathways and companions.** Lateral thinking and sharing experience with other disciplines, while staying focused on our target, will allow us to cross the third border.
4. **Tool kit for explorers.** To explore this land you need to be well equipped for complex and sometimes risky procedures: a tool kit that needs continuous training and update.
5. **Building bridges.** Crossing the fifth border requires the ability to favor translational research and to lower barriers to new technologies, with an approach similar to that adopted for “rare diseases”.
6. **Write down the map.** Crossing borders is worthless, if you don’t write down the map. Take your time to set the standards, share and validate protocols, tracing the way for the next explorer to come.
7. **Honor previous explorers.** Remember those that became “stars” and those who remained unknown, but yet gave their silent contribution to cross the next frontier.
8. **World is big, you are small.** Then cross the final border: your self-confidence. Bacteria were before you and will be after you, so... remain humble.



## Key Session 5

### [O52] IMPROVING OUTCOMES IN OPEN FRACTURES

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<sup>2</sup>BAPRAS

<sup>3</sup>CRG in specialised Orthopaedic surgery

There has been a steady evolution in our understanding of how and why open fractures become chronically infected. This has allowed us to offer better care and with a reduction in bone infection as well as an improvement in limb function. However, early thoughts on how to manage such injuries varied from applying wine soaked dressings to the encouragement of suppuration. The technical advances in modern Orthopaedic surgery and in Plastic surgery have allowed the possibility of salvaging limbs which would have been beyond saving some decades ago. I will discuss how we have become aware of the temporal relationships between surgical procedures and the avoidance of deep bone infection. The success of combined care has been firmly cemented in the ethos of severe limb trauma care as best practice and has culminated in the recommendations of Ortho-Plastic lists for the care of such patients by NICE. I will reflect on how this has been actioned in Bristol as a potential 'blueprint' for other major trauma centres.

### Key Session 5

#### [O53] USING PERFORATOR FLAPS TO COVER DEFECTS WITH CHRONIC OSTEOMYELITIS

Joon Pio (JP) Hong<sup>1</sup>

<sup>1</sup>Asan Medical Center University of Ulsan, Seoul, Korea

Treatment of chronic osteomyelitis involves aggressive debridement followed by robust soft tissue coverage. The dictum of muscle coverage being superior has been challenged by successful reports of coverage with skin flaps. The objective of this paper is to evaluate the efficacy of perforator flaps for reconstruction of chronic osteomyelitis defects.

A retrospective review of 120 patients with chronic osteomyelitis who underwent surgical debridement and reconstruction from April 2000 to November 2015 was done. Inclusion criteria were cases with chronic osteomyelitis for a minimum period of 6 weeks and with a follow up of at least one year after surgery. The correlation between recurrence and the following factors were analyzed: comorbidities, etiology, location of chronic osteomyelitis, duration of chronic osteomyelitis, chronic osteomyelitis grade (Cierny-Mader), limb vascular status, flap composition and orthopedic intervention. The outcomes analyzed were: flap loss, recurrence rate, primary remission rate, secondary remission rate and amputation rate.

There were total of 4% flap loss, 10% recurrence rate, 90% primary remission rate, 98% secondary remission rate and 1% amputation rate. Significant predictors of recurrence were major vessel compromise and patients with external fixator stabilization ( $p < 0.05$ ).

The perforator flap is able to achieve 90% primary remission rate and 98% secondary remission rate in the treatment of chronic osteomyelitis patients. The use of perforator flap is equivalent to the traditional muscle flap in effectiveness.

**Key Session 5**

**[O54] ROLE OF PLASTIC SURGEON IN PROSTHETIC JOINT INFECTION**

**Alex Ramsden<sup>1</sup>**

<sup>1</sup>Nuffield Orthopaedic Centre, Oxford University Hospitals, Oxford, United Kingdom

Prosthetic joint infection is a difficult surgical problem. Plastic surgeons have a range of skills and techniques that can contribute to successful long term eradication of infection but also the joint reconstruction. Subsequently they can play a key role in management of joint infection.

### Key Session 6

#### [O55] PREOPERATIVE ASSESSMENT AND PLANNING IN THE MANAGEMENT OF POST-TRAUMATIC OSTEOMYELITIS

**Charalampos Zalavras<sup>1</sup>**

<sup>1</sup>Keck School of Medicine of USC, Los Angeles, United States

Management of post-traumatic osteomyelitis is challenging. A detailed plan needs to be developed based on careful assessment of multiple factors involving the affected bone, the existing implants, the condition of the soft tissue envelope, the neurovascular and functional status of the extremity, the pathogen and clinical course of the infection, and the patient.

Bone considerations include anatomic location of osteomyelitis, status of fracture healing, extent of bone involvement, presence and size of bone defects, bone quality and presence of deformity. If implants are in place the treating surgeon needs to decide whether to remove them or not. Implants may be retained in acute post-traumatic infections, if they are providing stability, and be removed following fracture healing.

A well-vascularized soft tissue envelope promotes control of infection and fracture healing. Soft tissue abscesses need to be drained and previous incisions to be taken into account when planning the surgical approach. The need for soft tissue coverage should be evaluated. Neurovascular compromise of the extremity and adjacent joint stiffness may limit the potential for satisfactory function after management of post-traumatic osteomyelitis. The specific pathogen(s) and the previous clinical course of infection are important factors. Information about previous culture results and sensitivities, previous surgical management and antibiotic therapy, and the patient's response should be obtained.

Patient comorbidities affect the risk of recurrence of infection as well as the surgical risk and should be carefully assessed based on the Cierny-Mader classification. The patient should be medically optimized before surgery. Patient functional needs, expectations, compliance, and willingness to undergo potentially prolonged treatment should be evaluated.

Management of post-traumatic osteomyelitis starts with detailed preoperative assessment and planning. This is a multi-disciplinary process that requires the close collaboration of orthopaedic surgeons and infectious disease specialists.

## Key Session 6

### [O56] PATIENT-FRIENDLY SURGERY IN OSTEOMYELITIS

Martin McNally<sup>1</sup>

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**ABSTRACT NOT AVAILABLE AT PRINT**

### Key Session 6

## [O57] FROM DIAGNOSTICS TO DISCHARGE PLANNING: GETTING IT RIGHT FIRST TIME

Bridget Atkins<sup>1</sup>

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Patients with complex bone and joint infections often have unsatisfactory interactions with the healthcare profession, sometimes having the wrong diagnosis, the wrong orthopaedic surgery, poor soft tissue management and the wrong antimicrobial treatment. Even if three out of four elements on this list are correct, the outcome may still be poor. Sometimes all the elements are correct but they have not **all** been done at the same **time**. Patients may end up with multi-drug resistant organisms, drug side effects, pain, disability, leaking wounds, long hospital stays, depression and disillusionment with the medical profession.

Getting the diagnosis right is important – both anatomically and microbiologically. Risk factors for less common cause of osteomyelitis (e.g. tuberculosis, brucellosis) should be determined and an interactive relationship with the laboratory developed. Pre-op biopsies can sometimes be considered however meticulous intra-operative sampling, good laboratory processing and accurate interpretation of results is most crucial. No lab test will work well if surgical sampling is not expertly performed. This should be off antibiotics with no touch technique, separate sterile instruments and from multiple sites. Histology should always be performed. In the microbiology laboratory, prevention of contamination whilst adequately disrupting biofilm, using enriched media, culturing for an adequate duration and performing appropriate identification and antibiograms are vital to an accurate diagnosis. Sonication and molecular tests can be considered, their place in the clinical pathway being under evaluation.

Surgery should only be performed by a surgeon experienced in infection management and should take into account the patient's wishes and expectations. Soft tissue management is as important as the bones. Intra-operative and post-operative antibiotic therapy should be rational and managed with skill – whilst not causing harm to the patient. Clinical progress must be adequately monitored. Failure means a complete re-assessment, not simply prolonging antibiotics.

Much of this can only be delivered through multidisciplinary specialist bone infection units.

## Free Papers C

### [O58] COSTS AND RENUMERATION OF OSTEOMYELITIS TREATMENT INVOLVING FREE FLAPS: IMPLICATIONS OF RETURN TO THEATRE

Janka Fazekas<sup>1</sup>, Rebecca Shirley<sup>1</sup>, Martin McNally<sup>1</sup>, Alex Ramsden<sup>1</sup>

<sup>1</sup>Nuffield Orthopaedic Centre, Oxford, United Kingdom

**Aim:** This study aimed to define the increased costs incurred by a return to theatre for cases requiring free tissue transfer for surgical treatment of chronic osteomyelitis. We hypothesised that there would be a significantly greater cost when patients required re-exploration of the free flap.

**Method:** We retrospectively analysed the costs of a consecutive series of sixty patient episodes treated at the Bone Infection Unit in Oxford from 2012 to 2015. Treatment involved excision of osteomyelitis with free tissue transfer for immediate soft tissue cover. We compared the costs of uncomplicated cases with those who returned to theatre and determined the profit/loss for the hospital from remuneration through the UK National Health Service Tariff Structure.

**Results:** Hospital income according to UK HRG tariff was compared to the actual cost of treatment and these 60 cases were significantly underfunded overall ( $P < 0.005$ ). In just 1 case, the cost to the hospital was completely covered by tariff.

Six patients (10%) returned to theatre for urgent flap re-exploration with five flaps salvaged and one failed, requiring another free flap reconstruction (1.7%). These six patient episodes had a significantly higher mean cost compared to the uncomplicated cases. The average financial loss to the hospital for patients who did return to theatre was £18992 (range £8103 to £48380) and in those who did not was £9600 (range - £600 to £23717). The case requiring further free tissue transfer cost a total of £74158, £48380 more than the hospital was paid: the most extreme discrepancy. The overall loss for this group of 60 patients was £590766

**Conclusions:** Surgery for chronic osteomyelitis is multidisciplinary, complex and therefore expensive. However, this study demonstrates that the hospital currently makes a financial loss on almost all patients but especially if flap complications occur. This study has implications for the long term viability of specialist units treating this important disease.

### Free Papers C

#### [O59] ANTIBIOTIC RESISTANCE PROFILES OF SURGICAL SITE INFECTIONS IN HIP HEMIARTHROPLASTY; COMPARING LOW DOSE SINGLE ANTIBIOTIC VERSUS HIGH DOSE DUAL ANTIBIOTIC IMPREGNATED CEMENT

Ben Tyas<sup>1</sup>, Martin Marsh<sup>1</sup>, Catherine Molyneux<sup>2</sup>, Ramsay Refaie<sup>1</sup>, Tamsin Oswald<sup>2</sup>, Mike Reed<sup>1</sup>

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**Aim:** The incidence of fractured neck of femur (FNOF) is increasing yearly. Many of these patients undergo hip hemiarthroplasty. High dose dual-antibiotic cement (HDDAC) has been shown to reduce rates of deep surgical site infection (SSI) when compared to the current standard low dose single-antibiotic cement (LDSAC) in a quasi-randomised controlled trial. Some concerns exist regarding the use of HDDAC and the development of resistance. We reviewed cases of infection in LDSAC and HDDAC bone cement with regard to causative organism and resistance profile.

**Method:** A retrospective analysis was undertaken of all hemiarthroplasties within our trust from April 2008 to December 2014. We identified all patients in this time period who acquired a deep SSI from the trust SSI surveillance database. The infecting organisms and susceptibility patterns were collated for each cement.

**Results:** We identified 1941 hemiarthroplasties. There were 36 deep surgical site infections representing an infection rate of 3.1% in LDSAC patients and 1.2% in HDDAC patients. A wider variety of organisms were seen in the LDSAC compared to HDDAC. *Staphylococcus epidermidis* accounted for the majority of infections in both LDSAC and HDDAC patients. Infection with *Corynebacterium* species and *Staphylococcus aureus* was eliminated completely in HDDAC. There was minimal change in the proportion of Gram-negative and Gram-positive bacteria. A change in resistance was not demonstrated amongst infections caused by Gram-negative bacteria. In Gram-positive bacteria, resistance to a number of antibiotics increased using HDDAC compared to LDSAC, most notably to clindamycin and gentamicin within the coagulase negative staphylococci. However, levels of resistance remained low to teicoplanin, vancomycin, daptomycin, linezolid and rifampicin.

**Conclusions:** A lower infection rate was seen in HDDAC. Direct comparison demonstrated changes in resistance profiles caused by Gram-positive organisms. 24,000 patients undergo hip hemiarthroplasty annually. Extrapolating our results to this cohort would demonstrate 744 infections in LDSAC and 288 infections in HDDAC. Of these, resistance to both clindamycin and gentamicin would be seen in 180 patients with LDSAC and 177 patients with HDDAC. Overall, this review supports the continued use of HDDAC in FNOF patients.

High dose dual antibiotic cement = Copal G+C, Heraeus Medical, UK

Low dose single antibiotic cement = Palacos R+G, Heraeus Medical, UK



## Free Papers C

### [O60] PROPHYLACTIC EFFECT OF AN INJECTABLE HYDROXYAPATITE / CALCIUM SULPHATE BIOCOMPOSITE ELUTING ANTIBIOTIC IN THE TREATMENT OF OPEN FRACTURES WITH PLATE

**Damiano Papadia**<sup>1</sup>, Antonio Musetti<sup>1</sup>, Luciano Bertoldi<sup>1</sup>

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**Aim:** Open fractures with bone loss and skin lesions carry a high risk of infection and complication. Treatment options is usually a two-stage approach (debridement, temporary stabilization with external fixation followed by open reduction and stabilization with plate). We describe a experience for a single stage procedure with an antibiotic eluting bone graft substitute (BGS) for prophylaxis of implant-related infection.

**Method:** Between December 2014 and January 2016 were analyzed the data of twenty-six patients with open fractures (Gustilo and Anderson grade I and II) or with skin lesion and high risk of contamination and bone loss . They where treated with debridement of soft tissue, closed reduction of fracture, placement of a plate augmented with BGS eluting antibiotic (gentamicin (1) and /or Vancomicin (2)).

Ampicillin and sulbactam 3g three times daily was used as systemic antibiotic prophylaxis minimum for one week. Clinical outcome and radiographic bone defect filling were assessed by blinded observers.

**Results:** From 2014 to 2015 twelve male and fourteen female with mean age 53yrs (24-77) were treated with plate and BGS. Fracture locations were four distal femur (m:4; f: 1), four tibial plateau (m:3; f:1), one proximal humerus (f:1), seven calcaneus (m:4; f: 3), one talus (m:1), four forearm (m:3), one elbow ( f:1) and two phalanx (m: 2). Follow up was fourteen month (range: 3 – 26 months). During follow-up no implant-related infection was observed. One patient developed sterile seroma, which wastreated conservatively. ThecalciumsulphatephaseofBSdissolvedinallcaseswithin4-6weeks. Bone ingrowth was assessed at 1, 2, 3, 6 and 12 months. On six patients large bone was treated with a revision surgery (autologous cancellous bone graft combined with BGS and antibiotic. No complications were reported.

**Conclusions:** We suggest the application of polytherapy for the treatment of bone defects. BGS eluting antibiotic is easy to use and offers the opportunity for a one-stage procedure and might reduce the risk of implanted-related infection and allow early joint mobilization.

Good early clinical outcomes were observed in almost all cases. More studies and larger series are necessary to confirm the potential for the prophylaxis of infection in the treatment of open fractures.

(1): CERAMENT™|G

(2): CERAMENT™|V"

### Free Papers C

#### [O61] TREATMENT OF CHRONIC OSTEOMYELITIS OF THE LOWER LIMB WITH A NEW INJECTABLE, VANCOMYCIN-LOADED, CALCIUM SULFATE / HYDROXYAPATITE COMPOSITE

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**Aim:** Treatment principles of chronic osteomyelitis include debridement, clean sampling, excision of dead bone, stabilization, dead space management, soft tissue closure and systemic antibiotic therapy. Dead space management becomes very complicated, if the bone infection is caused by multi-resistant bacteria. The aim of this investigation was to evaluate the effect of a new vancomycin-loaded hydroxyapatite / calcium sulfate composite\* in the treatment of chronic osteomyelitis (OM) caused by multi-resistant bacteria.

**Method:** From June 2015 to November 2015, 7 patients (4 males, 3 females, average age 52.6y) were treated according to the above mentioned principles using the new vancomycin-loaded hydroxyapatite / calcium sulfate composite\*. Infections were caused by methicillin-resistant *Staphylococcus aureus* (MRSA), multi-resistant *Staphylococcus epidermidis* (MRSE) and polymicrobial, vancomycin-sensitive bacteria.

We used a two-stage protocol with debridement, excision of bone and external stabilization in the first stage, followed by bone defect reconstruction. To fill the residual bone defects, in 3 patients the new vancomycin-loaded hydroxyapatite / calcium sulfate composite\* (10mL) was used on its own and in 4 patients combined with 18mL of an unloaded calcium sulfate / hydroxyapatite composite\*\*. Post-operative follow-up was evaluated clinically and by radiographs and CT scans at 6, 14 and 24 weeks.

**Results:** In 6 of 7 patients rapid control of infection was achieved. Soft tissue reactions and prolonged white wound drainage (caused by calcium sulfate dissolution) was seen in 3 of 7 patients. In 6 of 7 patients recurrence of infection has not been observed so far. Radiographs showed different elution intervals of the radiocontrast agent (Iohexol), depending on anatomical location. Bone remodeling or replacement of the composite by new bone was not uniform in the patients and showed specific radiographic signs. In addition to the so-called „puddle sign“, we found septae, membranes, vacuoles and sometimes arc-like structures. Therefore, we suggest the name “arc-sign” for these formations.

**Conclusions:** During the follow-up of the first 7 patients treated with the unloaded calcium sulfate / hydroxyapatite composite\*\*. in 6 of 7 cases no recurrence of infection was observed. This is very promising in the difficult situation of bone infections caused by multi-resistant bacteria. Follow-up radiographs and CT-scans showed specific patterns during the resorption of the composite and the formation of new bone, which have not been described in other bone graft substitutes so far. The bone defects are not completely filled yet, but the affected bones are clinically stable and patients can ambulate with full weight bearing.

\*CERAMENT™ V, Bonesupport, Lund, Sweden

\*\*CERAMENT™ | BONE VOID FILLER

## Free Papers C

### [O62] RADIOGRAPHIC AND HISTOLOGICAL ANALYSIS OF A SYNTHETIC BONE GRAFT SUBSTITUTE ELUTING GENTAMICIN IN THE TREATMENT OF CHRONIC OSTEOMYELITIS: A RETROSPECTIVE STUDY IN HUMANS

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**Aim:** This study describes and correlates the radiographic and histologic changes which develop in a Gentamicin-eluting synthetic bone graft substitute\* in the management of bone defects after resection of chronic osteomyelitis (COM).

**Method:** 100 patients with COM were treated with a single stage procedure, including management of the dead space with insertion of a Gentamicin-eluting synthetic bone graft substitute\*. Radiographs of 73 patients with a follow-up of at least 12 months (range 12-33 months) were available for review. Bone defects were diaphyseal in 32, metaphyseal in 34 and combined in 7 patients. In 3 patients, radiographs were not of sufficient quality to allow analysis.

Five patients had subsequent surgery, not related to recurrence of infection, which allowed biopsy of the implanted material. These biopsies were harvested between 12 days and 9 months after implantation. Tissue was fixed in formalin and stained with haematoxylin-eosin and immunohistochemically for bone matrix markers.

**Results:** Radiographic: 31 of 34 diaphyseal implantations (91%) demonstrated remodelling of the biocomposite, gradually over many months, producing new bone and resulting in a "normal post-osteomyelitic" appearance. In metaphyseal implantations, new bone filled two-thirds or more of the defect in 55% of cases, one to two-thirds was filled in 31% and one third or less was filled in 14%. 22% of patients exhibited radiographic signs of dissolution and remodelling which are specific to this material. The 'Halo' sign of peripheral zone remodelling, the 'Marble' sign of dissolution and the 'Puddle' sign of distal migration can be described.

Histologic: Histological assessment revealed early active remodelling of the biocomposite. The material was osteoconductive with accumulation of osteoblasts and osteoid and woven bone formation on the surface of the Gentamicin-eluting synthetic bone graft substitute\* separated by fibrous tissue at the edge of the defect beneath reactive viable host bone. Fibrous tissue contained a heavy macrophage infiltrate and the newly formed matrix contained the specific bone proteins, dentine matrix protein-1 and podoplanin. There was limited evidence of remodelling into lamellar bone at 20 weeks after implantation.

**Conclusions:** The Gentamicin-eluting synthetic bone graft substitute\* exhibits a specific pattern of radiographic change over many months after implantation. The resolution of the bone defect would appear to be due to bone formation, as seen in the histologic and immunohistochemical analysis.

\*Cerament G™

### Free Papers C

#### [O63] AB-CEMENTED INTERLOCKING IN INFECTED NON-UNIONS OF LOWER EXTREMITY: 5 YEARS FOLLOW-UP

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**Aim:** We performed this Institutional Review Board-approved study to evaluate the efficacy of antibiotic-impregnated cement nailing for management of this condition.

