Trauma
Prevention
Are you going out to dinner in Philadelphia tonight?

A. Agree
B. No
C. Abstain
T-1 (Former T-46) What is the relationship between smoking and infection in fracture procedures? Is smoking history or only current smoking important? Does nicotine cessation at time of fracture reduce complication rates?

RESEARCHED BY:

Sánchez Correa, Carlos A MD, Colombia
Citak, Mustafa MD, Germany
Haasper, Carl MD, Germany
Literature:

- Metanalysis 2, Prospective/Randomized 0, Retrospective 24

  Current literature lacks high level evidence to state a direct relationship between these two factors. Recommendation provided is inconclusive.
**Recommendation:** Smoking seems to increase the risk of infection in fracture procedures. It is unknown if nicotine cessation (smoking) at time of fracture reduces complication rates.

**Level of Evidence:** Limited
T-2 (Former T-47) What is the role of nutritional supplementation in avoiding infection in acute fracture cases?

RESEARCHED BY:

Matsushita, Kazuhiko MD, Japan

Stangl, Paul MD, Colombia
Literature:

- Metanalysis 1, Prospective/Randomized 2, Retrospective 16

Current literature lacks high level evidence on orthopaedic surgical trauma procedures to support the role of nutritional supplementation on avoiding infection in acute fracture.
Recommendation: 1. Evidence does not support the role of nutritional supplementation (NS) for avoiding infections in isolated fractures in well-nourished individuals.
2. However, literature has stated that in patients with nutritional deficiency or catabolic state restoring nutritional parameters might reduce the risk of infection.

Level of Evidence: 1. Limited
2. Moderate

A. Agree
B. Disagree
C. Abstain
T-3 (Former T-5) Does preoperative pneumonia/UTI/trophic ulcers increase PJI/SSI risk in femoral neck fracture patients treated by partial/total hip arthroplasty?

RESEARCHED BY:

Kates, Stephen MD, USA
Literature:

• Metanalysis 1, Prospective/Randomized 0, Retrospective 8
• There is no evidence to suggest that preoperative pneumonia/UTI/trophic ulcers result in an increase risk for PJI/SSI in femoral neck fracture patients treated by partial/total hip arthroplasty.
Recommendation: There is a paucity of literature examining whether preoperative pneumonia/UTI/trophic ulcers increase SSI/PJI risk for patients with femoral neck fractures treated by hemi- or total hip arthroplasty. Further study suggested.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
T-4 (Former T-12) Is there a role for bacterial decolonization (for example, of MRSA in nares) in trauma cases?

RESEARCHED BY:
Abuodeh, Yousef MD, Qatar  Åkesson, Pe MD, Sweden
Literature:

- Metanalysis 0, Prospective/Randomized 0, Retrospective 23

  For orthopaedic trauma cases, no prospective study of bacterial decolonization exists.
**Recommendation:** It is unknown if bacterial decolonization in trauma patients reduces surgical site infection.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
T-5 (Former T-3) Are there microorganism specific risk factors for acute infection in trauma patients (i.e., Does being a nasal carrier of MRSA increase the risk for MRSA infection after trauma?)

RESEARCHED BY:

Costa Salles, Mauro J MD, Brazil
Morgenstern, Mario MD, Switzerland
Obremskey, William T MD, USA
Current evidence of MRSA colonization predicting acute infection in trauma patients is scarce, but it suggests that assessment and decolonization may be beneficial at reducing fracture-fixation infection rates.
**Recommendation:** Current evidence of increased risk of infection is based on several risk factors, including MRSA colonization, presence of external fixator, anatomical location of surgery and severe open fractures. In these situations, alterations in antibiotic prophylaxis could be considered.

**Level of Evidence:** Moderate

- A. Agree
- B. Disagree
- C. Abstain
T-6 (Former T-23) What are the ideal strategies to prevent secondary and nosocomial contamination of open fracture wounds which are left open?