**Method:** The study included 41 patients with infected non-unions of femur (23) and tibia (18) treated from 01.2009 to 09.2014. 32 (78%) patients were male and 9 (22%) patients were female. Mean age was 41.8 (range 20-78) years old. Mean time from the injury to AB-cement nailing was 21.2 (range 6-91) months. Mean follow-up duration was 18 (8-36) month. 6/23 femoral and 9/18 tibial fractures were initially open. Other fractures were closed and infected non-union developed as complication of previous surgeries: IM-nailing, ORIF or Ilizarov external fixation. Sinuses were revealed in all patients, but have closed by the time of AB-cement nailing in 30 cases. Pre- and intraoperative cultures revealed *S.aureus* in 20, *S.epidermidis* in 8, *Klebsiella Pneumoniae* in 3, *Enterobacter cloacae* in 2, *Acinetobacter baumannii* in 1 and no grows in 7 cases. We used 9-12 mm nails\* for femur and 8-10 mm for tibia with 2 mm cement thickness. Gentamicin-impregnated cement was mixed with thermostable antibiotic according to the predetermined sensitivity (vancomycin or daptomycin). Nails were coated using silicone tube with equal diameter for the entire length. After debridement and preparation of intramedullary cavity with reamers the locked IM-osteosynthesis was performed. In all cases nails were locked proximally and distally to improve bone stability. Patients additionally received intravenous antibiotics according to the sensitivity for two weeks. Full weight-bearing was allowed 3 months after surgery. Follow-up was performed in 6, 12, 24 and 52 weeks.

**Results:** One year after surgery, X-ray revealed bone union in 36 (87.8%) patients and all 41 (100%) patients were full weight-bearing. In 5 (12.1%) cases, X-ray has not reveal evident consolidation, but 3 of them achieved bone union after repeated surgery with autologous bone grafting. Open fistulas were found in 6 (14.6%) patients and required hardware removal and debridement.

**Conclusions:** AB-cement nailing achieved elimination of infection and fracture healing in the majority of patients. This method can be effectively used for maintaining patients' active life and mobility.

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### [O64] EXTERNAL FIXATION USING A LOCKING PLATE: A RELIABLE WAY IN TREATING DISTAL TIBIAL POST-TRAUMATIC OSTEOMYELITIS

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**Aim:** The fixation methods of distal tibial post-traumatic osteomyelitis are still challenging. The aim of this study was to evaluate the clinical and radiographic results associated with the use of a precontoured distal femoral locking plate as an external fixator in treating distal tibial post-traumatic osteomyelitis.

**Method:** From January 2012 to July 2014, 85 patients with distal tibial post-traumatic osteomyelitis were consecutively enrolled in this study. The initial fractures were 39 OTA 43.A1, 28 43.A2, and 18 43.A3, including 11 closed and 71 open fractures. All patients underwent thorough En-block debridement and first stage bone grafting. The precontoured distal femoral locking plate was placed on the anteromedial aspect of the tibia as an external fixator. All patients were followed for an average of 18 months.

**Results:** The mean surgical duration was 65 (40–80) minutes. The mean time until fracture healing was 16.7 (12–24) weeks. At final follow-up, the mean American Orthopaedic Foot and Ankle Society score was 80 (68–100). There were 4 cases of recurrent infection and no nonunions, or implant fractures. 10 patients had transient superficial pin site infection, but these did not change the clinical outcome.

**Conclusions:** External fixation using a precontoured distal femoral locking plate is a reliable option in treating distal tibial post-traumatic osteomyelitis. The procedure is easy to perform and the low profile plate can be concealed under stockings and can be conveniently removed.

### Free Papers C

#### [O65] NOVEL CALCIUM PHOSPHATE ANTIBIOTIC CARRIER FOR BONE HEALING WITH SLOW RELEASE PROPERTIES

Siddhesh Angle<sup>1</sup>, Michael Strunk<sup>1</sup>, Jerry Chang<sup>1</sup>

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**Aim:** Chronic osteomyelitis often requires surgical debridement and local antibiotic treatment. Disadvantages of PMMA carriers include low dose release and the requirement of surgical removal in the case of PMMA-beads[1] . Synthetic nanocrystalline calcium phosphate (nCP) materials, which mimic the chemical structure of the mineral composition of bone, have been well accepted as bone grafting materials due to their consistent osteoconductivity, ease of use, and mechanical properties[2] . Such a material which remodels into native bone is a much more attractive option. The aim of this study is to investigate the release of gentamicin from CaP in vitro and in vivo when implanted in a rabbit femoral condyle defect.

**Method:** Three formulations of nCP were evaluated in this study: putty, paste and porous. Four cylindrical dowels were made for each group with gentamicin sulphate at a concentration of 20mg/cc of paste. Material were eluted in PBS at 37C and pH 7.0 and elutions were tested every day up to 30 days. Eighteen New Zealand white rabbits will undergo surgeries. Briefly, a drill defect will be created in the metaphyseal bone of the lateral femoral condyle. The formulations will be implanted in the created defect at time of surgery and the wound will be closed. Blood will be collected regularly and analyzed for gentamicin titers. Animals will be sacrificed at 6wk, 12wk or 24wk. Explanted femurs will be fixed, sectioned and stained.

**Results:** At 7 days the in vitro elution, showed a continued release of gentamicin. A large amount of gentamicin is released within the first day followed by a slow controlled release. The nCP putty shows the slowest release, followed by the paste and porous formulations respectively. There is a significant increase in the elution with an increase in porosity of the material. We expect to observe a similar trend in the rabbit study with an improved healing. At 6wk we expect the implant material to be still present at the site of implantation, which would remodel by 12wk and 24wk to significant levels due to active ossification.

**Conclusions:** nCP materials, which undergo remodeling, can be used an effective carrier for gentamicin or other antibiotic agents. Because of its potentially prolonged release of high levels of antimicrobial agents, this system could maintain long-term antibacterial effectiveness locally.

#### References:

- [1] Stallmann H et al, BMC Musculoskeletal Disorders 2006 (7) p18
- [2] Faour O et al, Injury 2011 (42) pS87

## Free Papers C

### [O66] IS AN ANTIBIOTIC-LOADED HYDROGEL COATING ABLE TO REDUCE EARLY POST-SURGICAL INFECTION AFTER INTERNAL OSTEOSYNTHESIS?

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**Aim:** Aim of this study is to present the first clinical trial on an antibiotic-loaded fast-resorbable hydrogel coating\*, in patients undergoing internal osteosynthesis for closed fractures.

**Method:** In this prospective, multi-center, randomized, controlled, prospective study, a total of 260 patients were randomly assigned, in five European orthopedic centers, to receive the antibiotic-loaded DAC coating or to a control group, without coating. Pre- and post-operative assessment of laboratory tests, wound healing, clinical scores and x-rays were performed at fixed time intervals.

**Results:** 253 patients were available at follow-up. On average, wound healing, clinical scores, laboratory tests and radiographic findings did not show any significant difference between the two groups. Six early surgical site infections (4.6%) were observed in the control group compared to none in the treated group ( $p < 0.02$ ). No local or systemic side effects related to DAC hydrogel coating were observed and no detectable interference with bone healing was noted.

**Conclusions:** The use of a fast-resorbable, antibiotic-loaded hydrogel implant coating provides a reduced rate of early surgical site infections after internal osteosynthesis for closed fractures, without any detectable adverse event or side effects.

\*Defensive Antibacterial Coating, DAC®

### Free Papers C

#### [O67] EFFICACY OF NEGATIVE PRESSURE WOUND TREATMENT (NPWT) IN THE MANAGEMENT OF SEPTIC TRAUMA CASES

**Laszlo Gergely Nöt<sup>1</sup>**, Nadine Henriëtte Maria de Groot<sup>1</sup>, Istvan Lázár<sup>1</sup>, Árpád Dandé<sup>1</sup>, Norbert Wiegand<sup>1</sup>

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**Aim:** Negative pressure wound treatment (NPWT) has been widely adopted in the management of septic wound complications or prophylactically after large surgeries. Recent publications have indicated the necessity of further investigations to support the use of NPWT with more evidences. Therefore, the purpose of this pilot-study was to investigate the efficacy of VAC-assisted dressing systems in the treatment of septic trauma cases.

**Method:** We analyzed data of 16 retrospective cases following traumas and septic soft tissue surgeries around the hip and knee. The collected data consisted of bacterial cultures, inflammatory markers (WBC, CRP/HCRP) and body temperature, taken periodically during treatment. Also recorded were the time periods the vacuum pump was used during treatment. To increase the number of measurements and to facilitate subsequent data analysis, the measurements were interpolated to regularly sampled curves with a sampling rate of one day. We used cross-plots and linear regression analysis to investigate trends in the data: 1) while the vacuum pump was switched on and 2) while it was switched off.

**Results:** The analysis shows that the average WBC and CRP/HCRP values decline in the first days after initiation of the VAC treatment. WBC values decline in the first four days of VAC treatment (linear regression,  $R^2=0.960$ ). CRP/HCRP values decline in the first thirteen days (linear regression,  $R^2=0.952$ ). No meaningful trends were observed in body temperature measurements. Importantly, there is a trend for an increase of WBC and CRP/HCRP, following the 4<sup>th</sup> and 14<sup>th</sup> days, respectively. These findings suggest that the prolonged use of VAC treatment may result in secondary relapses.

**Conclusions:** Our results indicate a marked decrease of inflammatory markers during the first two weeks, confirming the efficacy of NPWT in the management of septic wounds after traumas. Importantly, our analyses also show a periodic relapse with the prolonged use of NPWT. However, further studies are needed with a larger, standardized population to confirm these findings.



## Free Papers C

### [O68] MANAGEMENT OF INFECTIOUS FRACTURES WITH “CEMENT-PLATE COMPLEX” (CPC) METHOD

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**Aim:** The aim of this study was to evaluate the outcomes of internal fixation of cement and plating complex (CPC) after post-traumatic infection of the tibia or femur fractures.

**Method:** The study included 105 patients (48 female and 57 male). The mean age of patients was 46.6 years (range, 16-74 years). There were 47 femur and 68 tibia fractures. The mean follow-up period was 20.7 months (range, 14-36 months). The study comprised 81 open and 24 closed fractures. External fixator was used in 23, plate in 64, and intramedullary nail in 18 patients for initial surgery. Deep infection was diagnosed via clinical findings, laboratory parameters, and microbiological evaluation.

**Results:** Deep infection was diagnosed within a mean period of 6.5 days (range, 2-10 days). The infecting organism was methicillin-resistant staphylococcus aureus (MRSA) in 16, methicillin-sensitive staphylococcus aureus (MSSA) in 65, pseudomonas aeruginosa in 11, and enterobacteriaceae in 12 patients. Union achieved in all patients. Mean time to union was 24(range, 16-42) weeks. Delayed union was observed in 4 patients who required additional surgeries.

**Conclusions:** The CPC is an effective alternative method in the treatment of deep infection encountered after internal or external fixation for the tibia, or femur fractures.

### Free Papers D

#### [O69] THE MYTH OF SURGICAL STERILITY: BACTERIAL CONTAMINATION OF KNEE ARTHROPLASTY DRAPE

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**Aim:** The majority of peri-prosthetic joint infection occurring within 1 year of surgery is due to introduction of microbes at the time of surgery. Lavage of total knee replacement leaves a pool of fluid on the surgical drapes. This fluid could be a direct source of wound contamination via suction catheter tip, gloves or instruments.

**Method:** Twenty patients undergoing total knee arthroplasty had a sample of drape fluid sent, after prosthesis implantation, for standard and enrichment culture. The surgery took place in a laminar low theatre with scrub teams in togas\* and drapes\*\*. Normal saline was used as the wash. 20ml fluid was taken via syringe and transferred to blood culture bottles in theatre post-operatively.

**Results:** Ten samples (50%) showed bacterial contamination, of these 55% were one organism and 45% polymicrobial. Coagulase negative staphylococcus (CNS) occurred in 90% of positive samples, followed by moraxella (20%) and MSSA (10%). Organisms grown included skin, nasal, respiratory and environmental pathogens, all but one previously documented as causing septic arthritis.

**Conclusions:** The major contaminant found in our study, CNS, is a skin commensal. This could be from increasing resistance to skin preparations or a decline in theatre etiquette. Fluid collecting in the drapes is a source of potential contamination. All aspects of infection control protocol need continual re-assessment including drape quality, skin and patient preparation and theatre etiquette. Surgeons cannot assume that routine skin preparation and peri-operative antibiotics will eradicate bacterial contamination. It is all our responsibility to implement best infection control practice both in the operating room and through entire patient journey.

\*Stryker, AMMI level IV

\*\* Sangewold (EN 13795)

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### [O70] KNEE ARTHRODESIS AFTER PROSTHETIC JOINT INFECTION: ARE FUNCTIONAL OUTCOME AND COMPLICATION RATES COMPARABLE WITH ABOVE-THE-KNEE AMPUTATION?

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**Aim:** Prosthetic joint infections (PJI) after failed knee arthroplasty, especially in complicated courses with persisting or recurrent infections, may result in a considerable destruction of bone substance, the extensor apparatus and the surrounding soft tissue. In these cases reconstruction of a proper knee function may be impossible and the only solutions are: knee arthrodesis or above-the-knee amputation (AKA). However, both methods are associated with considerable functional deficits and high complication rates. The primary aim of the current study is to analyse the clinical course, outcome and complications in patients with knee arthrodesis and AKA after PJI and to compare these two methods in terms of the analysed parameters.

**Method:** Patients treated with a knee arthrodesis or AKA after PJI in an 11-years time period were included in this study. Demographic data, comorbidities, infecting characteristics and operative procedures were recorded. Patients were seen in regular intervals and underwent physical and radiographic examination. Major complications such as: re-infection, implant-failure, revision surgeries or stump healing disorders were recorded. Functional outcome with use of the Lower-Extremity-Functional-Score was assessed and the patients reported general health status (SF-12-questionnaire) was recorded.

**Results:** In total 87 patients with a knee arthrodesis and 32 patients with an AKA after PJI were included. Knee arthrodesis was performed in 81 patients with a modular system and in six cases with bone fusion. Re-arthrodesis had to be performed in 21 cases. Survival rate of knee arthrodesis was 86% after one year, 71% after five and 61% after ten years. Major complications such as recurrence of infection (n=16) implant loosening (n=12), implant failure (n=3) or per-implant fracture (n=5) occurred in 30% of the patients. In seven patients an amputation after failed arthrodesis had to be performed. In patients with AKA after PJI a similar complication rate of 34% (p=0.64) was seen. Recurrence of infection was diagnosed in nine patients and a re-amputation had to be performed in four cases. The final functional examination was assessed after a mean interval of 48 month and revealed comparably in both cohorts a comparable limitation of functionality (p=0.181) and a slightly worse physical quality of life after knee arthrodesis compared to patients with AKA (p=0.08).

**Conclusions:** Knee arthrodesis or above the knee amputation after PJI show similar functional limitations and comparably high complication rates. The patients have to be supervised by an interdisciplinary team to avoid complications and regain quality of life.

### Free Papers D

#### [071] SILVER-COATED MEGAPROSTHESES OF THE PROXIMAL TIBIA IN PATIENTS WITH BONE SARCOMA: DOES SILVER PREVENT INFECTION?

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**Aim:** In patients with bone sarcoma, placing megaprotheses in the proximal tibia is associated with high rates of infection. In studies with small numbers of patients and short follow-up periods, silver-coated megaprotheses have been reported to lead to reduced infection rates. To the best of our knowledge, this study is the largest one that has compared the infection rates with titanium versus silver-coated megaprotheses in patients treated for sarcomas in the proximal tibia.

**Method:** The infection rate in 98 patients with sarcoma or giant cell tumour in the proximal tibia who underwent placement of a titanium (n = 42) or silver-coated (n = 56) megaprosthesis\* was assessed, along with the treatments administered for any infection.

**Results:** As the primary end point of the study, the rates of infection were 16.7% in the titanium group and 8.9% in the silver group, resulting in 5-year prosthesis survival rates of 90% in the silver group and 84% in the titanium group. Overall, seven of 56 patients in the silver group (12.5%) developed periprosthetic infection. Two patients became infected after revision surgery due to mechanical failure of the prosthesis. In the titanium group, one patient developed a periprosthetic infection after revision surgery (which was carried out in 50% of patients) due to a mechanical prosthetic failure, leading to an overall infection rate of 19.0% (eight of 42). Overall, nine of 12 (75%) periprosthetic infections in the two groups occurred within the first 2 years postoperatively, if later revision surgery due to mechanical failure was not necessary. Whereas three of the eight patients in the titanium group (37.5%) ultimately had to undergo amputation due to infected proximal tibia replacement, these mutilating surgical procedures were necessary in the silver group in only one patient (14.3%). In the titanium group, two-stage revision surgery with a temporary antibiotic-impregnated cement spacer was ultimately successful in four of eight patients (50.0%), but this procedure was necessary in only one patient in the silver group (14.3%).

**Conclusions:** The use of silver-coated prostheses reduced the infection rate in a relatively large and homogeneous group of patients. In addition, less aggressive treatment of infection was possible in the group with silver-coated prostheses.

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### [O72] INTRA-OSTEOBLASTIC SYNERGY OF DAPTOMYCIN WITH OXACILLIN AND CEFTAROLINE

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**Aim:** Intracellular persistence of *S. aureus* is believed to be one of the major mechanisms leading to bone and joint infection (BJI) chronicity and relapses. Despite its poor intracellular activity, daptomycin (DAP) is increasingly used in the treatment of staphylococcal BJI. The well-known in vitro synergy of daptomycin with various betalactam antibiotics consequently led us to investigate whether these combinations enhance the activity of daptomycin against the intracellular reservoir of methicillin-susceptible (MSSA) and -resistant (MRSA) *S. aureus* in an ex-vivo model of human osteoblast infection.

**Method:** Osteoblastic MG63 cells were infected for 2h with MSSA strain or its isogenic MRSA. After killing the remaining extracellular bacteria with lysostaphin, infected cells were then incubated for 24h with DAP, oxacillin (OXA) or ceftaroline (CPT) alone or in combination, at the intraosseous concentrations reached with standard human therapeutic doses. Intracellular bacteria were then quantified by plating cell lysates. Minimum inhibitory concentrations (MICs) of these molecules alone and in combination were determined using the checkerboard method at pH7, but also at pH5 to mimic intracellular conditions.

**Results:** Compared to untreated cells, DAP reduced significantly intracellular inoculum for MRSA only ( $p < 10^{-3}$ ). OXA and CPT were active on MSSA and MRSA ( $p < 0.05$  for all). The OXA-DAP combination reduced the intracellular inoculum of MSSA and MRSA more efficiently than antibiotic alone ( $p < 0.05$ ). In contrast, no synergy was observed with the association DAP-CPT (Table1).

|                | MSSA                  | MRSA                  |
|----------------|-----------------------|-----------------------|
| <b>DAP</b>     | +5,7%[-12,1 ; +23,6]  | -27,6%[-37,0 ; -18,2] |
| <b>OXA</b>     | -23,9%[-40,3 ; -7,5]  | -43,2%[-52,9;-33,5]   |
| <b>CPT</b>     | -33,1%[-40,3 ; -25,9] | -28,9%[-44,2 ; -13,6] |
| <b>DAP+OXA</b> | -44,4%[-51,8 ; -37,0] | -57,2%[-65,7 ; -48,7] |
| <b>DAP+CPT</b> | -33,9%[-41,3 ; -26,4] | -34,2%[-45,4 ; -23,0] |

Table 1: Decrease of the intracellular inoculum compared to untreated cells  
In vitro, an important increase in DAP MICs was observed at acidic pH for the two strains (0.3 (pH7) to 2mg/L (pH5)). On the contrary, decreasing pH from 7 to 5 led to a drop in OXA MICs from 0.5 to 0.1mg/L for MSSA and from 128 to 0.5mg/L for MRSA.

**Conclusions:** Our results confirm the low activity of DAP against intra-osteoblastic *S. aureus*, probably due to its inactivation by acidic pH condition encountered in lysosomes. On the opposite, betalactams are still active in intracellular compartment, including OXA on MRSA due to an acidic pH-related activity restauration. The OXA-DAP combination allows amplifying the intracellular effect of DAP on MSSA and MRSA. This synergy is not observed with CPT.

## Free Papers D

### [O73] GLOBAL CHANGES IN STAPHYLOCOCCUS AUREUS GENE EXPRESSION DURING HUMAN PROSTHETIC JOINT INFECTION

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**Aim:** The aim of this study was to gain insight into the *in vivo* expression of virulence and metabolic genes of *Staphylococcus aureus* in a prosthetic joint infection in a human subject.

**Method:** Deep RNA sequencing (RNA-seq) was used for transcriptome profile of joint fluid obtained from a patient undergoing surgery due to acute *S. aureus* prosthetic joint infection. The *S. aureus* gene expression in the infection was compared with exponential culture of a *S. aureus* isolate obtained from the same sample using EdgeR. In addition, the genome of the isolate was sequenced on Miseq, assembled in CLC genomics workbench and annotated by MaGe. Moreover, using nuclear magnetic resonance (NMR) spectroscopy we analysed the metabolites in the joint fluid and in the culture supernatants to determine the biochemical composition of the environments.

**Results:** Antibiotic susceptibility testing by disk diffusion (EUCAST) demonstrated that the strain was susceptible to  $\beta$ -lactams (penicillin and cefoxitin) and macrolides (erythromycin and roxitromycin). This was indirectly confirmed by the annotated genome, because of absence of known resistant genes. The patient showed no signs of improvement during 2-days treatment with antibiotics (different  $\beta$ -lactams and gentamicin) prior to the surgery. The RNA-seq data indicated that the strategy employed by *S. aureus* to survive and proliferate in the host during antibiotic treatment involved overexpression of various enzymes related to cell-wall synthesis and multidrug efflux pumps. Interestingly, these efflux pumps are only known to be related to fluoroquinolone resistance. Many of the genes encoding virulence factors were upregulated, including toxins and superantigen-like proteins, hemolysins, and immune evasion proteins. A number of chaperones and stress related genes were overexpressed indicating a stress response. Furthermore, the RNA-seq data provided clues of the potential major nutrient sources for the pathogen *in vivo*. Several amino acid degradation pathways were highly upregulated, e.g. arginine, histidine. Additional carbon sources included N-acetylneuraminate and purine/pyrimidine deoxyribonucleosides as indicated by the upregulation of the genes involved in the degradation pathways of these compounds and higher concentration of these substances in the joint fluid compared to culture supernatants.

**Conclusions:** Our results show that the gene expression pattern of *S. aureus in vivo* is vastly different from that of an *in vitro* grown exponential culture, indicating that the pathogen adapts to host environmental conditions by altering gene expression. Finally our study emphasizes the importance of *in vivo* study in elucidating pathogenesis of *S. aureus* in prosthetic joint infections.

Free Papers D

[074] TREATMENT OF INFECTION AFTER PRIMARY TOTAL HIP ARTHROPLASTY IN A UNIVERSITY HOSPITAL

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**Aim:** To see what surgical strategy was used in treating infected total hip arthroplasties (THA), relative to bacterial findings, level of inflammation, length of antibiotic treatment (AB) and re-revisions. Further, to assess the results of treatment after three months and one year.

**Method:** We used our national arthroplasty register (NAR) to identify THA revised for deep infection from 2004-2015 reported from our hospital. We identified the strategy of revision, i.e. one-stage exchange (one-stage), two-stage exchange (two-stage), debridement and implant retention (DAIR), or Girdlestone, and reported re-revisions for infection. We defined cure as no AB, no need for further surgery and joint with prosthesis (not Girdlestone). From the hospitals' medical records we retrieved bacterial findings from the revisions, level of C-reactive protein (CRP), type of antibiotics given, duration of antibiotic therapy and clinical data regarding the patients. The information reported to the NAR was also validated.

|             | Number of patients | Age  | Gender (female/male) | ASA (mean) | Duration of symptoms in days (mean/median) | CRP pre surgery (mean) | Main microbe     | Patients with re-revision | Success at three months (no further surgery, no AB) | AB-free after one year (percent) |
|-------------|--------------------|------|----------------------|------------|--|------------------------|------------------|---------------------------|---|----------------------------------|
| DAIR        | 32                 | 69,9 | 16/16                | 2,5        | 11/11                                      | 134                    | S. aureus        | 9                         | 58%   | 89                               |
| One-stage   | 4                  | 75,7 | 2/2                  | 2          | 139/133                                    | 19                     | Culture negative | 0                         |   | 100                              |
| Two-stage   | 29                 | 67,2 | 14/15                | 2,8        | 244/-365                                   | 74                     | CoNS             | 3                         | 62%   | 92                               |
| Girdlestone | 4                  | 72,1 | 2/2                  | 3          | 128/53                                     | 45                     | S. aureus        | 0                         |   | 100                              |

Table 1:  
Findings in infected total hips treated with different surgical strategies.



## Free Papers D

### [O75] POWDER TECHNOLOGY APPLIED TO THE MAJOR ACETABULAR BONE LOSS: A INNOVATIVE MASSIVE CUSTOM MADE ACETABULAR COMPONENT. THREE YEARS OF FOLLOW-UP FOR 13 PATIENTS

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**Aim:** To introduce and promote a new technic and a new component using the 3D technology in the extreme acetabular revisions.

**Method:** Since 2012, 13 patients, nine women and four men, were treated, 12 for a chronic complex PJI and one for an aseptic loosening. The average age was 75 years old (60 -90 years), the average follow-up 18,6 months (7-36 months).

The revisions were bipolar in 12 cases and unipolar in one case for the oldest patient. For the septic cases, we performed 7 one stage procedure and 5 two stages. The femoral components were in 7 cases a modular stem, in 5 cases a massive component and a total femur. All theses massive components were combined with a cemented double cup.

The bone loss was evaluated with the AAOS, the Praposky and the Saleh classifications.

A preoperative and postoperative Oxford score was used.

**Results:** The bone loss are major; 9 stades III, 4 IV for the AAOS classification, 7 III A, 6 III B for the Praposky and 3 III, 6 IV, 4 V for the Saleh classification. The classifications weren't change by the component removal.

10 components were implanted without using cement. For the three cemented implants, the bone loss interested the columns and the roof. An acetabular disruption isn't a contrindication of an uncemented option.

We report one early failure, in relation with no surgical postoperative complications. A good preoperative anchorage had never failed in the follow-up.

The preoperative Oxford score was on average 8,9 (4-15) and the postoperative 33,6 (16-44).

We report one early failure f a two stage procedure. Two patients underwent a recovery for partial change with no custom made implant involvement. In doing so, we have found that these cement less implants were well integrated and stable two months after the implantation.

The most significant events are skin complications always after an extensive debridement, treated systematically by an iterative debridement.

None of these complications appear to be related to the use of these implants.

**Conclusions:** It's the first series which reports the use of the powder technology for a custom made component. In our series, it interests specific situations; elderly patients failing conventional medico-surgical strategies in complex functional and PJI. First results are really promising.

This technology simplifies the complex acetabular reconstructions. It's a key point for the immediate postoperative functional management and to limit complications.

### Free Papers D

#### [076] EPIDEMIOLOGY, CLINICAL FEATURES AND OUTCOMES OF NATIVE JOINT SEPTIC ARTHRITIS IN ADULTS IN SOUTH AUCKLAND, NEW ZEALAND

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**Aim:** To describe the epidemiology, clinical features and outcomes of native joint septic arthritis in adults admitted to Middlemore Hospital in Auckland, New Zealand.

**Method:** Single-centre retrospective cohort study from 2009 to 2014. Patients  $\geq 16$  years of age were identified using ICD-10AM coding data. Electronic records were reviewed for demographic, clinical, laboratory, treatment and outcome data. Total and hemi-arthroplasty infections were excluded.

**Results:** 543 episodes in 521 patients were included, with 90% fulfilling Modified Newman's criteria. Septic arthritis incidence was 26/100,000 patient years and was unchanged over the study period. Incidence correlated strongly with age ( $R^2=0.79$ ) and socioeconomic deprivation ( $R^2=0.76$ ).

Median age was 49 years, and gender 70% male. Ethnicity was Pacific Island in 36% (22.8% of catchment population). The most commonly involved joints were hand interphalangeal (19%), knee (19%), metacarpophalangeal (17%) and glenohumeral (11%). Arthritis was monoarticular in 93%.

Underlying conditions included current smoking (42%), osteoarthritis (29%), diabetes (22%) and gout (15%). Rheumatoid and seronegative arthritis were uncommon (each 2%). Skin/soft tissue infection occurred within 3 months prior in 38%. Osteomyelitis occurred in 26%. Sources of infection included haematogenous (42%), traumatic (34%), and iatrogenic (17%).

Causative organism(s) were isolated in 80% of episodes, most commonly *Staphylococcus aureus* (53%, 13% of which were MRSA) then *Streptococcus pyogenes* (15%). 28% of culture-positive episodes were polymicrobial. Median antibiotic duration was 4 weeks, with 38% having definitive therapy orally. A median of 1 surgical procedure was undertaken during treatment.

Mortality at 30 days was 3%, at 90 days 5% and treatment failure (defined as any of: death <90 days; relapse; reinfection; or ongoing joint infection leading to readmission, amputation, arthrodesis or excision arthroplasty) occurred in 17%. Treatment failure was significantly more common in cases involving large joints (23%, (69/302) vs. 11%, (26/241),  $p=0.0002$ ) and in haematogenous episodes versus traumatic episodes (21% (47/229) vs. 10% (19/168),  $p=0.0045$ ).

**Conclusions:** This is the largest series of adult native joint septic arthritis currently available. The extremely high observed septic arthritis incidence (26/100,000 person years) may relate to high rates of skin and soft tissue infection in Auckland, particularly among Pacific people. Small joint infection, often excluded from previous studies, is associated with significantly better outcomes than large-joint infection. Mortality is lower in this cohort than previously reported, possibly due to the inclusion of small joint infections and exclusion of prosthetic joint infections.

**Acknowledgements:** No additional funding was received for this work.

## Free Papers D

### [O77] OPEN VERSUS ARTHROSCOPIC TREATMENT OF ACUTE SEPTIC ARTHRITIS OF THE NATIVE KNEE

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<sup>2</sup>School of Medicine and Public Health, University of Newcastle (Australia), Callaghan, Australia

**Aim:** We compared open versus arthroscopic methods as the initial surgical intervention in acute septic arthritis of native knee joints.

**Method:** At our institution native knee septic arthritis is regarded an orthopaedic emergency and is treated surgically. We conducted a retrospective cohort study. The intervention under study was an arthroscopic versus an open irrigation procedure. The primary outcome was the need to return to the operating theatre for a further procedure. Secondary outcomes were total number of operations required, range of motion (ROM) assessed post-operatively, length of inpatient stay (LOS) and mortality.

All the records of all patients treated at our institution for their episode of native knee septic arthritis diagnosed pre-determined criteria were included. Clinical findings, knee radiographs, and laboratory results including cultures on blood and synovial fluid we collated.

Logistic regression was used to adjust for any effects of severity of infection, co-morbidities, osteoarthritis, or infecting organism.

**Results:** 161 patients (166 knees) with acute native knee septic arthritis treated between 2000 and 2015 were included. One-hundred and twenty-three knees were initially treated by arthroscopic irrigation and forty-three were treated by open irrigation. Fifty percent of the arthroscopic group compared to 71% of the open group required repeat irrigation (Odds Ratio 2.4). The superiority of an arthroscopic procedure persisted after adjustment for potential confounders with an odds ratio of 2.6 (95% C.I. 1.2 to 6.0,  $P = 0.022$ ). After three irrigation procedures the cumulative success rate was 97% in the arthroscopic group and 83% in the open group ( $P = 0.011$ ). The total number of irrigation procedures required was fewer in the arthroscopic group ( $P = 0.010$ ). In the arthroscopic group mean post-operative range of motion was greater ( $P = 0.016$ ) and median length of stay was shorter ( $P = 0.088$ ). There was no mortality difference.

**Conclusions:** Arthroscopic treatment for acute native knee septic arthritis was a more successful initial procedure and required fewer total irrigation procedures compared to open treatment. Post-operative range of motion was also significantly greater following arthroscopic treatment.

### Free Papers D

#### [078] POSITIVE MSIS MINOR-CRITERIA HAVE AN IMPACT ON THE OUTCOME OF THA AND TKA REVISIONS: A MATCHED-PAIR ANALYSIS

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**Aim:** Aim of the study was to find out whether patients with positive minor criteria but without meeting the MSIS definition have a difference in the outcome after revision-surgery compared to patients without any MSIS-criteria? And does the reason for revision-surgery (eg. loosening) have an additional influence on the outcome parameters in patients with positive minor criteria?

**Method:** A retrospective matched-pair analysis with 98 patients who had undergone revision-surgery after TJA was performed. Forty nine patients who showed 1 to 3 positive minor criteria (PMC) whereas 49 patients without any positive minor criteria (aseptic complications control group) were compared regarding re-revision-rate and revision-free survival. Patients were matched regarding sex, age, joint and comorbidities using the classification system by McPherson et al. Reasons for revisions were categorized in loosening, body wear, periprosthetic fracture/mechanical failure and soft-tissue complication. Endpoints were defined as re-revision for any cases.

**Results:** In the group of patients with PMC 30.6% (n=15) had to undergo re-revision compared to 6.12% (n=3) in the true aseptic complication (AC) control group. The overall-survival in the PMC-group was 69.4% (95% CI: 47-69 months) and in the AC-group 93.9% (95% CI: 82-94 months) (p=0.001). In patients with PMC but not exchange of the implant the overall-survival was 94.1% (95%CI survival time: 71-88 months) and in comparison the cohort with exchange of the prosthesis showed an overall-survival of 56.25% (95% CI survival time: 29-53 months) (p=0.008).

**Conclusions:** Our findings suggest that in dependence of the occurrence of prosthetic loosening even single positive minor-criteria may have an impact on the outcome after THA- and TKA revision-series.

## Free Papers D

### [O79] INFECTION RELATED READMISSIONS FOLLOWING ELECTIVE ORTHOPAEDIC & TRAUMA SURGERY - EXPERIENCE FROM A MAJOR TRAUMA CENTRE

Anup Pradhan<sup>1</sup>, **Aaron Dean**<sup>1</sup>, James Geddes<sup>1</sup>, Bala Sivasubramanian<sup>1</sup>, Iain Mcfadyen<sup>1</sup>

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**Aim:** This study was carried out to assess the prevalence of infection related admissions and its consequences in a Major Trauma Centre (MTC). Surgical site infection and deep infection following orthopaedic surgery is rare due to current antimicrobial prophylaxis. However, when post-operative infection occurs, it is associated with high morbidity, poor mobility and even mortality. In addition, there are cost implications for the health service.

**Method:** Patients with infection related complications post surgery were identified from the Trauma & Orthopaedic Admissions Database at the UHNM. Our one year study period was from 1st April 2014 to March 31st 2015. Information collected included patient demographics, type of infection, procedure details, management, length of stay and clinical outcomes.

**Results:** During the study period, 3276 patients were admitted or referred from other specialties, of which 74 patients (2.2%) were identified to have post-operative infection. There were 42 males and 32 females with the mean age of 59.7 years (15-96). 44/74 (59%) of infections were seen after elective procedures. 23/45 (51%) of the patients with positive microbiology results had *staphylococcal aureus* infections with a further 3/45 (7%) patients having methicillin resistant *staphylococcus aureus* (MRSA) infections. 36% of the infections were deep with 47% of the patients surgically managed. Nine patients died during admission with seven deaths following infected hip hemiarthroplasty and 2 following infected total hip replacements. The mean length of stay was 14.8 days (1-124).

**Conclusions:** This study has highlighted the prevalence of infection following elective and trauma surgery in a MTC. Infection was surprisingly found to be higher in the elective patient group. All patients who died had infected hip implants, with seven out of the nine being hip fracture patients. This study has shown that the post-operative infection rate was less than 3%. However, the risk of death following infection was 12%. We have shown that the burden of infection from elective surgery patients was higher than trauma patients.

## Oral Abstracts

### Key Session 7

#### [O80] TREATMENT STRATEGIES IN PJI OF THE HIP

**Jason C J Webb<sup>1</sup>**

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Prosthetic joint infection (PJI) remains one of the most feared complications of total hip arthroplasty. With it, there are significant costs both in financial terms for the healthcare system caring for the problem and in morbidity for the patient. Numerous treatment strategies can be employed in the treatment of PJI but for many years empiric approaches based on local preferences, perceived 'gold-standards' and fear of litigation have guided treatment. Zimmerli et al (2004) introduced the concept of a case-based algorithm approach and this has led to more centres employing bespoke/individualised systems that co-ordinate the surgical and antimicrobial treatments.

This lecture will provide an evidence-based summary of the common treatment options for infected hip replacements as provided by a regional PJI team. It will also discuss the UK INFORM Trial.

## Key Session 7

### [O81] THE ROLE OF THE ID PHYSICIAN IN TREATMENT OF PJI

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The treatment of periprosthetic joint infection (PJI) requires integrated and coordinated teamwork between orthopedic surgeons and infectious diseases (ID) specialists. Often other specialists such as plastic surgeons, pharmacologists, microbiologists, pathologists, and radiologists complete the team. The decision on the most appropriate treatment to achieve infection cure with preservation of joint function should be made interdisciplinary prior to the surgical intervention. Therefore, the extent and duration of infection and characteristics of involved microorganisms (e.g., virulence, resistance patterns, potential to adhere to foreign bodies) must be estimated. Recommendations for empirical treatment, both for routine cases as well as for complex cases vary between institutions. Therefore, intra-institutional surveillance and collaboration with infection control is required. Protocols on how and when biopsy samples should be obtained, transport modalities to microbiology and histopathology laboratories, and culturing process in defined media are pivotal steps in the diagnostic work-up. This underlines the importance of collaboration with the microbiology team. Also, histopathologists should use defined criteria for infection diagnosis. After isolation of causative pathogens, empiric antimicrobial treatment must be streamlined to targeted therapy. Dose adaptation to renal and liver function, therapeutic drug monitoring, interactions with other drugs and possible adverse effects need to be considered. The optimal time point for adding rifampin in case of rifampin-susceptible staphylococci and the switch from intravenous to oral formulation are further issues in the patient management. It includes also adherence to the antibiotic regime and attention to adverse effects that may occur at later time points of the treatment period. The optimal duration of antibiotic treatment is an inter-institutional matter of debate, though the majority of centers recommend between 6 weeks and 3 months. Cure of infection is commonly ascertained after a relapse-free interval of 2 years.

### Key Session 7

#### [O82] PATIENT-ADAPTED TREATMENT OF AN INFECTED TKA: A SWISS ALGORITHM

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<sup>1</sup>Unité de Traumatologie, Unité de Chirurgie Septique, Service d'Orthopédie et de Traumatologie, Lausanne, Switzerland

Prosthetic joint replacement is one of the most successful surgical procedures of the last century and the number of implanted artificial joints is rapidly growing. While the results of the procedure are generally positive, infections may occur leading to patient suffering, surgeon's frustration and important costs to the health system. Infection after prosthetic joint replacement is thus a feared complication as healing rates can be low, functional results poor and satisfaction of the patient abysmal.

The patient-adapted treatment concept is based on five strong pillars: teamwork, understanding biofilm, proper diagnostics, clear classification and optimal surgical choice. The surgeon has different surgical options like débridement and retention, one-step exchange, two-step exchange with short or long interval and finally resection arthroplasty or amputation. It is wrong to declare one of these procedures to be the gold standard or the best way to treat an infected total joint arthroplasty, as the treatment must be adapted to each patient personally. Thanks to the concept of patient-adapted treatment an overall success rate of above 90% can be obtained.



## Key Session 8

### [O83] DIAGNOSING DIABETIC FOOT OSTEOMYELITIS: CONTENTIOUS OR CONSENSUS?

Benjamin A. Lipsky<sup>1</sup>

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Among patients presenting with a diabetic foot wound many with a mild infection and the majority of those with a severe infection have underlying bone involvement. As infectious bone involvement of the diabetic foot increases the risk for and duration of hospitalization, prolonged (especially parenteral) antibiotic therapy and lower extremity amputation, diagnosing diabetic foot osteomyelitis (DFO) is important. Making the diagnosis depends first on considering it, then proceeding through a series of steps to document whether or not DFO it is present.

The process should begin with clinical examination. Clinicians should consider the possibility of DFO in any diabetic patient with a long-standing or a large or deep foot wound. On examination, the presence in a wound of visible bone, a positive “probe-to-bone” test, or a “sausage toe” suggests DFO. Among laboratory tests or biomarkers, a markedly elevated erythrocyte sedimentation rate (especially if >70 mm/hour) is most useful. Imaging is appropriate for all diabetic foot wounds, and should begin with plain x-rays. As radiography is insensitive in the first few weeks of infection, they should either be repeated in about two weeks, or the patient should undergo an advanced imaging test. Among nuclear medicine tests leukocyte scans (optimally combined with a bone scan) are the most sensitive. Currently, magnetic resonance imaging is the best advanced imaging test for seeking both bone and soft tissue infection, but newer methods (e.g., SPECT/CT, PET/CT) may emerge as more useful.

The criterion standard for diagnosing DFO remains examination of a bone specimen, obtained either at surgery or percutaneously, for histopathology and culture. Of note, false-positive and false-negative results can occur, especially in patients who have been recently treated with antibiotic therapy. In the past decade several guideline groups have offered helpful approaches for diagnosing DFO

### Key Session 8

#### [O84] THE MANAGEMENT OF DIABETIC FOOT CHRONIC OSTEOMYELITIS WITH FLAPS

Joon Pio (JP) Hong<sup>1</sup>

<sup>1</sup>Asan Medical Center University of Ulsan, Seoul, Korea

The treatment of diabetic foot ulceration is complex with multiple factors involved and it may often lead to limb amputation. Hence a multidisciplinary approach is warranted to cover the spectrum of treatment for diabetic foot but in complex wounds surgical treatment is inevitable. Only after good wound management controlling blood sugar level, nutrition and infection, the next step to reconstruction can take place. Surgery may involve the decision to preserve the limb by reconstruction or to amputate it. Reconstruction involves preserving the limb with secure coverage. Local flaps usually are able to provide sufficient coverage for small or moderate sized wound but for larger wounds soft tissue coverage involves flaps that are distantly located from the wound. Reconstruction of distant flap usually involves microsurgery and now further innovative methods such as supermicrosurgery have further given complex wounds a better chance to be reconstructed and limbs salvaged. The reconstructed flaps on the clinically clean wound will increase the blood flow and circulation to the defect and the infected bone thus helping the antibiotics to be delivered to this region of defect. This presentation reviews the role of microsurgery involved in reconstruction against diabetic foot chronic osteomyelitis and introduces the new method of supermicrosurgery.