RESEARCHED BY:

O'Toole, Robert MD, USA
Literature:

• Metanalysis 0, Prospective/Randomized 4, Retrospective 13

• Four randomized trials with conflicting results investigating the practice of negative pressure wound therapy over simple gauze dressings between surgical debridement and no randomized trials examining antibiotic bead pouches.
**Recommendation:** Data support local antibiotics and early wound closure to reduce contamination of open fracture wounds.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
T-7 (Former T-8) Is periprosthetic fracture a risk for the development of a PJI?

RESEARCHED BY:

Saxena, Arjun MD, USA
Literature:

• Metanalysis 1, Prospective/Randomized 0, Retrospective 7

• Studies suggest an increased SSI in patients who undergo re-operation for treatment of periprosthetic fracture of the femur after total hip and knee arthroplasty.
**Recommendation:** Infection rates from level III and IV evidence studies suggest an increased surgical site infection in patients who undergo re-operation for treatment of periprosthetic fracture of the femur after total hip and knee arthroplasty. There is limited literature available on periprosthetic acetabular and tibial fractures. Further study investigating the outcomes for treatment of periprosthetic fracture is recommended.

**Level of Evidence: Limited**

A. Agree
B. Disagree
C. Abstain
T-8 (Former T-6) Is there a difference in the risk of PJI with use of internal versus external fixation for treatment of periprosthetic fractures?

RESEARCHED BY:

Harris, Mitch MD, USA
Kallel, Sofiene MD, Tunisia
Literature:

- Metanalysis 0, Prospective/Randomized 0, Retrospective 11

Outside of case reports, there is no systematic study of this topic. Thus, it is challenging to make a definitive statement regarding differential risk for PJI after internal or external fixation of periprosthetic fractures.
**Recommendation:** Unknown. There is limited evidence comparing the risk of PJI with use of internal versus external fixation to treat periprosthetic fracture. The potential for pin tract infection, particularly with inadvertently placed intra-articular pins, make internal fixation the preferable treatment option in most cases.

**Level of Evidence: Consensus**

- A. Agree (90%)
- B. Disagree (5%)
- C. Abstain (5%)
T-9 (Former T-17) Should definitive fixation of fracture in a multi trauma patient and open abdomen be delayed until the abdomen is closed?

RESEARCHED BY:

García, Maria Fernanda MD, Colombia
Literature:

- Metanalysis 1, Prospective/Randomized 0, Retrospective 5

  Based on the limited available literature there is no reason to delay definite fracture fixation in multi trauma patients with open abdomen.
Recommendation: Definitive fracture fixation in the presence of an open abdomen should not be delayed and could be performed safely if the patient is suitable to undergo surgery.

Level of Evidence: Limited
T-10 (Former T-4) Are there predictors of the need for allogeneic blood transfusion in arthroplasty for acute hip fractures?

RESEARCHED BY:

Kenny, Paddy MD, Ireland
Saxena, Arjun MD, USA
Kvederas, Giedrius MD, Lithuania
Literature:

- Metanalysis 2, Prospective/Randomized 3, Retrospective 19
- A systematic review and meta-analysis of studies comparing surgical approaches and four studies comparing surgical approach for HA showed no difference in ABT rates between anterior, lateral and posterior approaches.
**Recommendation:** Pre-operative predictors for the need for allogeneic blood transfusion include anemia (Strong), dementia and hypoalbuminemia (Limited). Anticoagulation or anti-platelet medications do not predict the need for ABT (Moderate). There is conflicting data with regard for the need for ABT when comparing hemiarthroplasty to total hip arthroplasty.