## Key Session 8

### [O85] INTERNAL PEDAL AMPUTATIONS

Armin Koller<sup>1</sup>

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Internal amputations are not a contemporary concept. Link in 1887 and Witzel and Hoffmann in 1889 performed internal Chopart amputations when skeletal tuberculosis was a common problem. Due to the rarity of tuberculosis these days, an internal Chopart amputation represents just one of various pedal amputation techniques that have fallen into oblivion.

Problems with the technically demanding fitting of prostheses or custom-made orthopaedic shoes had resulted in a replacement of those procedures by standardised transtibial amputations. Vast improvements of prosthetics and custom shoemaking within the past few decades justify the re-evaluation of individual and atypical resections and amputations possible within the foot.

Additional tools like external fixators or antibiotic-loaded bone void fillers make those procedures particularly suitable for limb salvage in marked bone infections among diabetic foot patients.

### Free Papers E

#### [086] ANTIBIOTIC PROPHYLAXIS NOT INDICATED FOR DENTAL PROCEDURES IN PATIENTS WITH JOINT PROSTHESES: A NEW DUTCH GUIDELINE

Geert Walenkamp<sup>1</sup>, Dirk Jan Moojen<sup>2</sup>, Hans Hendriks<sup>3</sup>, Theo Goedendorp<sup>4</sup>, Willem Rademacher<sup>5</sup>, Fred Rozema<sup>5</sup>

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<sup>5</sup>Acta Academic Dental Research Centre, Dutch Dental Society, Amsterdam, Netherlands

**Aim:** A previous Dutch guideline for prophylaxis of hematogenous PJI (HPJI) caused defensive medicine and incorrect own guidelines. There was a need for a better national guideline, developed cooperatively by orthopedic surgeons and dentist.

**Method:** A committee of Dutch Orthopedic and Dental Society, performed a systematic literature review to answer the question: *“Is there a difference in the risk for hematogenous infection between always or never giving antibiotic prophylaxis to patients with a joint prosthesis undergoing a dental procedure”*.

We included 9 papers as follows:

1. RCT's and systematic reviews: 539 abstracts > 33 full papers > 1 paper included.
2. observational studies: 289 abstracts > 12 full papers > 5 papers.
3. reference-to-reference: 3 papers.

The nine papers' quality was scored according the GRADE method.

In addition we studied in non-included literature on further information about additional questions of pathophysiology, risk factors and risk procedures.

**Results:** No evidence was found that prophylactic antibiotics have an effect on the incidence of HPJI (Grade score: very low).

We concluded from the non-included literature that:

1. Bacteremia in dental procedures is frequent, but even more frequent in daily life. The influence of antibiotics on bacteremia is uncertain.
2. There is no evidence that in the first 2 years after implantation the risk for HPJI is increased.
3. There is no evidence that “bleeding” during dental procedures is associated with more bacteremia.
4. The relation between decreased immune status and the risk for HPJI is unclear. Also in these patients the cumulative dose of bacteremia is much higher in daily life as compared with dental procedures.
5. A risk/benefit analysis could not be made, since the data are too uncertain of effectiveness of antibiotics, incidence of HPJI and of side effects of antibiotics.
6. For the same reason a cost/effectivity analysis was not possible. Even reliable data are missing about the prevalence of joint prosthesis patients.

- 7. There are increasing data about the relation between the oral and general health. Therefore good oral hygiene and regular dental controls is advised.
- 8. We could not conclude if the prophylactic use of oral Chlorhexidine prior to a dental procedure has any positive influence on HPJI incidence.

**Conclusions:** the guideline states:

- 1. there is no indication for antibiotic prophylaxis in dental procedures
- 2. also not in case of decreased immunity
- 3. patients should be advised to maintain good oral hygiene and have regular dental control.

### Free Papers E

#### [O87] FUNCTIONAL OUTCOME OF DEBRIDEMENT, ANTIBIOTICS AND IMPLANT RETENTION (DAIR) IN HIP PERI-PROSTHETIC JOINT INFECTION – A CASE-CONTROL STUDY

Ben Kendrick<sup>1</sup>, George Grammatopoulos<sup>1</sup>, Andrew Philpott<sup>2</sup>, Hemant Pandit<sup>3</sup>, Bridget Atkins<sup>1</sup>, **Marie-Eve Bolduc**<sup>1</sup>, Abtin Alvand<sup>1</sup>, Nick Athanasou<sup>1</sup>, Martin McNally<sup>1</sup>, Peter McLardy-Smith<sup>1</sup>, David Murray<sup>3</sup>, Roger Gundle<sup>4</sup>, Adrian Taylor<sup>1</sup>

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**Aim:** Advocates of Debridement-Antibiotics-and-Implant-Retention (DAIR) in hip peri-prosthetic joint infection (PJI) argue that a procedure not disturbing a sound prosthesis-bone interface is likely to lead to better survival and functional outcome compared to revision. However, no evidence supports this. This case-control study's aims were to compare outcome of DAIRs for infected 1° total hip arthroplasty (THA) with outcomes following 1° THA and 2-stage revisions of infected 1° THAs.

**Method:** We retrospectively reviewed all DAIRs, performed for confirmed infected 1° THR (DAIR-Group, n=80), in our unit between 1997-2013. Data recorded included patient demographics, medical history, type of surgery and organism identified. Outcome measures included complications, mortality, implant survivorship and functional outcome using the Oxford Hip Score (OHS). Outcome was compared with 2 control groups matched for gender and age; a cohort of 1° THA (1°-THA-Group, n=120) and a cohort of 2-stage revisions for infection (2-Stage-Revision-Group, n=66).

**Results:** The mean age at DAIR was 69 years and mean follow-up was 8 years (SD:5). 60% of DAIRs were for early PJI (< six weeks). Greater infection eradication with DAIR was detected with early-PJI, interval less than a week between onset of symptoms and exchange of modular components with the DAIR procedure. Infection eradication, complications and re-operation rates were similar in the DAIR- and 2-stage-revision Groups ( $p>0.05$ ). For hips with successful infection eradication with DAIR, the 5-yr survival (98%) was similar to the 1°THA-Group (98%) ( $p=0.3$ ). The DAIR-Group had inferior OHS (38) compared to the 1°THA-Group (42) ( $p=0.02$ ) but significantly better OHS compared to the 2-stage-revision-Group (31) ( $p=0.008$ ). Patients that required only one DAIR for infection eradication had similar OHS (41) to the 1° THA-Group ( $p=0.2$ ).

**Conclusions:** DAIRs are associated with similar complication and infection eradication to 2-stage revisions. Exchange of modular components is advised for improved chances of infection eradication. Functional outcome following DAIRs was better than a 2-stage revision and as good as that of a 1° THA if a single DAIR was necessary for infection eradication.

## Free Papers E

### [O88] INCISE DRAPING\* IS PROTECTIVE AGAINST SURGICAL SITE CONTAMINATION DURING HIP SURGERY: A PROSPECTIVE, RANDOMIZED TRIAL

Maryam Rezapoor<sup>1</sup>, Timothy Tan<sup>1</sup>, Mitchell Maltenfort<sup>1</sup>, **Antonia Chen<sup>1</sup>**, Javad Parvizi<sup>1</sup>

<sup>1</sup>The Rothman Institute, Philadelphia, United States

**Aim:** Different perioperative strategies have been implemented to reduce the devastating burden of infection following arthroplasty. The use of iodophor-impregnated adhesive incise drapes is one such strategy. Despite its wide adoption, there is little proof that this practice leads to a reduction of bacterial colonization. The aim of this randomized, prospective study was to evaluate the efficacy of iodophor-impregnated adhesive drapes for reducing bacterial count at the incision site.

**Method:** A total of 96 patients undergoing open joint preservation procedure of the hip were enrolled in this prospective, randomized clinical trial of iodophor-impregnated adhesive drapes\*. One half of patients (n=48) had iodophor-impregnated adhesive drapes\* applied to the skin prior to incision and kept on throughout the procedure, while the other half (n=48) underwent the same surgery without the use of iodophor-impregnated adhesive drapes\*. Culture swabs were taken from the surgical site at five different time points during surgery (pre-skin preparation, after skin preparation, post-incision, before subcutaneous closure, and prior to dressing application) and sent for culture and colony counts. Mixed-effects and multiple logistic regression analyses were utilized.

**Results:** Iodophor-impregnated adhesive drapes resulted in a significant reduction of bacterial colonization of the surgical incision. At the conclusion of surgery, 12.5% (6/48) of incisions with iodophor-impregnated adhesive drapes\* and 27.0% (13/48) without adhesive drapes were positive for bacteria. When controlling for preoperative colonization and other factors, patients without adhesive drapes were significantly more likely to have bacteria present at the incision at the time of closure (odds ratio (OR) 11.88, 95% confidence interval (CI) 1.45-80.00), and at all time-points when swab cultures were taken (OR 2.48, 95% CI 1.00-6.15).

**Conclusions:** Based on this skin sampling study, incise draping significantly reduces the rate of bacterial colonization/contamination during hip surgery. The bacterial count at the skin was extremely high in some patients without iodophor-impregnated adhesive drapes\*, which raises the possibility that a subsequent surgical site infection or periprosthetic joint infection could likely arise if an implant had been utilized.

\*IOBAN

### Free Papers E

#### [O89] PROSTHETIC JOINT INFECTIONS IN AUSTRALIA AND NEW ZEALAND: THE FIRST 275 PATIENTS FROM THE PIANO (PROSTHETIC JOINT INFECTION IN AUSTRALIA AND NEW ZEALAND OBSERVATIONAL) STUDY

Joshua Davis<sup>1</sup> on behalf of the PIANO investigators and the ASID clinical research network\*

<sup>1</sup>John Hunter Hospital, Department of Infectious Diseases, Newcastle, Australia

**Aim:** There is a lack of both epidemiological data and of high-quality evidence to guide the management of Prosthetic joint infection (PJI). We hypothesised that there is substantial heterogeneity in the clinical presentation and management of PJI in Australia and New Zealand, and that the proportion with clinical cure at 24 months is independently associated with modifiable variables in surgical and antibiotic management.

**Method:** Prospective binational multicentre observational study aiming to enrol 400-600 patients with large joint PJI, defined as per IDSA criteria. Following screening and written informed consent, data are collected at baseline and after 3, 12 and 24 months. The main outcome measures are clinical cure, functional status (based on Oxford joint and SF12 scores) and direct health care costs at 24 months.

**Results:** As of April 2016, 15 sites in Australia and 5 in New Zealand have full ethics approval and have begun recruitment and over 275 patients have been recruited, of whom 59% were male and the average (SD) age was 69 (11.3) years. Obesity was common, with a mean body mass index of 32, and 23% of the cohort were diabetic. The most common joints involved were knees (55%) and hips (39%). Most infections were late postoperative acute haematogenous infections (41%), with early post-operative (<30 days) and chronic infections less common. *Staphylococcus aureus* was the most common causative organism (38%) and debridement and implant retention (DAIR) was the main initial management strategy (61%), with a two-stage revision the next most common (25%). The median duration of IV antibiotics was 42 days, regardless of management strategy. Rifampicin was used in only 38% overall, and in only 60% in the subgroup with Gram positive infections treated with DAIR.

**Conclusions:** There are no generally agreed upon guidelines for the management of PJI in Australia and New Zealand, and this is reflected in heterogeneity of management strategies. Acute haematogenous infections are more common, and rifampicin use less common than expected. The PIANO study has been successfully established with minimal funding and will serve as a platform for much needed interventional studies to answer important questions about PJI management including the role of rifampicin and the timing and duration of antibiotic treatment.

**Acknowledgements:** \*PIANO Study Group - Craig Aboltins, Eugene Athan, Thi Aung, Tim Blackmore, Steve Chambers, Roy Chean, Peter Choong, Benjamin Clark, Josh Davis, Nick Graves, Steven Graves, Kate Grimwade, Garry Hooper, Paul Huggan, Justin Jackson, Chris Lemoh, Peter Leung, Mark Loewenthal, David Looke, Penny Lorenc, Christopher Luey, Laurens Manning, Stephen McBride, Sarah Metcalf, Nora Mutalima, Vana Nagendra, David Paterson, Kerry Read, Alistair Reid, Owen Robinson, Marjoree Sehu, Yuen Su, Archana Sud, Adrienne Torda, Ashley Watson and Piers Yates. The PIANO study is supported by a research grant from Hereus Medical; they played no role in study design, data analysis or the decision to publish.



## Free Papers F

### [O90] PHOTODYNAMIC THERAPY AS AN ANTIMICROBIAL TECHNIQUE TARGETING BACTERIAL STRAINS COMMON TO ORTHOPAEDIC INFECTIONS

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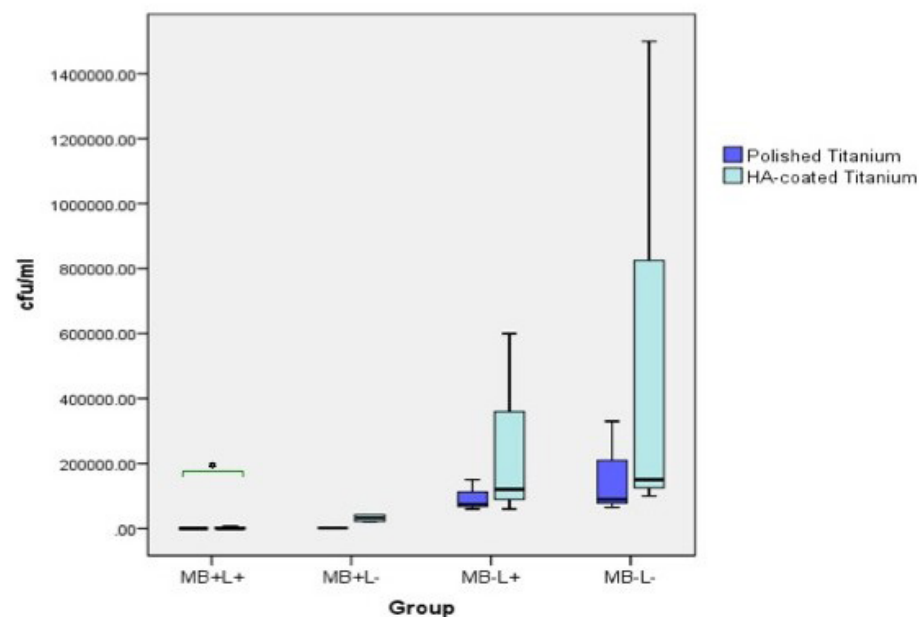
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**Aim:** Photodynamic therapy (PDT) requires a photosensitizer, a light source of an appropriate wavelength, and the presence of molecular oxygen. Once stimulated to its excited phase by the light, the photosensitizer reacts with oxygen to form free radicals of 'singlet oxygen' which is cytotoxic to microorganisms.

We aim to demonstrate the effectiveness of PDT as an *in-vitro* antimicrobial technique against *Staphylococcus aureus*, *Methicillin resistant Staphylococcus aureus*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa* and *Acinetobacter baumannii*. This will form the scientific basis for further animal and human studies assessing PDT for treatment of periprosthetic infections, septic arthritis, and open fractures.

**Method:** A PDT treatment protocol was devised using lawns of bacteria on agar plates. PDT was targeted towards the bacteria and the remaining microorganisms were quantified using a serial dilution technique. In order to assess the ability of photodynamic therapy to target biofilms on metallic implants, biofilms were cultured on polished titanium and hydroxyapatite-coated titanium discs and subjected to PDT.

**Results:** Reductions in bacterial colony forming units of up to 7 log were achieved using PDT. The figure is a box plot representing a comparison of the amount of biofilm *Pseudomonas aeruginosa* (cfu/ml) remaining on the polished titanium disc and hydroxyapatite-coated titanium disc following treatment with photodynamic therapy. (MB+/-: photosensitizer present/absent; L+/-: laser present/absent).



**Conclusions:** PDT has long been used in dermatology and dentistry as an antimicrobial technique. Its potential for treating orthopaedic infections has not yet been investigated. This study demonstrates potential for PDT as an antimicrobial technique in the treatment of bacteria commonly found in periprosthetic infections, septic arthritis, and open fractures. This *in-vitro* work lays the foundations for future animal and clinical studies. We envision PDT being used as an adjunct to antibiotics in treatment of these conditions, helping prevent ongoing infection, and the development of resistance.

## Free Papers F

### [O91] AUDIOVISUAL DISTRACTION AS AN ADJUNCT TO EPIDURAL ANAESTHESIA IN “AWAKE” PATIENTS UNDERGOING COMPLEX SURGERY FOR OSTEOMYELITIS

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**Aim:** In our Bone Infection Unit, epidural anaesthesia and sedation (EA+Sed) is the technique of choice for complex orthoplastic surgery involving lower limb free tissue transfer (LLFTT) (1) as it avoids complications of prolonged general anaesthesia (GA). Following our initial reports of successful use of audio-visual distraction (AVD) as an adjunct to regional anaesthesia we wished to evaluate the AVD effect on the patients' experience during long duration, complex orthoplastic surgery for chronic osteomyelitis under EA+Sed.

**Method:** Our AVD equipment consists of a WiFi connected tablet and noise reducing head phones, providing access to downloaded music, films and the internet. Patients are also allowed to use their own equipment.

All patients were fully informed about AVD and EA+Sed as a choice of anaesthesia. EA was established in the anaesthetic room and continued perioperatively. Sedation with propofol was titrated to the patients' requirements to ensure comfort during surgery.

All patients were followed up postoperatively with a structured questionnaire.

**Results:** Ten patients underwent LLFTT surgery for chronic bone infection under EA+Sed+AVD (picture). Mean duration of surgery was 550 min (480–600 min).

Patients used the AVD to listen to music, watch movies, play internet games and use e-mail and social media.

All 10 patients were very satisfied, and 9 reported feeling comfortable or very comfortable intraoperatively. All rated their experience better than previous GAs, with quicker general recovery. All patients would recommend this technique to others.

## Oral Abstracts

**Conclusions:** Our case series of patients undergoing prolonged surgery for osteomyelitis under EA+Sed has shown very positive impact of AVD on patients' experience and confirmed our earlier encouraging observations (1,2). This clinical service improvement deserves further evaluation and funding.



### References:

1. S. Galitzine. Regional Anaesthesia and Pain Medicine 2014; 39(5) Supp 1: E245.
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## Free Papers F

### [O92] PERIPROSTHETIC FUNGAL INFECTIONS, OUTCOMES AND PREDICTIVE FACTORS

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**Aim:** Periprosthetic joint infections (PJI) are rare and require complex multi-disciplinary management. Successful single and two-stage revision procedures have been described. We describe the clinical features of this rare diagnosis from a single institution.

**Method:** Patients were identified retrospectively from a prospectively collected institutional infection database. Clinical notes were evaluated for demographic, comorbid and clinical outcomes. The diagnosis of PJI, and any recurrence following treatment, was made in accordance with the Musculoskeletal Infection Society criteria. Failure was defined as recurrence of infection necessitating implant removal, excision arthroplasty or amputation.

**Results:** Between 2005 and 2015, 25 patients were diagnosed with fungal PJIs involving hip(7) and knee(13) arthroplasties and endoprostheses(5). All included patients met the MSIS criteria for PJI. 88% had polymicrobial infections, 88% had multiply revised joints and 88% had coexisting multidrug resistant bacterial infections. Surgical protocol consisted of single stage (4) and two-stage (20) revision and excision arthroplasty. At mean three years follow-up (range 1 to 9 years) 19 patients were available for follow-up as six had died. At final follow-up there were 11 failures: one excision arthroplasty, two cases of recurrent PJI (8%) and 8 (32%) amputations.

**Conclusions:** Revision specialists should maintain a low threshold for consideration of fungal PJI, particularly in the polymicrobial and multiply-revised cases. The detection of fungal organisms in multiorganism PJI is strongly associated with amputation and patients should be counselled at the outset.

### Free Papers F

#### [O93] CAN SONICATION CHALLENGE ASEPTIC VS PJI BARRIER

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**Aim:** Clear differentiation between aseptic failure and prosthetic joint infection remains one of the goals of modern orthopaedic surgery. New diagnostic methods can provide more precise evaluation of the etiology of prosthetic joint failure. With the introduction of sonication an increasing number of culture-negative prosthetic joint infection were detected. The aim of our study was to evaluate culture-negative prosthetic joint infections in patients who were preoperatively evaluated as aseptic failure.

**Method:** For the purpose of the study we included patients planned for revision surgery for presumed aseptic failure. Intraoperatively acquired samples of periprosthetic tissue and explanted prosthesis were microbiologically evaluated using standard microbiologic methods and sonication. If prosthetic joint infection was discovered, additional therapy was introduced.

**Results:** Between October 2010 and till the end of 2014 151 cases were operated (38 revision knee arthroplasty, 113 revision hip arthroplasty). 40 (26,5%) cases had positive sonication and negative periprosthetic tissue samples (knee 7 cases, hips 33 cases), 13 (8,6%) cases had positive tissue samples but negative sonication (knee 7 cases, hips 6 cases), in 13 (8,6%) cases both tests were positive (knee none, hips 13 cases) and in 85 (56,3%) cases all microbiologic tests were negative (knee 24 cases, hips 61 cases). In both groups cases coagulase-negative staphylococci and *P.acnes* were most common, followed by mixed flora.

**Conclusions:** With the increasing number of patients requiring revision arthroplasty, a clear differentiation between aseptic failure and prosthetic joint infection is crucial for the optimal treatment. Sonication of explanted material is more successful in the isolation of pathogens compared to periprosthetic tissue cultures. Sonication of explanted prosthetic material is helpful in the detection of culture-negative prosthetic joint infections.

## Free Papers G

### [O94] INPATIENT SYSTEMIC SEPSIS ALERT SYSTEMS DO NOT DEMONSTRATE UTILITY AFTER JOINT ARTHROPLASTY

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**Aim:** Hospital systems have recently instituted early systemic sepsis recognition systems, where vital signs and laboratory findings are monitored and automatically alert providers to potential sepsis. Although there are very few reports evaluating the use of sepsis alert systems outside of the emergency room or intensive care unit, many hospital systems have made the decision to apply the sepsis alarm protocols to all inpatients. The purpose of this study was to evaluate if an alarm system using systemic inflammatory response syndrome (SIRS) criteria is a valuable tool to predict systemic sepsis in the immediate postoperative period (POD#0-4) after total joint arthroplasty (TJA).

**Method:** 10,791 primary and revision TJA patients at one institution, from 2010-2014, were retrospectively reviewed for positive SIRS criteria on each hospital day from the date of surgery to postoperative day four (POD#4). SIRS criteria included temperature > 38°C or < 36°C, heart rate > 90 beats per minute, respiratory rate > 20 breaths per minute, and white blood cell (WBC) > 12,000/mm<sup>3</sup> or < 4,000/mm<sup>3</sup>. Additionally, hospital coding data was cross-referenced to identify patients who were diagnosed with systemic sepsis within 10 days after having a TJA.

**Results:** Of the 10,791 patients undergoing a primary or revision TJA, only 1 patient was diagnosed with sepsis within 10 days of TJA, yielding a prevalence of 0.00009. During POD#0-4, 1798 patients would have triggered at least a 2 criteria SIRS alarm, yielding a false positive rate of 16.7% and a positive predictive value for systemic sepsis of 0.06% (95%CI: 0 to 0.31%). 416 patients would have triggered at least 3 criteria SIRS alarm, yielding a false positive rate of 3.9% and positive predictive value of 0.24% (95%CI:0.01 to 1.33%). The SIRS criteria in the one septic patient in this study did become positive, but did so only after the clinical team had already initiated sepsis care.

**Conclusions:** A SIRS based alarm system for sepsis does not appear to have any utility in the postoperative period after TJA. We are concerned that the high false positive rate of these alarms may result in unnecessary sepsis work-ups, extended hospital stays, and potentially degrade the perceived importance of the sepsis alarms in other cohorts of hospital patients. Further research is necessary to determine if TJA patients with a length of stay greater than normal may benefit from an automatic sepsis alarm system.

### Free Papers G

#### [095] DIAGNOSIS OF PERSISTENT INFECTION IN PROSTHETIC TWO-STAGE EXCHANGE: PCR ANALYSIS OF SONICATION FLUID FROM BONE CEMENT SPACERS

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<sup>1</sup>University Hospital of Lausanne (Chuv), Service of Orthopedics and Traumatology, Lausanne, Switzerland

**Aim:** When treating periprosthetic joint infections with a two-stage procedure, antibiotic-impregnated spacers are used in the interval between removal of prosthesis and reimplantation. The spacer provides local antibiotics; however, it may also act as foreign-body that can be colonized by microorganisms. According to our experience, cultures of sonicated spacers are most often negative. The objective of our study was to investigate whether PCR analysis would improve the detection of bacteria in the spacer sonication fluid.

**Method:** A prospective monocentric study was performed at Lausanne University Hospital from September 2014 until January 2016. Inclusion criteria were two-stage procedure for prosthetic infection and agreement of the patient to participate in the study. For a two-stage procedure the interval before reimplantation ranged between 2 and 8 weeks. Spacers were made of cement impregnated with gentamycin, tobramycin and vancomycin. Cultures of intraoperative deep tissues samples from first and second stage procedures, prosthesis sonication and spacer sonication were analyzed. Multiplex-PCR\*, pan-bacterial PCR (16S), and a Staphylococcus-specific PCR analysis were performed on the sonicated spacer fluid.

**Results:** 23 patients were identified (12 hip, 10 knee and 1 ankle replacements). Initial infection was caused by *Staphylococcus aureus* (27%), *Streptococcus epidermidis* (27%), *S. dysgalactiae* (13%), *S. milleri* (9%), *S. pneumoniae* (4%), *S. capitis* (4%), *S. salivarius* (4%), *P. acnes* (4%), *E. faecalis* (4%) and *C. fetus* (4%). At reimplantation, cultures of tissue samples and spacer sonication fluid were all negative. Of culture-negative samples, the PCR analyses were negative except for 5 cases. 4 cases of infection recurrence were observed, with bacteria different than for the initial infection in 3 cases. For these cases, no germs were detected in the spacer sonication fluid by neither cultures nor PCR.

**Conclusions:** The 3 different PCR analyses performed did not detect any bacteria in spacer sonication fluid that was culture-negative. In our study, PCR did not improve the bacterial detection and did not help to predict whether the patient will present a recurrence of infection. Prosthetic 2-stage exchange with short interval and antibiotic-impregnated spacer is an efficient treatment to eradicate infection as both culture- and molecular-based methods were unable to detect bacteria in spacer sonication fluid after reimplantation.

\*Unyvero



## Free Papers G

### [O96] INTRAOPERATIVE MICROBIOLOGICAL INVESTIGATION IN PROSTHETIC JOINT INFECTIONS – SONICATION BRINGS ADDED VALUE BUT IS NOT A SUBSTITUTE FOR TRADITIONAL SAMPLING

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**Aim:** Diagnosing prosthetic joint infections(PJI) is sometimes difficult. Being able to identify the bacteria involved in intraoperative samples is an essential diagnostic criterion.

There are however some cases in which the traditional cultures are not capable of providing a definitive diagnosis. In this regard, implant sonication has emerged as a complementary test.

The aim of this study was to analyze the results of microbiological studies obtained with and without implants sonication, in order to understand its real contribution to diagnosis.

**Method:** We retrospectively evaluated all cases of infected total hip or knee arthroplasty surgically treated between January 2009 and December 2013. The definition of infection met the criteria set out recently in the international consensus meeting.

The number and type of bacteria identified in each patient and the type of microbiological study made were registered.

Two different groups were created, with and without sonication, and the results were compared.

**Results:** In a total of 93 patients with PJI, there were only three cases (3.2%) in which we failed to isolate any microorganism. In the 41 cases in which sonication was not used, 54 different microorganisms (an average of 1.32 per patient) were found and no microorganism was found in two cases (4.9%).

In the 52 patients in whom sonication was used, we identified 74 different microorganisms (an of average 1.42 per patient) and only one case (1.9%) of negative cultures. In 25 patients (27 microorganisms) there was complete correspondence between the findings of sonication and traditional tissue culture. In 22 cases, 34 different microorganisms were found in tissue samples and sonication offered negative cultures. On the other hand, there were four patients in with 13 microorganisms were identified in sonication with negative tissue cultures.

**Conclusions:** An analysis made in our institution several years ago, showed a percentage of culture negative PJI of almost 20%. Since then, several changes have been introduced in our clinical practice. Of these, sonication, whose value has been amply demonstrated in the literature, is the most demanding in terms of logistics.

The authors believe that the implementation and especially the widespread adoption of simple rules for proper sampling is effective for a significant reduction in cases where it is not possible to isolate any microorganism in PJI's. We believe sonication should be seen as an additional diagnostic tool that contributes to increasing sensitivity but should not be considered a substitute for traditional study.

### Free Papers G

#### [097] STABILITY OVER 6 WEEKS OF ANTIBIOTICS IN AQUEOUS SOLUTION AT BODY TEMPERATURE WITH AND WITHOUT INITIAL HEAT TREATMENT MIMICKING CURING BONE CEMENT

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**Aim:** Thermal stability is a key property determining the suitability of an antibiotic agent for local application. Long-term data describing thermal stability without interference from carrier materials are scarce.

**Method:** In this study, a total of 38 common antibiotic agents have been maintained at 37 °C in saline solution, and degradation and antibacterial activity assessed over 6 weeks. The impact of an initial supplementary heat exposure mimicking exothermically-curing bone cement has also been tested. Antibiotic degradation was assessed by chromatography coupled to mass spectrometry or immunoassays, as appropriate. Antibacterial activity was determined by Kirby-Bauer disk diffusion assay.

**Results:** The heat exposure mimicking curing bone cement had minimal effect on stability for most antibiotics, except for gentamicin, which experienced approximately 25% degradation as measured by immunoassay. Beta-lactam antibiotics were found to degrade quite rapidly at 37°C regardless of whether there was an initial heat exposure or not. However some of them maintained relevant concentrations and activity for 2-3 weeks, particularly aztreonam. Excellent long-term stability was observed for aminoglycosides, glycopeptides, tetracyclines and quinolones under both conditions.

**Conclusions:** This study provides a valuable dataset for orthopaedic surgeons considering local application of antibiotics. For example, tobramycin would be more suitable for application with bone cement than gentamicin, as it was found to be resistant to heat exposure mimicking curing bone cement.

## Free Papers G

### [O98] HYDROGEL IMPREGNATION OF BONE CHIPS ALLOWS PROLONGED CEFAZOLIN RELEASE

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**Aim:** To prevent infections after orthopedic surgery, intravenous antibiotics are administered perioperatively. Cefazolin is widely used as the prophylactic antibiotic of choice. Systemic antibiotic therapy may however be less effective in longstanding surgery where bone allografts are used. Bone chips have been shown to be an effective carrier for certain types of antibiotics and may provide the necessary local antibiotic levels for prophylaxis. To be efficient a prolonged release is required. In contrast to vancomycin with proven efficient prolonged release from Osteomycin, this has not been described for cefazolin. We developed a protocol to bind cefazolin to bone chips by means of a hydrogel composed of proteins naturally present in the human body.

**Method:** Three types of bone chips were evaluated: fresh frozen, decellularized frozen and decellularized lyophilized. Bone chips were incubated with 20 mg/ml cefazolin or treated with liquid hydrogel containing either 1 mg/ml fibrin or 1 mg/ml collagen and 20 mg/ml cefazolin. The cefazolin hydrogel was distributed in the porous structure by short vacuum treatment. Bone chips with cefazolin but without hydrogel were either incubated for 20 min- 4h or also treated with vacuum. Cefazolin elution of bone chips was carried out in fetal bovine serum and analyzed by Ultra Performance Liquid Chromatography – Diode Array Detection.

**Results:** Soaking of bone chips without hydrogel resulted in a quick release of cefazolin, which was limited to 4 hours. When vacuum was applied elution of >1 µg/ml cefazolin was measured for up to 36 hours. Combination with collagen hydrogel resulted in a higher cefazolin concentration released at 24 hours (3.9 vs 0.3 µg/ml), but not in a prolonged release. However, combination of decellularized frozen bone chips with fibrin hydrogel resulted in an initial release of 533 µg/ml followed by a gradual decline reaching the minimal inhibitory concentration for *S. aureus* at 72 hours (1.7 µg/ml), while not measurable anymore after 92 hours.

**Conclusions:** Processed bone chips with hydrogel-cefazolin showed a markedly prolonged cefazolin release. When combined with a fibrin hydrogel, high initial peak levels of cefazolin were obtained, followed by a decreasing release over the following three days. This elution profile seems desirable, with high initial levels to maximize anti-bacterial action and low levels for a limited time to stimulate osteogenesis. Further preclinical studies are warranted to show effectiveness of hydrogel-cefazolin impregnated bone chips.

### Free Papers G

#### [099] RADIOGRAPHIC REMODELING PATTERNS OF A GENTAMICIN-ELUTING HYDROXYAPATITE / CALCIUM SULFATE BIOCOMPOSITE. PRELIMINARY RESULTS FROM A LARGE ANIMAL MODEL

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**Aim:** A gentamicin-eluting biocomposite consisting of hydroxyapatite and calcium sulfate<sup>1</sup> can provide effective dead space management in chronic osteomyelitis. However, radiographic follow-up after implantation of this novel material has consistently shown evidence of several unique imaging features previously not described with other comparable bone graft substitutes. Conclusive interpretation of these newly described imaging features is difficult as long term follow-up and histological correlation is not yet available. The aim of this study was to establish a large animal model, closely simulating the clinical situation in order to permit further analysis of imaging features in correlation with histological progression of bone remodeling.

**Method:** Standardised bone defects were created in ten Merino-wool sheep (age: two to four years). Large drill holes (diameter 2.5cm, depth 2cm, volume approx. 10ml) were placed in the medial femoral condyles of both hind legs and filled with a gentamicin antibiotic eluting bone graft substitute\*. Initially surgery was carried out on the right hind leg. Three months later, an identical intervention was performed on the contralateral side. With sacrifice planned after six or twelve months, bone voids three, six, nine and twelve months post-implantation are obtained for evaluation. The study was approved by the Animal Care Committee of Thuringia, Germany.

**Results:** We present our preliminary radiographic results after a follow-up of six months. The biocomposite was clearly visible on all initial post-operative radiographs, showing intimate contact to the surrounding cancellous bone of the distal femur. At one month, a radio-dense ring around the bone void (the so called “halo sign”) was found in four of six bone voids treated with the biocomposite. From 2 months onwards this “halo” typically appeared to progress towards the centre of the treated defects, where spherical remnants of the composite often become increasingly apparent. This pattern has been termed “marble sign” and often appears in combination with the halo-sign. Between three to six months bone remodeling appears to continue, halo- and marble sign increasingly disappear and the composite becomes more and more indistinct from surrounding cancellous bone.

**Conclusions:** We have established a large animal model, which appears to mimic the clinical situation very well and reproduces comparable radiographic post implantation features previously observed and described in clinical cases (including the “halo” and the “marble” sign). We expect that this model will provide valuable information regarding the correlation between histological and basic & advanced imaging features (including MRI, CT and DEXA scans) in the future.

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## Free Papers G

### [O100] POSTOPERATIVE INFECTIONS AFTER ARTHROSCOPIC ROTATOR CUFF REPAIR. TREATMENT AND RESULTS IN A PROSPECTIVELY REGISTERED COHORT

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**Aim:** Acute postoperative infection is reported to occur in 0.3-2% after arthroscopic rotator cuff repair. Few reports have addressed this dreaded complication although the costs are high both for the patient and for society. The aim of this prospective study was to describe incidence, treatment and outcome after acute postoperative infections following arthroscopic rotator cuff repair.

**Method:** Patients undergoing arthroscopic rotator cuff repair in our department have been prospectively registered since 2009. 11 out of 1072 patients undergoing surgery developed an acute postoperative infection. The patients were examined with an MRI scan and/or functional scores (Constant Murley (CM) and WORC) at final follow-up.

**Results:** All 11 patients that developed acute postoperative infections were male. Mean age was 54 (41-68) years. Except for male gender, no common underlying predisposing risk factor for infection could be identified. 1/11 patient had diabetes mellitus and 2/11 smoked. Average BMI was 27 (21-36). 1/11 was categorized as ASA 3 and the rest of the patients were ASA 1 and 2.

All patients underwent arthroscopic debridement and biopsies were collected 26 (14-50) days after primary surgery. In 10 patients *Propionibacterium acnes* was cultured, and 6 of these patients also had positive cultures for coagulase negative staphylococci. In the remaining patient only coagulase negative staphylococcus was cultured.

5/11 patients were treated with one arthroscopic debridement, 5/11 had two arthroscopic debridements, whereas 1/11 required arthroscopic debridement four times before the infection was eradicated. Only 2/11 patients had to have their implants removed during the reoperation due to loosening of the suture anchors.

All 11 patients were treated with parenteral antibiotics for 7-28 days, followed by oral treatment for 1-5 weeks, and all infections had resolved at final follow-up. Median CM score was 84 and median WORC score was 81% at follow-up median 22(11-28) months. 10 patients had a postoperative MRI scan after median 23 (3-49) months, 8 of them showing a healed cuff repair.

**Conclusions:** Acute postoperative infections after arthroscopic rotator cuff repair can be eradicated with arthroscopic debridement(s) and removal of implants may not be necessary if patency is adequate. Despite the postoperative acute infection our patients presented good functional results and were satisfied at last follow-up.

### Free Papers G

#### [O101] INTERNALIZATION OF PROPIONIBACTERIUM ACNES BY OSTEOBLASTS DEPENDS ON P. ACNES GENETIC BACKGROUND

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**Aim:** *Propionibacterium acnes* is an emerging pathogen especially in orthopedic implant infection. Interestingly, we previously reported a difference in the distribution of the clades involved in spine *versus* hip or knee prosthetic infection. To date, no study has previously explored the direct impact and close relationship of *P. acnes* on bone cells according to their own genetic background. The aim of this study was to investigate this interaction of *P. acnes* clinical strains involved in spine material infections, arthroplasty infections and acne lesions with bone cells.

**Method:** From a large collection of 88 *P. acnes* clinical isolates collected between January 2003 and December 2014, a subset of 11 isolates was studied. Four isolates were recovered from spine infections, two from prosthetic infections (knee and hip), three from acne lesions and two reference strains (ATCC11827 and ATCC6919). Implant-associated infections were confirmed according to Infectious Diseases Society of America guidelines for bone and joint infections. Multi-Locus Sequence Typing (MLST) was carried out on all isolates as described by Lomholt *et al.* *PLoS ONE* 2010. Bacterial internalization experiments with MG63 osteosarcoma cells were adapted from Crémet *et al.* *Pathog Dis* 2015.

**Results:** Among the nine clinical isolates, three isolates belonged to clonal complexes (CCs) 18; three to CC28 and three to CC36. ATCC isolates belonged to CC18. Bacterial internalization experiments revealed that CC36 *P. acnes* strains were less invasive than CC18 and CC28 *P. acnes* strains towards osteoblasts (mean percentage of internalized bacteria (< 0.01% for the CC36 *P. acnes* strains *versus* more than 1% for the CC18 and CC28 *P. acnes* strains). Surprisingly, the ATCC11827 CC18 *P. acnes* strain exhibited invasiveness similar to CC36 isolates.

**Conclusions:** Evasion mechanism observed for CC36 *P. acnes* isolates could allow this clade to leave the site of infection, disseminate into deeper tissue layers and beget arthroplasty infection. Inside the deeper tissue, close to the material, the local immune defect fosters the low-grade infections observed with *P. acnes* clinical strains. On the another hand, for CC18 et CC28 clades, mostly involved in spine infection, the internalization process observed could allow these clades to escape from the numerous immune cells located under the skin and generate an infection locally, favored by the spine instrumentation close to the skin, especially during long spine surgeries.

## Free Papers H

### [O102] CALCIUM SULFATE INDUCED MEMBRANE IN A RAT FEMUR CRITICAL-SIZED DEFECT MODEL: CHARACTERISTICS AND DIFFERENCES FROM PMMA INDUCED MEMBRANE IN MASQUELET TECHNIQUE

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**Aim:** Calcium sulfate has been recently applied in clinics as a local antibiotic carrier for the treatment of chronic osteomyelitis. We found that calcium sulfate can also induce the formation of membrane in clinical cases. This study aimed to investigate characteristics of calcium sulfate induced membrane and its differences from the membrane in Masquelet technique induced by polymethylmethacrylate (PMMA).

**Method:** Sprague Dawley rats (n=32) were equally randomized to PMMA group or calcium sulfate group. After femur critical-sized defect model was made, PMMA or calcium sulfate was placed in the site of bone defect. Cellular components, histological changes and growth factor expressions in the calcium sulfate and PMMA induced membranes were compared at 2, 4, 6 and 8 weeks, respectively. In addition, expressions of vWF, IL-6, VEGF, BMP-2, TGF- $\beta$  and ALP genes in were also compared.

**Results:** The structural characteristics including locations of blood vessels were similar between calcium sulfate and PMMA induced membranes. However, calcium sulfate induced membrane was thicker than that by PMMA. Mesenchymal stem cell (MSCs; CD34+, CD54+, CD90+) was found in calcium sulfate induced membrane. Levels of BMP-2, TGF- $\beta$ , ALP and VEGF in calcium sulfate induced membrane were significantly higher than those by PMMA at all time points ( $P \leq 0.05$ ). In addition, we found that osteogenic and neovascular activities of both calcium sulfate and PMMA induced membranes achieved the highest levels at 6 weeks. Moreover, expressions of vWF, VEGF, BMP-2, TGF- $\beta$  and ALP genes in calcium sulfate induced membrane were significantly higher than those in PMMA induced one ( $P < 0.05$ ).

**Conclusions:** Calcium sulfate induced membrane has similar structural characteristics but a better capacity of generating higher levels of different growth factors. Calcium sulfate and PMMA induced membrane achieve the highest levels of osteogenic and neovascular activities at 6 weeks. Considering the degradable feature of calcium sulfate, it may have the potential ability to replace PMMA as a novel spacer in Masquelet technique.