**Level of Evidence:** Limited
Diagnostic
T-11 (Former T-27) What is best open fracture classification used presently? Gustilo-Anderson versus OTA open fracture classification (based on inter-observer reproducibility and predictiveness of outcomes)

RESEARCHED BY:

Pinzon, Andres MD, Colombia

Egol, Kenneth MD, USA
Literature:

• Metanalysis 1, Prospective(Randomized) 0, Retrospective 13

While further studies validating the OTA-OFC are needed, current literature suggests that it provides a method of describing open fractures with greater specificity compared to the Gustilo-Anderson classification with comparable interobserver agreement.
**Recommendation:** OTA-OFC. Based on currently available data, the OTA-OFC provides a more robust description of the injury with inter-observer agreement that is comparable or superior to the Gustilo-Anderson classification. Additionally, the OTA-OFC, according to its subcategories, may predict outcomes such as the likelihood of early amputation and need for adjuvant treatments.

**Level of Evidence: Limited**

A. Agree  
B. Disagree  
C. Abstain
What diagnostic criteria must be fulfilled to qualify as a SSI (surgical site infection) or FRI (fracture related infection) in Orthopedic trauma (including external fixators)?

RESEARCHED BY:

Haasper, Carl MD, Germany

Leal, Jaime A MD, Colombia
Literature:

- Metanalysis 0, Prospective/Randomized 4, Retrospective 11
- Current literature lacks high level evidence so diagnostic criteria has not been well established for SSI in orthopaedic trauma.
Recommendation: Diagnostic criteria proposed by the International Consensus Group on Fracture-related Infection, published in 2017, should be used to diagnose infection in fracture cases. In cases, more than 4 weeks from fracture, histological confirmation of >5 neutrophils per high power field is confirmatory of infection.

Level of Evidence: Consensus
T-13 (Former T-25) What diagnostic criteria define infected non-union of long bone?

RESEARCHED BY:

Suda, Arnold MD, Germany

Metsemakers, Willem-Jan MD, Belgium
Literature:

- Metanalysis 1, Prospective/Randomized 1, Retrospective 43

There is a scarcity of scientific evidence regarding the diagnostic criteria for FRI. With respect to serum inflammatory markers, tissue, and sonication fluid sampling and imaging modalities, only a small number of studies are available.
Recommendation: The lack of scientific evidence precludes the development of diagnostic criteria that are solely based on sound evidence. The combination of the consensus definition of fracture-related infection (FRI) with a nonunion is a reasonable starting place, however definitions of nonunion vary and both the FRI definition and any proposed criteria for long bone nonunion will need scientific validation.

Level of Evidence: Moderate

A. Agree (86%)
B. Disagree (9%)
C. Abstain (5%)
What is considered chronic osteomyelitis versus acute osteomyelitis? Does it matter?

RESEARCHED BY:

Giannoudis, Peter MD, UK
Literature:

- Metanalysis 0, Prospective/Randomized 1, Retrospective 28

  Current literature is lacking consistent criteria for a distinct time point that differentiates the acute and chronic forms of infection.
Recommendation: Current literature is lacking consistent criteria for a distinct time point that differentiates the acute and chronic forms of infection. Differentiating between acute and chronic types may have practical implications on treatment plan and final prognosis.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
T-15 (Former T-10) Is synovial fluid or fracture hematoma always aseptic? If not, could this play a role in acute infection or PJI after ORIF?

RESEARCHED BY:

Harris, Mitch MD, USA
Literature:

- Metanalysis 0, Prospective/Randomized 0, Retrospective 4

  Current literature lacks high level evidence to state whether hematoma or synovial fluid are always aseptic.
**Recommendation:** Fracture hematoma is not always aseptic. It is unknown if synovial fluid is always aseptic. In addition, it is unclear if this plays a role in acute infection or PJI after ORIF.

**Level of Evidence:** Moderate

- A. Agree
- B. Disagree
- C. Abstain
T-16 (Former T-45) What is the relationship between implanted metal and colonization under a VAC in open fractures?