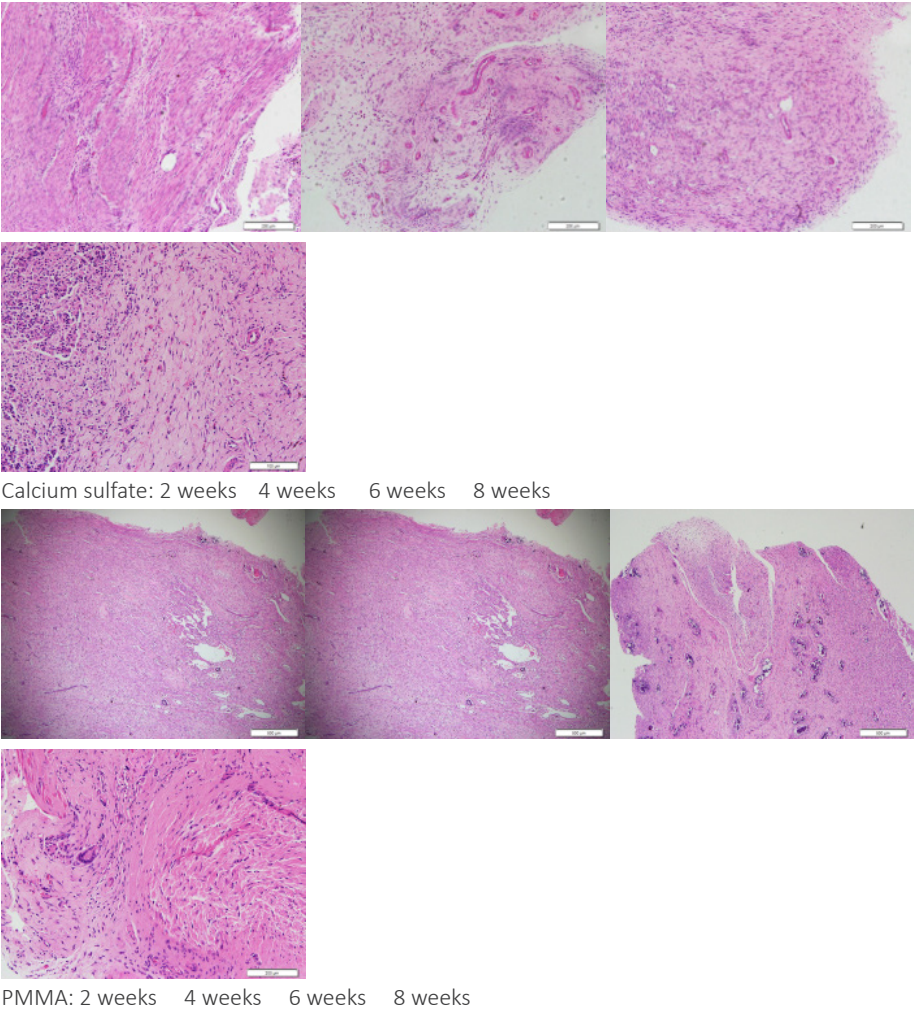


Fig. 1 H&E staining between calcium sulfate and PMMA induced membranes at 2, 4, 6 and 8 weeks, respectively



## Free Papers H

### [O103] THE ROLE OF PREOPERATIVE ASYMPTOMATIC BACTERIURIA IN THE DEVELOPMENT OF PERIPROSTHETIC JOINT INFECTION OF THE HIP

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**Aim:** Despite of all the important improvements emerged in recent years, periprosthetic joint infection (PJI) still remains one of the most challenging complications in joint arthroplasty. Preoperative screening for active infection is considered to be important, however the role of asymptomatic bacteriuria in the development of PJI is controversial. Our aim was to investigate any existing correlation between PJI and asymptomatic bacteriuria.

**Method:** A retrospective, monocentric study was conducted at our Clinic. The charts of 990 patients operated with total hip arthroplasty between 2011 and 2012 were reviewed. Occurent preoperative asymptomatic bacteriuria, the causing bacteria, the treatment and its outcome were recorded. Any existing correlation between PJI and the above data were investigated.

**Results:** Of our patients 236 had asymptomatic bacteriuria, which was treated successfully in 200 cases, leaving 36 patients having total hip arthroplasty with urinary tract infection. Fifteen patients developed PJI, 5 of them with unsuccessfully treated urinary tract infection, in the remaining 10 patients the asymptomatic bacteriuria was treated successfully. Abortively treated asymptomatic bacteriuria proved to be an independent risk factor for PJI (odds ratio: 3.22, 95% CI 0,9814 - 9,5695) There was no correspondence between the bacteria found in the urinary tract and those causing PJI.

**Conclusions:** Based on our results, asymptomatic bacteriuria proved to be an independent risk factor in the development of PJI. Its role is still controversial, since correspondence between the bacteria causing UTI and PJI could not be observed.

### Free Papers H

#### [O104] INDIUM -111 WHITE-CELL SPECT CT SCAN: AN EMERGING IMAGING MODALITY WITH GREAT POTENTIAL IN BONE AND JOINT INFECTION

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**Aim:** To demonstrate the use of indium-111 white-cell labelled SPECT CT (In111-WC-SPECT-CT) in bone infection.

**Method:** This novel imaging modality is useful in bone infection. We present three cases of complex osteomyelitis to illustrate this. All were imaged with conventional modalities, but conclusive diagnosis could not be achieved. In111-WC-SPECT-CT was used to provide the definitive imaging that allowed successful treatment.

**Results:** Case 1- A 29 y/o Male with spina bifida presented with chronic calcaneal osteomyelitis. Previous treatment included debridement, but recurrent infection ensued. MRI showed widespread changes consistent with infection throughout the calcaneus and a below knee amputation was planned. In111-WC-SPECT-CT (Figure 1) showed a distinct localised nidus of infection. A targeted sequestrectomy was performed and the patient has been infection free for four years. He was spared the amputation.

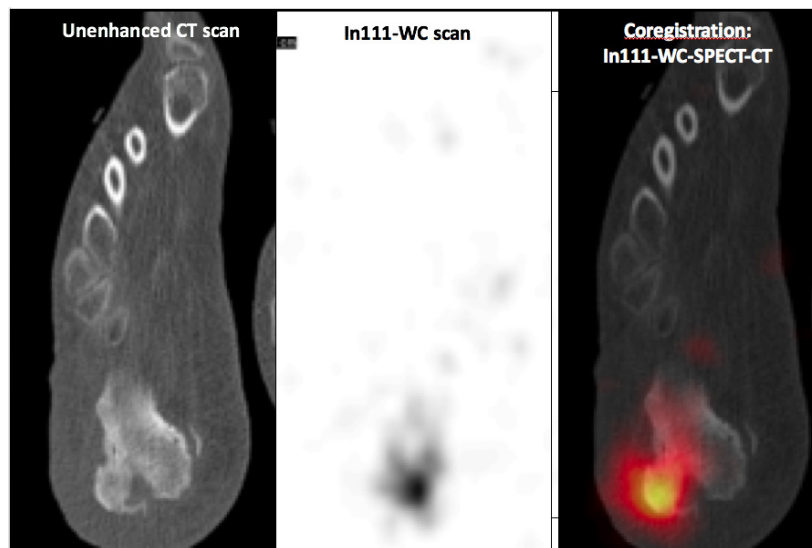


Figure 1

Case-2- A 73 y/o male presented with a radiation induced colo-cutaneous fistula and pelvic chronic osteomyelitis. Surgical treatment included multiple debridements and sequestrectomy. He re-presented pain with pain in his pelvis six months later. MRI was performed and oedema seen in the bone. This was presumed to be infection and further surgery was planned. An In111-WC-SPECT-CT was then performed and confirmed no residual bone infection. The patient was spared surgery.

Case-3- A 38 y/o female was involved in an RTA 6 months prior to presentation. She underwent fixation of her tibia with skin grafting for an open fracture. There was clinical suspicion of deep infection. The metalwork made MRI difficult to interpret. An In111-WCC-SPECT-CT confirmed infection around the metal screw and this evidence instigated a prolonged course of antibiotics to suppress the infection. The screw will be removed after the fracture heals.

**Conclusions:** In-111-WC-SPECT-CT is an emerging imaging modality. We present three cases of complex bone and joint infection; where this imaging has altered the course of treatment.

### Free Papers H

#### [O105] RIFAMPIN COMBINATION THERAPY IN EARLY STAPHYLOCOCCAL PROSTHETIC JOINT INFECTIONS: A RANDOMIZED CONTROLLED TRIAL

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**Aim:** Prosthetic joint infection (PJI) is a much feared complication to arthroplasty with significant patient morbidity. Rifampin is increasingly used in staphylococcal PJIs treated with debridement and retention of the prosthesis. The evidence supporting rifampin combination therapy in PJIs is limited due to the lack of controlled studies. The aim of this study is to evaluate the effect of adding rifampin to conventional antimicrobial therapy in early staphylococcal PJIs treated with debridement and retention.

**Method:** In this multicentre randomized controlled trial, 99 patients with PJI after hip and knee arthroplasties were enrolled. All patients underwent a standardized surgical debridement. 65 patients had PJI caused by staphylococci and further included in the study. They were randomly assigned to receive rifampin or not in addition to standard antimicrobial therapy with cloxacillin, or vancomycin in case of methicillin resistance. They received parenteral antibiotics for two weeks, then oral antibiotics for 4 weeks. In case of methicillin resistance, vancomycin was administered i.v. for 6 weeks. The primary end point was no signs of infection after 2 years follow-up.

**Results:** 48 patients were included in the final analyses. There were no differences in patient characteristics or co-morbidities between the two groups. There was no significant difference in remission rate between the rifampin combination group (17 of 23 (74%)) and the monotherapy group (18 of 25 (72%)), relative risk 1,03; 95% confidence interval 0,73 to 1,45,  $p=0.88$ ). Five patients aborted the rifampin treatment because of adverse effects and continued with monotherapy. All five had complete remission. These patients were not included in the final analysis.

**Conclusions:** Our study has not proven a statistically significant advantage by adding rifampin to the antibiotic treatment in staphylococcal PJIs. Bigger studies on the subject are needed. Our good success rate raises the question whether the standardized revision surgery is the key to success in these infections rather than rifampin.

[O106] POST TRAUMATIC OSTEOMYELITIS OF THE FEMUR OR TIBIA:  
AN EVALUATION OF THE CLINICAL OUTCOME, FUNCTIONAL OUTCOME,  
AND QUALITY OF LIFE

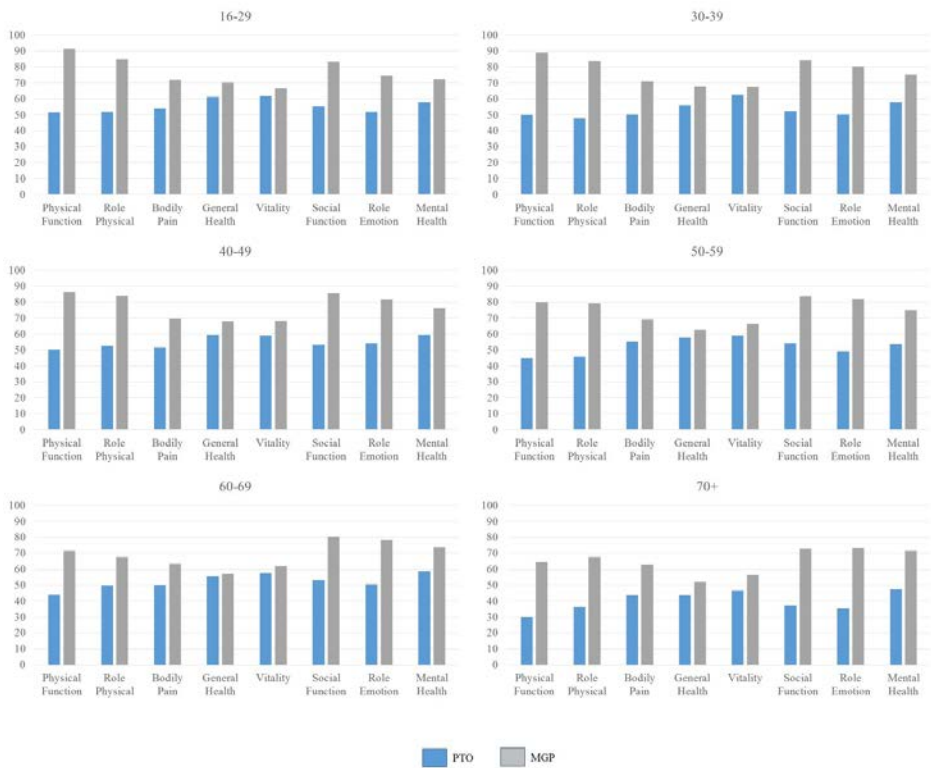
**Khairul Rizal Zayzan**<sup>1</sup>, Nazri Mohd Yusof<sup>1</sup>, Jamalludin Ab Rahman<sup>2</sup>

<sup>1</sup>International Islamic University Malaysia, Kuantan, Malaysia <sup>2</sup>Statistician

**Aim:** This study was conducted to investigate the clinical outcome, functional outcome, and quality of life of patients treated for post traumatic osteomyelitis (PTO) of femur and tibia from July 2007 to June 2014.

**Method:** Forty seven patients consented and participated in this study. The median age of participants was 44 years old, and ranges from 16 to 80 years old. There were 26 tibia and 21 femur osteomyelitis evaluated in this study. Thirty-eight participants (80.9%) had implants inserted. The PTO patients were classified according to Cierny-Mader (CM) classification: 2 CM-I; 8 CM-II; 18 CM III; 19 CM IV and 25 CM-A and 19 CM-B. The participants were follow up for a mean duration of 4.6 years (range 2.3-9.5 years). Interviews were then conducted and clinical assessments were performed to evaluate the clinical outcome. Their functional outcome was evaluated using the Lower Extremity Functional Score (LEFS) and the quality of life was evaluated using the validated SF-36v2 and the results were compared to the general population (GP).

**Results:** Forty four (93.6%) of participants had achieved union without recurrence of infection. Others who had failure of treatment were CM-IIIA, CM-IVA, and CM-IVB. Concurrent medical problem and CM-B (Systemic) hosts significantly contributed to poorer functional outcome, and lower quality of life score especially the Physical Component domain.



\*Figure 1. Comparison between mean SF-36v2 scores of PTO and GP according to age group

**Conclusions:** Most patients with post traumatic osteomyelitis had successful treatment. However their quality of life was poorer in comparison to the general population. Concurrent medical problem and CM-B (Systemic) hosts had significantly poorer functional outcome and quality of life than the general population.

**References:**

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## Free Papers H

### [O107] MONITORING THE INCIDENCE OF PROSTHETIC JOINT INFECTIONS IN A COMPLICATION REGISTRY

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<sup>1</sup>St Olavs Hospital, Trondheim, Norway

**Aim:** The incidence of prosthetic joint infections can be severe to monitor, as they are rare events. Recent publications from National registries points toward a significant underestimation of reported infections. The aim of this project was to develop a complication register that could report the “true” and momentaneous incidence of prosthetic infections after total knee and hip arthroplasty.

**Method:** All patients operated with total hip arthroplasty (THA) or total knee arthroplasty (TKA) at our hospital were included in a local quality registry. All complications were reported at follow-up at 2 and 3 months for total knee and hip arthroplasties respectively, and at 1-year follow up. Both primary and revision surgeries were included. In order to monitor complications of special interest, such as deep postoperative infections, key variables were presented in a g-chart. This chart shows the number of uncomplicated surgeries between each complication (such as infection) in a bar diagram. This diagram is easily read as high bars indicate a low incidence of complications and low bars indicate a high incidence. The diagram is updated and distributed for information every month.

**Results:** From September 2010 till December 2015 we included 2093 primary total hip arthroplasties and 272 hip revisions. The overall incidence for prosthetic infection after primary THA within 1 year after surgery was 1.8% and for hip revisions 3.4%. The momentaneous incidence in December 2015 was 3% for both primary and revision THA together. In the same period 1555 total knee arthroplasties and 155 knee revisions were included. The overall incidence of prosthetic infection after primary TKA within 1 year after surgery was 1.2% and for knee revisions 2.2%. The momentaneous incidence in December 2015 was 2.5% for primary and revision TKA together.

**Conclusions:** Reporting the number of uncomplicated surgeries between every unwanted event or complication, such as postoperative infections, is a good method for describing rare events. This method will reveal changes in the trend at an earlier stage and can be an important tool in the work on preventing postoperative infections. A local quality register can be important in order to report a “true” incidence of postoperative infections, as the risk of underestimation is lower than in a national registry.

Free Papers H

[O108] ACTIVITY OF A GENTAMICIN-LOADED BONE GRAFT SUBSTITUTE AGAINST DIFFERENT BACTERIAL BIOFILM BY MICROCALORIMETRY

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**Aim:** To investigate the antimicrobial activity of a gentamicin-loaded bone graft substitute (GLBGS) in the prevention and eradication of bacterial biofilms associated with prosthetic joint infections (PJI).

**Method:** The GLBGS (17,5 mg gentamicin/ml paste) with 40% hydroxyapatite/60% calcium sulfate<sup>1</sup> was tested against biofilms of methicillin-resistant *Staphylococcus aureus* (MRSA) ATCC 43300, methicillin-susceptible *S. aureus* (MSSA) ATCC 29213, *Escherichia coli* Bj HDE-1, *S. epidermidis* ATCC 12228 and *Enterococcus faecalis* ATCC 19433. For prevention studies, glass beads and different combinations of GLBGS were co-incubated for 24h at 37°C in CAMH broth with 1-5 x 10<sup>6</sup> CFU/mL of bacteria. For eradication, biofilms were formed on glass beads for 24h at 37°C in CAMH broth. Then, beads were incubated with different combinations of GLBGS in medium at 37°C for 24h. For microcalorimetric measurements, beads were placed in ampoules and heat flow (μW) and total heat (J) were measured at 37°C for 24h. The minimal heat inhibitory concentration (MHIC) was defined as the lowest gentamicin concentration reducing the heat flow peak by ≥90% at 24h.

**Results:** The GLBGS showed a good activity against all tested strains in both biofilm prevention and eradication. All MHIC values are reported in Table 1. Lower MHICs were observed when GLBGS was tested against *E. coli* (9.6 μg/mL prevention and 19.2 μg/mL eradication) and *S. epidermidis* (86 μg/mL and 38.8 μg/mL, respectively). For both prevention and eradication of MSSA, GLBGS MHIC was 631 μg/mL. *E. faecalis* biofilm formation was prevented with 631 μg/mL and eradicated with double concentration. MRSA showed a higher resistance to GLBGS up to 2516 μg/mL, both in biofilm prevention and eradication.

**Conclusions:** This GLBGS is a valid composite for the prophylaxis and treatment of PJI. Further studies will be performed to evaluate the activity of higher concentrations of GLBGS against MRSA.

<sup>1</sup>CERAMENT™ | G, BONESUPPORT AB, Sweden

**Table 1.** Minimal heat inhibitory concentrations (MHIC) of gentamicin in gentamicin-loaded ceramic bone graft substitutes for prevention and eradication of bacterial biofilms.

|                                  | PREVENTION MHIC (μg/mL) | ERADICATION MHIC (μg/mL) |
|----------------------------------|-------------------------|--------------------------|
| <i>E. faecalis</i> ATCC 19433    | 631                     | 1236                     |
| <i>E. coli</i> Bj HDE-1          | 9.6                     | 19.2                     |
| MRSA ATCC 43300                  | >2516                   | >2516                    |
| MSSA ATCC 29213                  | 631                     | 631                      |
| <i>S. epidermidis</i> ATCC 12228 | 86                      | 38.8                     |



## Free Papers H

### [O109] UTILITY OF GENE EXPRESSION PATTERN OF TOLL-LIKE RECEPTORS AND IL-1/IL1R FAMILY FOR ASSESSMENT OF PERIPROSTHETIC JOINT INFECTION IN TOTAL JOINT ARTHROPLASTY

Regina Fillerova<sup>1</sup>, Anna Petrackova<sup>1</sup>, Petr Gajdos<sup>2</sup>, Milos Kudelka<sup>2</sup>, Eva Kriegova<sup>1</sup>, **Jiri Gallo**<sup>3</sup>

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<sup>3</sup>Dept. of Orthopaedics, Faculty of Medicine and Dentistry, Palacky University & University Hospital, Olomouc, Czech Republic

**Aim:** The diagnosis of periprosthetic joint infection (PJI) in total joint arthroplasty (TJA) remains a serious clinical challenge. Nowadays, limited biomarkers associated with PJI are available. We investigated therefore the utility of gene expression pattern of Toll-like receptors (TLR) and members of interleukin (IL)1/IL1R family, molecules critically involved in the innate immune response to invading pathogens, for detecting PJI in periprosthetic tissues around TJA.

**Method:** Periprosthetic tissues were collected from 37 patients presenting with PJI and 39 patients having an aseptic failure of TJA. mRNA expression of known TLR receptors (TLR1-10) and 21 members of IL-1/IL-1R family was investigated using an innovative Smartchip Real-Time RT-PCR System\*; the data were normalized relative to the housekeeping gene GAPDH. Statistical tests were performed using GraphPad Prism\* and bio-data mining methods.

**Results:** In PJI, elevated mRNA expression levels of TLR1 ( $P=0.03$ ), TLR4 ( $P=0.01$ ) and TLR6 ( $P=0.01$ ) were detected when compared to tissues from aseptic cases. On the contrary, lower mRNA expression of TLR3 ( $P=0.04$ ) and TLR7 ( $P=0.047$ ) were detected in PJI than in aseptic loosening. From IL1/IL-1R family, PJI was associated with elevated levels of IL1 $\beta$  ( $P=0.0004$ ), IL1RN ( $P=0.05$ ), IL1R1 ( $P=0.04$ ), IL1R2 ( $P=0.01$ ), and IL18RAP ( $P=0.02$ ) comparing to aseptic failure. Multivariate analysis and sophisticated bio-data mining analysis are ongoing to determine the potential of TLRs and IL1/IL1R family as biomarkers of PJI in TJA.

**Conclusions:** Tissue expression of TLRs and IL1/IL-1R family differ in terms of pattern and expression level between septic and aseptic failure of TJA. Our data support the potential of “innate gene” expression panel as candidate biomarker for assessment of PJI. Further studies are required to replicate our data and also to enable valid interpretation of our findings.

Grant support: AZV MZ CR VES15-27726A, VES16-131852A, IGA LF UP\_2016\_011

\*WaferGen Bio-Systems, CA, USA, \*\*GraphPad Prism 5.01, GraphPad Software, CA, USA

## Oral Abstracts

### Key Session 9

#### [0110] POST TRAUMATIC OSTEOMYELITIS, PITFALLS AND BEST PRACTICES IN NUCLEAR MEDICAL IMAGING

**Geertje Govaert<sup>1</sup>**

<sup>1</sup>University Medical Center, UMCG, Groningen, Netherlands

**ABSTRACT NOT AVAILABLE AT PRINT**

## Key Session 9

# [O111] ULTRASOUND AND MRI IN THE DIAGNOSIS OF PAEDIATRIC OSTEOMYELITIS

James Teh<sup>1</sup>

<sup>1</sup>Nuffield Orthopaedic Centre, Oxford University Hospitals

**ABSTRACT NOT AVAILABLE AT PRINT**

### Key Session 9

#### [O112] ORTHOPAEDIC DEVICE RELATED INFECTION: TIME FOR A CULTURE CHANGE?

**Andrew J. Brent<sup>1</sup>**

<sup>1</sup>Oxford University Hospitals NHS Foundation Trust, Oxford, United Kingdom

Microbiology plays a pivotal role in the diagnosis of prosthetic joint infections (PJI), and in determining the infectious aetiology of PJI to guide individualized antimicrobial therapy. However bacterial culture is imperfectly sensitive in clinical practice, sample contamination limits culture specificity, and rigorous evaluation of both sensitivity and specificity is made challenging by the lack of a robust reference standard for PJI diagnosis.

Underpinned by a better understanding of the pathobiology, progress has nevertheless been made in improving microbiological diagnosis of PJI. We review the effects of optimized tissue sampling, sonication of explanted prostheses, and culture methodology on PJI diagnosis.

**Key Session 9**

**[O113] THE MOST RELIABLE LABORATORY TESTS FOR PJIS: HAVE WE ACHIEVED A GOLDEN STANDARD?**

**Lorenzo Drago<sup>1</sup>**

<sup>1</sup>IRCCS Galeazzi Institute – University of Milan

In the last two decades, significant improvements in laboratory diagnosis of PJI have been reported. As far as microbiological analysis, although debate exists on the minimum number of samples required to diagnose PJI with an acceptable sensitivity and on how to process these samples, development of methods to dislodge biofilm-embedded bacteria from infected prostheses have led to a significant increase in sensitivity of cultures. Particularly, our group has shown that treatment of prosthetic components and periprosthetic tissues with dithiothreitol (DTT), a sulphhydryl compound able to chemically detach microbes from biofilm adhered to prosthesis, has a sensitivity and a specificity similar or even higher than traditional methods, such as sonication. More recently, we have contributed to development of a novel device for collection, transport and treatment of prosthetic samples (implants and tissues). The main novelties of the new system reside in the possibility to collect in the same container both prosthetic components and periprosthetic tissues, thus reducing sample processing and the use of a completely closed system which may contribute to limit risks for contamination and, consequently isolation of contaminants. As far as pre-operative PJI diagnosis, analysis of synovial fluid represents a critical issue. Traditionally leukocyte and differential counts and culture are performed on synovial fluid. However, sensitivity of synovial fluid culture does not permit to exclude with sufficient certainty the preserapidnce of infection. On the other hand, preoperative determination of traditional blood markers of infection, such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) are not sufficiently specific for PJI, since concomitant conditions, such as inflammatory diseases, may alter ESR or CRP levels and in some cases, particularly when low-virulent bacteria, such as coagulase negative staphylococci and propionibacteria, are involved no or smooth changes in ESR and CRP may be observed.

### 12 Best Papers

#### [O114] INFECTED BONE TISSUE DECREASES THE PENETRATION OF CEFUROXIME

Mikkel Tøttrup<sup>1</sup>, Mats Bue<sup>1</sup>, Janne Koch<sup>2</sup>, **Louise Kruse Jensen**<sup>3</sup>, Pelle Hanberg<sup>1</sup>, Bent Aalbæk<sup>3</sup>, Kurt Fuursted<sup>4</sup>, Henrik Elvang Jensen<sup>3</sup>, Kjeld Søballe<sup>1</sup>

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<sup>4</sup>Statens Serum Institut, København S, Denmark

**Aim:** A reason for treatment failure, in cases of periprosthetic bone infections and osteomyelitis, may be incomplete or heterogeneous tissue distribution of antimicrobials to the affected bone. Decreased bioavailability has been demonstrated in healthy bones but never in pathological bone tissue. Therefore, the aim was to obtain pharmacokinetic parameters of cefuroxime in infected bone tissue by means of microdialysis in a porcine model of implant associated osteomyelitis

**Method:** An implant cavity of 4 mm in diameter was drilled 25 mm into the right tibial bone of ten pigs (30 kg/BW). Subsequently, a small steel implant (K-wire 2 x 2 mm) and 10<sup>4</sup> CFU of *Staphylococcus aureus* was inserted and injected into the implant cavity. Five days after inoculation, two additional drill holes of 2 x 25 mm were drilled into the trabecular bone tissue adjacent to the implant cavity and into the left uninfected tibia. After intravenous administration of 1500 mg of cefuroxime, the concentration was measured in plasma and in the three tibial drill holes for 8 hours. All measurements were performed with microdialysis. Post mortem, the presence of bone infection was assessed by computed tomography (CT) scans and cultures of swabs.

**Results:** Destruction of bone tissue was seen on CT scans around all implant cavities but not in the adjacent trabecular bone tissue of the right leg or in the left leg. All swabs from the implant cavity and 8/10 swabs from the adjacent trabecular tissue were positive for *S. aureus*. Conversely, all swabs from the left tibia were negative. The area under the concentration-time curves differed significantly, with the lowest found in the implant cavity (P<0.001). Although not significant, cefuroxime penetration into the adjacent bone tissue was incomplete.

**Conclusions:** This is the first study to show, by microdialysis, that the destructive bone processes associated with implant associated osteomyelitis significantly impair cefuroxime penetration. Our results support the clinical conception of fast diagnosis and initiation of antibiotic treatment if surgery is to be avoided. It is of crucial importance to know the exact level of antibiotics, which actually reaches a pathological bone focus in order to obtain more targeted and effective antibiotic treatments of bone infections.

**References:** Effects of implant associated osteomyelitis on cefuroxime bone pharmacokinetics – assessment in a porcine model. JBJS 2016; 98: 63-69.

## 12 Best Papers

### [O115] INFECTION AFTER FRACTURE FIXATION OF THE TIBIA: ANALYSIS OF HEALTHCARE UTILIZATION AND RELATED COSTS

Willem-Jan Metsemakers<sup>1</sup>, Bart Smeets<sup>1</sup>, Stefaan Nijs<sup>1</sup>, Harm Hoekstra<sup>1</sup>

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**Aim:** The objective of this study was to define hospital-related healthcare costs associated with infection after fracture fixation (IFF) of the tibia and identify the subset of clinical variables relevant in driving these costs within the Belgium's healthcare system.

**Method:** Between January 1<sup>st</sup> 2009 and January 1<sup>st</sup> 2014, a total of 358 patients treated operatively for AO type 41, 42 and 43 tibial fractures, were included in this study. The calculated costs were related to the Belgium's healthcare financing context and limited to costs induced by hospital related care. Five main hospital-related cost categories were studied: honoraria, materials, hospitalization, day care admission, and pharmaceuticals. In addition, a total of 19 clinical and process variables were defined.

**Results:** The median total treatment cost for all tibial fractures was €6.962 euro (IQR €4932 – €10.972), with AO type 42 being the most expensive fracture type. In 12 (3.4%) patients the treatment was complicated by deep (implant-related) infection. Subsequently, the treatment costs for deep (implant-related) infection were almost 7-times higher compared to non-infected patients (€44.680 vs. €6.855  $p < 0.001$ ) with hospitalization, length of stay (LOS), accounting for 50% of the total amount of the cost. The bivariate correlation between total treatment costs and LOS was close to 1. Multivariate analyses showed deep (implant-related) infection, non-union, age and ASA-3 as most important drivers ( $p < 0.001$ ) for both the total treatment costs and LOS. Moreover, the LOS was also driven by a delayed staged surgery protocol.

**Conclusions:** One of the most challenging complications in trauma surgery is the development of IFF. Infections associated with fracture fixation devices result in significant patient morbidity and a prolonged treatment period. Currently, there is a lack of data regarding the definition, functional outcome and health care burden of this musculoskeletal complication. This study shows that treatment costs for deep (implant-related) infection were almost 7-times higher compared to non-infected patients. Furthermore, LOS accounted for 50% of the total amount of the cost. This study shows that future research needs to focus more on prevention rather than treatment strategies, not only to reduce patient morbidity but also to reduce the socio-economic impact.

### 12 Best Papers

#### [O116] POST-OPERATIVE BLOOD GLUCOSE LEVELS PREDICTS PJI AFTER PRIMARY TOTAL JOINT ARTHROPLASTY

Antonia Chen<sup>1</sup>, Michael Kheir<sup>1</sup>, Timothy Tan<sup>2</sup>, Matthew Kheir<sup>1</sup>, Mitchell Maltenfort<sup>1</sup>

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**Aim:** Perioperative hyperglycemia has many etiologies including medication, impaired glucose tolerance, uncontrolled diabetes mellitus (DM), or stress, the latter of which is common to post-surgical patients. This acute hyperglycemia may impair the ability of the host to combat infection.<sup>1</sup> Our study aims to investigate if post-operative day 1 (POD1) blood glucose level is associated with complications, including periprosthetic joint infection (PJI), after total joint arthroplasty (TJA) and to determine a threshold for glycemic control that surgeons should strive for during a patient's hospital stay.

**Method:** A single-institution retrospective review was conducted on 24,857 primary TJAs performed from 2001-2015. Demographics, Elixhauser comorbidities, laboratory values, complications and readmissions were collected. POD1 morning blood glucose levels were utilized and correlated with PJI, as defined by the Musculoskeletal Infection Society criteria. The Wald test was used to determine the influence of covariates on complication rate. An alpha level of 0.05 was used to determine statistical significance.

**Results:** The rate of PJI significantly increased linearly from blood glucose levels of 115 mg/dL onwards. We determined that blood glucose (OR 1.004, 95% CI: 1.001-1.006, p=0.001), male gender (OR 1.480, 95% CI: 1.185-1.848, p=0.001), body mass index (OR 1.049, 95% CI: 1.033-1.065, p<0.001), operative time (OR 1.004, 95% CI: 1.001-1.007, p=0.006), length of stay (OR 1.059, 95% CI: 1.038-1.080, p<0.001), post-operative hematocrit (OR 0.751, 95% CI: 0.621-0.909, p=0.003), peripheral vascular disease (OR 1.942, 95% CI: 1.042-3.617, p=0.037), liver disease (OR 2.576, 95% CI: 1.344-4.935, p=0.004), rheumatic disease (OR 1.991, 95% CI: 1.266-3.132, p=0.003), and alcohol abuse (OR 2.588, 95% CI: 1.096-6.110, p=0.030) were associated with PJI. The Youden index was used to determine an optimal blood glucose threshold of 132 mg/dL to reduce the likelihood of PJI.

The PJI rate in the entire cohort was 1.59% (1.46% in non-diabetics compared to 2.39% in diabetics, p=0.001). Diabetics did not have an association between blood glucose level and PJI (OR 1.002, 95% CI: 0.998-1.006, p=0.331), although there was a linear trend for postoperative glucose predicting PJI.

**Conclusions:** The relationship between POD1 blood glucose levels and PJI increased linearly, with an optimal cut off of 132 mg/dL. Immediate and strict post-operative glycemic control is critical in reducing post-operative complications, and we demonstrate that even mild hyperglycemia is significantly associated with PJI.

<sup>1</sup>Turina M. Crit Care Med. 2005 Jul; 33(7):1624-33.



## 12 Best Papers

### [O117] ANTIBIOTIC-LOADED HYDROGEL COATING TO PREVENT EARLY POST-SURGICAL INFECTION AFTER JOINT ARTHROPLASTY. RESULTS FROM A MULTI-CENTER EUROPEAN TRIAL

Konstantinos Malizos<sup>1</sup>, Nicola Capuano<sup>2</sup>, Riccardo Mezzoprete<sup>3</sup>, Michele D'Arienzo<sup>4</sup>, Catherine Van Der Straeten<sup>5</sup>, Lorenzo Drago<sup>6</sup>, **Carlo Romano**<sup>7</sup>

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**Aim:** Infection remains among the first reasons of failure of joint prosthesis. According to various preclinical reports, antibacterial coatings of implants may prevent bacterial adhesion and biofilm formation. Aim of this study is to present the first clinical trial on an antibiotic-loaded fast-resorbable hydrogel coating\*, in patients undergoing hip or knee prosthesis.

**Method:** In this multi-center, randomized, prospective, study, a total of 380 patients, scheduled to undergo primary or revision total hip or knee joint replacement, using a cementless or a hybrid implant, were randomly assigned, in six European orthopedic centers, to receive the antibiotic-loaded DAC coating or to a control group, without coating. Pre- and post-operative assessment of clinical scores, wound healing, laboratory tests and x-ray were performed at fixed time intervals.

**Results:** Overall 373 patients were available at a minimum follow-up of 6 months (maximum 24 months). On average, wound healing, laboratory tests and radiographic findings did not show any significant difference between the two-groups. Eleven early surgical site infections (6%) were observed in the control group, compared to one (0.6%) in the treated group ( $p=0.003$ ). No local or systemic side effects related to DAC hydrogel coating were observed and no detectable interference with implant osteointegration was noted.

**Conclusions:** The use of a fast-resorbable, antibiotic-loaded hydrogel implant coating provides a reduced rate of early surgical site infections after hip or knee joint replacement using cementless or hybrid implants, without any detectable adverse event or side effects.

\*Defensive Antibacterial Coating, DAC®

### 12 Best Papers

#### [O118] PATIENT-REPORTED QUALITY OF LIFE AND HIP FUNCTION AFTER REVISION OF TOTAL HIP ARTHROPLASTY DUE TO CHRONIC PERIPROSTHETIC JOINT INFECTION - AN ANALYSIS OF ONE-STAGE AND TWO-STAGE REVISION

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**Aim:** Very limited information is available regarding health-related quality of life (HRQOL) and patient reported hip function following treatment for chronic periprosthetic hip joint infection (PJI). Several reviews have not found any clear differences in clinical outcome parameters comparing the most commonly applied treatment strategies for chronic hip PJI. Studies describing patients HRQOL of one-stage and two-stage revision could provide important information regarding patient counselling. The purpose of this study was to investigate HRQOL and patient reported hip function after one-stage revision and two-stage revision in chronic hip PJI.

**Method:** The one-stage group was identified in a prospective clinical study on one-stage revision in chronic hip PJI. Fifty-one patients were followed for two years on an outpatient basis and completed three questionnaires; EuroQol-5D (EQ-5D), Short Form Health Survey 36 (SF-36) and Oxford Hip Score (OHS) at 3, 6, 12 and 24 months follow-up. The two-stage group was identified retrospectively in the National Patient Register and 45 patients completed EQ-5D and OHS. The observed results were compared to normative population data for SF-36 and EQ-5D.

**Results:** In the one-stage group the improvement in HRQOL appeared in the first 6 months after surgery, reached a plateau, and decreased slightly again. The largest improvements at 2 years were OHS with an effect size (ES): 1.3 and SF-36's physical role limitation and bodily pain with ES: 1.1. The one-stage group reached the matched population norm on all parameters at 12 months, but two scores declined from 12 to 24 months: physical functioning (66 to 50 (out of 100, population norm 71) and physical role limitation (58 to 40, population norm 63).

Neither the one-stage nor the two-stage group reached the EQ-5D population norm. When comparing the two groups, the mean scores (CI 95%) for one-stage revision were significantly higher compared to the two-stage revision group on EQ-5D<sub>VAS</sub> 12.9 (2.4;23.3 p=0.02) and OHS 5.9 (0.5;11.2 p=0.03), but not on EQ-5D<sub>index</sub> 0.065 (-0.04;0.17 p= 0.22).

**Conclusions:** Two years after receiving one-stage revision the patients experienced a significant increase in HRQOL and reported hip function, and matched the population norm on most parameters. The decrease in physical scores at 24 months could be attributed to co-morbidities. Neither group reached the EQ-5D population norm. Patients receiving one-stage revision obtained higher HRQOL and hip function compared to two-stage revision. However, a direct comparison of the two groups cannot be performed due to difference in study design.

## 12 Best Papers

### [O119] LOW INCIDENCE OF *P. ACNES* ON THE SKIN OF PATIENTS UNDERGOING PRIMARY SHOULDER ARTHROPLASTY

Raquel Marí Molina<sup>1</sup>, Anna Fraile Suari<sup>1</sup>, Pau Guirro Castellnou<sup>1</sup>, **Lluís Puig<sup>1</sup>**, Carles Torrens<sup>1</sup>

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**Aim:** Recent studies have indicated that the presence of *P. acnes* in the skin of the shoulder and around the acromion is higher than other body regions like the knee or the hip. The aim of this study was to estimate the presence of *P. acnes* in a real set of primary shoulder arthroplasty, after skin preparation with chlorhexidine and administration of empirical antibiotic therapy.

**Method:** A prospective observational study involving 63 patients undergoing primary shoulder arthroplasty was designed. In all patients two skin biopsies with a 3 mm dermal punch and one subcutaneous tissue sample after surgical incision were obtained. Skin biopsies were obtained at the most anterior part of the surgical wound in case of superior approach and at the upper part in the deltopectoral approach. All patients underwent preoperative antibiotic prophylaxis with cefazolin 2g ev and skin preparation with 2% chlorhexidine alcoholic tinted before the start of surgery twice. The aerobic cultures were incubated at 37°C for 7 days whereas the anaerobic ones incubated for 14 days.

**Results:** A total of 63 consecutive patients who underwent shoulder arthroplasty (58 reverse shoulder arthroplasty and 5 anatomical) were analysed. 54 women and 9 men, mean age of 73.94 (SD 6.19). The indication for arthroplasty was a secondary arthropathy cuff injury in 42 cases, primary osteoarthritis in 3, acute fracture in 9 and fracture sequelae in 9. We obtained 189 tissue cultures (126 skin cultures and 63 subcutaneous) and 4 cultures were positive (2.02%) for *P. acnes* in 3 different patients. A first patient (female) had both positive skin cultures, the second patient (male) only had positive the subcutaneous tissue cultures and the third patient had positive also the subcutaneous tissue culture. The first patient underwent anatomical shoulder arthroplasty whereas the second and third patients underwent reverse shoulder arthroplasty. The time to grow was 15 days in first patient and 14 days in the second and third patient (mean 14.5 days).

**Conclusions:** In a real setting of patients undergoing shoulder arthroplasty using antibiotic prophylaxis and standard preoperative skin preparation with chlorhexidine we found a low rate of positive cultures for *P. acnes* (2.02 %). The higher rate of *P. acnes* positive cultures in skin reported in previous studies may be caused by a different population study group (healthy and younger volunteers without antibiotic prophylaxis) or suboptimal culture technique (use of swaps).

### 12 Best Papers

#### [O120] SINGLE-STAGE TREATMENT OF CHRONIC OSTEOMYELITIS WITH A GENTAMICIN-LOADED, CALCIUM SULPHATE / HYDROXYAPATITE BIOCOMPOSITE: A PROSPECTIVE SERIES OF 100 CASES

**Martin McNally**<sup>1</sup>, Jamie Ferguson<sup>1</sup>, Michael Diefenbeck<sup>2</sup>, Adrian Lau<sup>1</sup>, David Stubbs<sup>1</sup>, Matthew Scarborough<sup>1</sup>, Alex Ramsden<sup>1</sup>, Bridget Atkins<sup>1</sup>

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**Aim:** Eradication of infection in chronic osteomyelitis requires effective dead space management after debridement. Residual bacteria in biofilm may be resistant to normal levels of systemic antibiotic penetrating bone and will contribute to recurrence of osteomyelitis. This study evaluated a new antibiotic-loaded biocomposite in the eradication of chronic infection from bone defects.

**Patients and Method:** We report a prospective study of 100 patients with Cierny and Mader types III and IV chronic osteomyelitis, in 105 bones. Osteomyelitis followed open fracture or ORIF of closed fractures in 71%. Nine had concomitant septic arthritis. 80% had co-morbidities (Cierny-Mader Class B hosts). Ten had infected non-unions.

All patients were treated by a multidisciplinary team with a single-stage protocol including; debridement, multiple sampling, culture-specific systemic antibiotics, stabilisation, dead space filling with Cerament G™ and immediate primary skin closure.

Stabilisation was required in 21 cases and 5 required joint fusion as part of the initial surgery. Plastic surgical skin closure was needed in 23 cases (18 free flaps).

Patients were followed up for a minimum of one year (mean 19.5 months; 12-34).

**Results:** Staphylococci were the commonest organism (41.8%), with MRSA in six patients. *Proteus mirabilis* and *Pseudomonas spp* were more common in polymicrobial infection, often with a gram-positive organism (usually *Staphylococcus aureus*). Sixteen patients cultured organisms which were shown to be gentamicin resistant using EUCAST breakpoints. Gentamicin resistance was just as likely to be present in patients with haematogenous infections (3/19; 15.8%) as in post-trauma (13/81; 16%) (Chi-square:  $p=0.978$ ) Gentamicin resistant organisms were more likely to be found in polymicrobial infections (9/21; 42.8%) than in single isolates (7/79; 8.9%) (Chi-square:  $p<0.001$ ). Infection was eradicated in 96% with a single procedure and all four recurrences were successfully managed with repeat surgery. All 5 fusions healed and 8/10 non-unions healed with the primary surgery alone. Adverse events were uncommon, with 3 fractures, 6 wound leaks and 3 deaths, unrelated to the infection or surgery. Outcome was not dependant on C-M host class, aetiology of infection, microbial culture, wound leakage or presence of non-union.

**Conclusions:** This protocol, facilitated by the absorbable local antibiotic, was effective in the treatment of C-M types III and IV chronic osteomyelitis. The single-stage approach with high bioavailability local antibiotics is a robust management strategy, applicable across a wide range of patients, including those with significant co-morbidities. It offers a more patient-friendly treatment compared to other published treatment options.

## 12 Best Papers

### [O121] VANCOMYCIN DISPLAYS TIME DEPENDENT ERADICATION OF MATURE STAPHYLOCOCCUS AUREUS BIOFILMS

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**Aim:** Determine the time concentration profile required to achieve vancomycin-mediated eradication of *Staphylococcus aureus* biofilm. This is critical for the identification of performance targets for local antibiotic delivery, yet has not been described.

**Method:** Mature *S. aureus* UAMS-1 biofilms were grown on titanium-aluminum-niobium discs in Mueller Hinton broth (MHB). After 7 days, the discs were incubated in MHB containing vancomycin at 100, 200, 500, 1'000 and 2'000 mg/L. Both static and shaking conditions were tested. Samples were retrieved at intervals for up to 28 days for quantification of residual biofilm by sonication and serial dilution plating. One additional disc was processed per time point for scanning electron microscopy.

**Results:** Progressive and significant reduction of viable bacteria was observed over time at all vancomycin concentrations in both static and shaking conditions. After 28 days under static conditions, the *S. aureus* biofilm was completely eradicated at 200 mg/L vancomycin and higher concentrations. Biofilm could however not be eradicated under shaking conditions at any concentration. Logistic regression documents time of exposure at  $\geq 200$  mg/L as being the essential determinant of eradication.

**Conclusions:** The clinical relevance of the present study is that it is not impossible to eradicate mature *S. aureus* biofilm from metal implants by vancomycin alone, fostering efforts to optimize local delivery. The required time concentration profile cannot be achieved yet by systemic administration or any of the local delivery vehicles available. Even longer exposure as 28 days might be required as wound fluid flow might influence unfavourably biofilm resistance to vancomycin

### 12 Best Papers

#### [O122] ADAPTATION OF VANCOMYCIN-INTERMEDIATE STAPHYLOCOCCUS AUREUS TO INTRACELLULAR COMPARTMENT LEADING TO BACTERIAL RESERVOIR RESPONSIBLE FOR CHRONIC INFECTION

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**Aim:** Vancomycin-intermediate *Staphylococcus aureus* (VISA) was associated with persistent infection and treatment failure. To date, two staphylococcal virulence mechanisms have been associated with persistence secondary to host immune evasion and vancomycin therapeutic failure: i) bacterial internalization in non-phagocytic cells and ii) biofilm formation. The present study aimed to compare clinical pairs of isolates composed by VISA and their Vancomycin-Susceptible (VSSA) progenitors toward these bacterial adaptive mechanisms.

**Method:** Methods: Three pairs of VSSA/VISA clinical isolates have been isolated from persistent bloodstream infections during prolonged antibiotic therapy. Clinical pairs were compared for different features: i) biofilm formation ability using the crystal violet staining method (mature biofilm) and the Biofilm test based on measurement of superparamagnetic microbeads mobility trapped by biofilm (early biofilm), ii) cytotoxicity and immune response by quantifying lactate dehydrogenase (LDH) and Interleukin(IL)-6 release and iii) intracellular bacterial persistence using in vitro "lysostaphin protection" infection model of human osteoblasts.

**Results:** Comparing between individual pairs, the crystal violet staining method after 24h or 48h of incubation revealed that VISA isolates formed significantly less mature biofilms than VSSA ( $p < 0.001$  for all pairs). In addition, using the Biofilm test\*, VISA isolates required more time to immobilize magnetic beads than VSSA, reflecting delayed early biofilm-forming ability. For instance, the number of beads immobilized by VISA isolates composing pair 1, 2 and 3 was 8.29-, 1.23- and 1.91-fold lower than VSSA parental isolates respectively ( $p < 0.05$  for all).

The two lysostaphin-susceptible pairs tested in the in vitro infection model revealed that VISA strains harbored a lower capacity to adhere to and invade osteoblasts, compared to VSSA. Regardless of the time post-infection (up to 14 days post-infection), the percentage of intracellular bacteria recovered after host cells lysis was always significantly greater in VISA- than VSSA-infected wells ( $p < 0.01$  for all) reflecting a higher intracellular persistence ability. The IL-6 and LDH released from the osteoblasts infected with VISA strains were significantly lower than those from the cells infected with VSSA strains within each pair ( $p < 0.01$  for all). These results were consistent even after adjusting for the number of intracellular bacteria between the VSSA and VISA pairs.

**Conclusions:** Our results suggest that once internalized, VISA were well-adapted to the intracellular compartment, which led to the formation of an intracytoplasmic bacterial reservoir that could explain the chronicity and the persistence observed during infection caused by VISA.

\*RingTest™

## 12 Best Papers

### [O123] SYNOVIAL FLUID TESTING FOR THE DIAGNOSIS OF PROSTHETIC JOINT INFECTION – IMPROVING ITS DIAGNOSTIC ACCURACY WITH SIMPLE AND INEXPENSIVE BIOMARKERS

Pedro Serrano<sup>1</sup>, Marta Santos Silva<sup>1</sup>, Joana Dias<sup>2</sup>, José Carlos Oliveira<sup>3</sup>, António Oliveira<sup>1</sup>, Ricardo Sousa<sup>4</sup>

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**Aim:** Our goal is to increase diagnostic accuracy of synovial fluid testing in differentiating prosthetic joint infection (PJI) by more exhaustively studying simple and inexpensive biomarkers. For that purpose, we sought to determine: 1) if synovial fluid C-reactive protein (CRP), alpha-2-macroglobulin (A2M), procalcitonin and adenosine deaminase (ADA) concentrations are different between infected and aseptic cases; 2) performance and optimal cutoff values of each marker; 3) whether any such test may help improve diagnostic performance of traditional leukocyte count.

**Method:** Between January/2013 and December/2015 total hip or knee arthroplasty revision cases (regardless of preoperative diagnosis) were prospectively included provided enough synovial fluid for biomarker analysis was collected and at least four tissue samples as well as the implant for sonication were gathered for microbiological study. Definitive diagnosis was classified as infection or aseptic on the basis of the recent International Consensus Meeting definition of PJI. Using receiver operating characteristic curves, we determined cutoff values as well as sensitivity and specificity for each marker.

**Results:** Fifty-five out of 143 revision arthroplasties fully respected the inclusion criteria. Two supposedly aseptic cases were ultimately classified as infected resulting in 32 aseptic and 23 infected cases available for analysis. Total leukocyte count, proportion of PMN, C-reactive protein, ADA and alpha-2-macroglobulin but not procalcitonin were significantly different between both groups. Cutoff values for optimal performance in the diagnosis of infection were: total leukocyte count >1,463 cells/μL; proportion of PMN >81%; CRP >6.7mg/L and ADA >61U/L. Table 1 shows diagnostic accuracy parameters for each such marker as well as several different possible combinations of results.

**Conclusions:** Synovial fluid leukocyte count offers great negative predictive value and interpreting it together with other more specific markers such as C-reactive protein and ADA is helpful in improving its positive predictive value. These simple and inexpensive markers may reduce the number of equivocal synovial fluid results requiring more expensive investigation.

| Table 1. Proposed ROC cutoff values for different synovial fluid parameters and diagnostic accuracy of each test and respective combinations |                 |                         |                         |                           |                           |
|--|-----------------|-------------------------|-------------------------|---------------------------|---------------------------|
|  | Proposed cutoff | Sensitivity (95% CI)    | Specificity (95% CI)    | Positive Predictive Value | Negative Predictive Value |
| Total leukocyte count (cells/ $\mu$ L)   | 1,463           | 100.0% (100.0 to 100.0) | 71.9% (60.0 to 83.8)    | 71.9% (60.0 to 83.8)      | 100% (100.0 to 100.0)     |
| Proportion of PMN (%)  | 81%             | 78.3% (67.4 to 89.2)    | 75.0% (63.6 to 86.4)    | 69.2%(57.0 to 81.4)       | 82.8%(72.8 to 92.7)       |
| C-reactive protein (mg/L)  | 6.7             | 78.3% (67.4 to 89.2)    | 93.8% (87.4 to 100.0)   | 90.0% (82.1 to 97.9)      | 85.7%(76.5 to 95.0)       |
| ADA (U/L)  | 61              | 78.3% (67.4 to 89.2)    | 96.9% (92.3 to 100.0)   | 94.7% (88.8 to 100.0)     | 86.1%(77.0 to 95.2)       |
| Leukocyte count > 1,463 <b>OR</b> PMN> 81%   |                 | 100.0% (100.0 to 100.0) | 71.9% (60.0 to 83.8)    | 71.9% (60.0 to 83.8)      | 100% (100.0 to 100.0)     |
| Leukocyte count > 1,463 <b>AND</b> PMN> 81%  |                 | 78.3% (67.4 to 89.2)    | 75.0% (63.6 to 86.4)    | 69.2% (60.0 to 83.8)      | 82.8% (72.8 to 92.7)      |
| Leukocyte count > 1,463 <b>OR</b> CRP > 6.7  |                 | 100.0% (100.0 to 100.0) | 65.6% (53.1 to 78.2)    | 67.6% (55.3 to 80.0)      | 100.0% (100.0 to 100.0)   |
| Leukocyte count > 1,463 <b>AND</b> CRP > 6.7   |                 | 78.3% (67.4 to 89.2)    | 100.0% (100.0 to 100.0) | 100.0% (100.0 to 100.0)   | 86.5% (77.4 to 95.5)      |
| Leukocyte count > 1,463 <b>OR</b> ADA > 61   |                 | 100.0% (100.0 to 100.0) | 71.9% (60.0 to 83.8)    | 71.9% (60.0 to 83.8)      | 100.0% (100.0 to 100.0)   |
| Leukocyte count > 1,463 <b>AND</b> ADA > 61  |                 | 78.3% (67.4 to 89.2)    | 96.9% (92.3 to 100.0)   | 94.7% (88.8 to 100.0)     | 86.1% (77.0 to 95.2)      |
| PMN> 81% <b>OR</b> CRP > 6.7   |                 | 95.6% (90.3 to 100.0)   | 68.8% (56.5 to 81.0)    | 95.6% (90.3 to 100.0)     | 68.8% (56.5 to 81.0)      |
| PMN> 81% <b>AND</b> CRP > 6.7  |                 | 60.9% (48.0 to 73.8)    | 75.0% (63.6 to 86.4)    | 74.4% (60.6 to 84.2)      | 78.0% (67.1 to 89.0)      |
| PMN> 81% <b>OR</b> ADA > 61  |                 | 91.3% (83.9 to 98.7)    | 68.8% (56.5 to 81.0)    | 95.6% (90.3 to 100.0)     | 92.3% (85.3 to 99.3)      |
| PMN> 81% <b>AND</b> ADA > 61   |                 | 65.2% (52.6 to 77.8)    | 96.9% (92.3 to 100.0)   | 93.8% (87.3 to 100.0)     | 79.5% (68.8 to 90.2)      |



## 12 Best Papers

### [O126] OPERATING ROOM VENTILATION AND RISK OF REVISION DUE TO INFECTION AFTER PRIMARY TOTAL HIP ARTHROPLASTY

Håkon Langvatn<sup>1</sup>, Johannes Cornelis Schrama<sup>1</sup>, Lars Birger Engesæter<sup>1</sup>, Egil Lingaas<sup>2</sup>, Håvard Dale<sup>1</sup>

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**Aim:** The aim of this study was to validate the information on operating room ventilation reported to the Norwegian Arthroplasty Register (NAR) and to assess the influence of this ventilation on the risk of revision due to infection after primary total hip arthroplasty (THA).

**Method:** Current and previous ventilation systems were evaluated together with the hospitals head engineer in 40 orthopaedic hospitals. The ventilation system of each operating room was assessed and confirmed as either conventional ventilation, vertical laminar airflow (LAF) or horizontal LAF. We then identified cases of first revision due to deep infection after primary THA and the type of ventilation system reported to the NAR in the period 1987-2014. The association between revision due to infection and operating room ventilation was estimated by relative risks (RR) in a Cox regression model.

**Results:** 103370 primary THAs and 971 (0.9%) first revisions due to deep infection were reported. 51% of the primary THAs were performed in a room with vertical LAF, 44% in a room with conventional ventilation and 5% in a room with horizontal LAF. There was a mean misreporting rate of approximately 12%.

There was similar risk of revision due to infection after THA performed in operating rooms with vertical laminar air flow compared to conventional ventilation (RR=0.95, 95 % CI: 0.8–1.1) and an increased risk of revision due to infection after THA performed in horizontal LAF conditions compared to conventionally ventilated conditions (RR=1.3, 95 % CI: 1.0–1.7).

**Conclusions:** Surgeons are not fully aware of what kind of ventilation there is in the operating room. This study may indicate that vertical LAF is not superior to conventional ventilation concerning reduction of THA infection, and therefore does not justify any increased installation costs. Also, horizontal LAF systems appear to be inferior to other ventilation systems.

### 12 Best Papers

#### [O127] TREATMENT CONCEPT AND COMPLICATION MANAGEMENT IN SPINAL INFECTIONS WITH AND WITHOUT ACUTE SPINAL CORD INJURY (ASCI)

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**Aim:** Spinal infections with and without aSCI represent a severe disease with a high lethality rate of up to 17%. The current treatment recommendations include an antimicrobial therapy and if necessary in combination with operative procedures. Aims of this study are the analysis of risk factors and treatment concepts and to compare the outcome of patients suffering a spinal infection with and without an aSCI.

**Method:** Monocentric prospective case study from 2013 – 2015. Patients were examined using a diagnostic algorithm (CT-thorax/abdomen, MRI total-spine, blood cultures, dental chart, echocardiogram). A calculated antimicrobial therapy was initially administered and later changed according to the antibiotic resistance. Additional operative procedures were performed with respect to the clinical and radiological findings.

**Results:** 68 patients (age  $69.8 \pm 13.7$  years) were included. A Charlson-Comorbidity-Index of  $3.9 \pm 2.5$  was calculated. An spinal infection with aSCI was associated with a significantly higher number of infected spinal segments ( $p=0.013$ ). The results of the blood cultures, dental charts and echocardiograms are presented in figure 1.

A longer duration of antibiotic treatment (statistically non-significant) and a higher operation rate was shown with aSCI. Also the inpatient and intensive-care unit treatment duration was significantly longer with aSCI.

The number of treatment-associated complications and the lethality were equal in both groups. The age (odds-ratio 1.1 per one year increase;  $p=0.02$ ) and the appearance of an epidural empyema (odds-ratio 7.9;  $p=0.04$ ) have been identified as independent lethality factors.

**Conclusions:** Patients with spinal infections are multimorbid and have multiple infectious origins, which warrant further diagnostic investigations. Treatment associated complications, lethality rates and clinical outcome of spinal infection with and without aSCI are comparable in a specialized unit. Lethality risk factors are age and presence of an epidural empyema. In subsequent studies the antibiotic treatment duration and the long-term follow up will be evaluated.

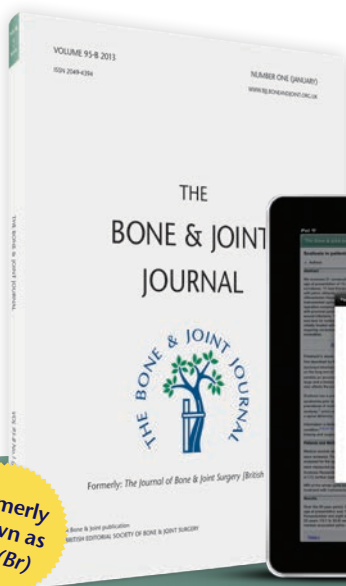
Figure 1|

|   | Without aSCI<br>(n=34)                       | With aSCI<br>(n=34)                            | p-value       |
|---|--|--|---------------|
| Age in years mean ( $\pm$ SD)                               | 70.79 $\pm$ 12.62                            | 68.81 $\pm$ 14.74                              | 0.557         |
| Gender female : male (%)                                    | 14 : 20 (41 : 59)                            | 17 : 17 (50 : 50)                              | 0.627         |
| Charlson-Comorbidity-Index ( $\pm$ SD)                      | 4.21 $\pm$ 3.08                              | 3.48 $\pm$ 2.14                                | 0.269         |
| Echocardiogram performed in n (%)                           | 18 (53)                                      | 21 (62)  | 0.619         |
| - Proof of infection in n (%)                               | 4 (22)                                       | 0 (0)  | <b>0,016*</b> |
| - Proof of other pathologies in n (%)                       | 2 (11)                                       | 0 (0)  |               |
| Blood cultures performed in n (%)                           | 21 (62)                                      | 20 (59)  | 1,000         |
| - Proof of infection in n (%)                               | 16 (76)                                      | 13 (65)  | 0,505         |
| Dental chart performed in n (%)                             | 17 (50)                                      | 12 (35)  | 0,327         |
| - Proof of infection in n (%)                               | 4 (24)                                       | 2 (17)   | 1,000         |
| Number of infected segments<br>1-2 : >2 (%)                 | 25 : 8 (76 : 24)                             | 15 : 19 (44 : 56)                              | <b>0,013*</b> |
| ASIA impairment score at discharge<br>A : B : C : D : E (%) | 0 : 0 : 0 : 0 : 34<br>(0 : 0 : 0 : 0 : 100 ) | 5 : 5 : 3 : 21 : 0<br>( 15 : 15 : 9 : 61 : 0 ) |               |
| Antibiotic treatment in n (%)                               |  |  |               |
| - < 6 weeks   | 5 (15)                                       | 2 (6)  |               |
| - 6 weeks - 3 months  | 26 (76)                                      | 18 (53)  |               |
| - > 3 months  | 3 (9)  | 14 (41)  |               |
| Operative : conservative treatment in<br>n (%)              | 25 : 9 (73 : 27)                             | 28 : 6 (82 : 18)                               | 0,560         |
| Duration intensiv-care-unit treatment<br>( $\pm$ SD)        | 7.29 $\pm$ 8,71                              | 13.23 $\pm$ 16,25                              | <b>0.008*</b> |
| Duration inpatient treatment ( $\pm$ SD)                    | 29.38 $\pm$ 17.63                            | 75.91 $\pm$ 52.96                              | <b>0.001*</b> |
| Pulmonary infections in n (%)                               | 10 (29)                                      | 9 (26)   | 1,000         |
| Urinary-tract infections in n (%)                           | 8 (24)                                       | 9 (27)   | 0,573         |
| Thromboembolism in n (%)                                    | 4 (12)                                       | 5 (15)   | 0,495         |
| Lethal outcome in n (%)                                     | 4 (12)                                       | 5 (15)   | 1,000         |



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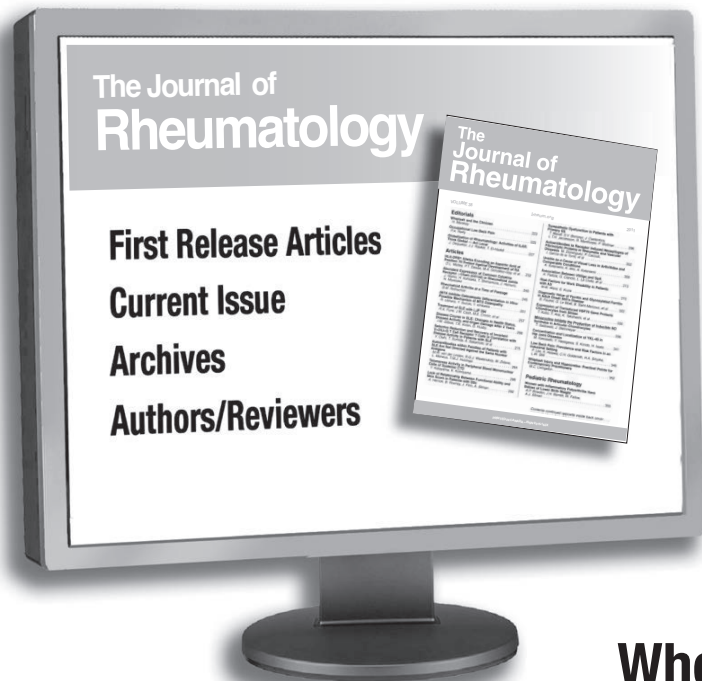
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