RESEARCHED BY:

Caba, Pedro MD, Spain
Klement, Mitchell MD, USA
Literature:

• Metanalysis 2, Prospective/Randomized 2, Retrospective 9

• There is evidence supporting the safety and efficacy of NPWT over exposed metal for a period of time without infectious complications, there are no published studies investigating this in open fractures.
**Recommendation:** The use of negative pressure wound therapy (NPWT or VAC) over exposed orthopedic implants has been reported but its role remains unknown. Furthermore, no evidence exists regarding the effect of NPWT on the colonization of metal implants in open fractures. Further research is required to provide more insight into this question.

**Level of Evidence:** Consensus

A. Agree
B. Disagree
C. Abstain
What is the most optimal prophylactic antibiotic coverage and treatment duration for open fractures of long bones?

RESEARCHED BY:

Metsemakers, Willem-Jan MD, Belgium

Zalavras, Charalampous MD, USA
Current literature suggests that antibiotics should be administered as soon as possible after the injury. The antibiotic of choice is a first-generation cephalosporin in order to target gram-positive organisms.
**Recommendation:** The use of prophylactic antibiotics for open fractures of long bones has a protective effect against early infection. Antibiotics should be administered as soon as possible after the injury. The antibiotic of choice should target gram-positive organisms. Additional coverage for gram-negative organisms is recommended for patients with high-energy open fractures. Antibiotics should not be continued for more than 72 hours after wound closure.

**Level of Evidence: Moderate**

A. Agree  
B. Disagree  
C. Abstain
What antibiotic should be used for low energy open fractures? What antibiotic(s) should be used for high energy and grossly contaminated open fractures?

RESEARCHED BY:

Pesantez, Rodrigo MD, Colombia
Suarez, Cristina MD, Colombia
Literature:

• Metanalysis 0, Prospective(Randomized) 0, Retrospective 12

• The efficacy of first-generation cephalosporins for open fractures has been confirmed in level I and II studies. Type III fractures had a high rate of gram-negative infections which supports the addition of an aminoglycoside or a third-generation cephalosporin.
Recommendation: 1) Antibiotic treatment targeting gram-positive organisms is recommended as soon as possible for all open fractures; low and high energy. 2) In high energy or grossly contaminated open fractures, additional antibiotics should be given for gram-negative coverage.

1) Level of Evidence: Strong
2) Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
T-19 (Former T-39) What is the optimal mechanism for delivery of local antibiotics in contaminated or infected wounds?

RESEARCHED BY:

Metsemakers, Willem-Jan MD, Belgium
Literature:

• Metanalysis 2, Prospective/Randomized 0, Retrospective 24

The beneficial effect of local antibiotics in open limb fractures was proven by pooling data exclusively from cohort studies that compared the effect of additional local antibiotics to standard systemic antibiotic prophylaxis.
**Recommendation:** There is moderate evidence to support the use of local antibiotic delivery in contaminated or infected wounds. Future data collection seems important to improve our knowledge on this topic.

**Level of Evidence:** Moderate

A. Agree  
B. Disagree  
C. Abstain
T-20 (Former T-13) Is there a role for combination of local and systemic antibiotic delivery systems to treat open fractures with overlying contaminated wounds?

RESEARCHED BY:

Haggard, Warren MD, USA

Nana, Arvind MD, USA
Literature:

- Metanalysis 3, Prospective/Randomized 0, Retrospective 9
- Several retrospective studies do support the combination of systemic and local antibiotic delivery for infection prevention during the treatment of open bone fractures.
**Recommendation:** The administration of systemic antibiotic and a local antibiotic delivery device (system) is an effective treatment strategy for open bone fractures with contaminated wounds.

**Level of Evidence:** Moderate

- A. Agree
- B. Disagree
- C. Abstain
T-21 (Former T-36) What is the most optimal antibiotic treatment for chronic osteomyelitis?

RESEARCHED BY:

Kates, Stephen MD, USA

Hendershot, Edward MD, USA
Literature:

• Metanalysis 2, Prospective/Randomized 1, Retrospective 17

• While the studies to date do not provide a clear optimal antibiotic choice, duration or route of administration for the treatment of chronic osteomyelitis, some observations are consistent from the data available.
**Recommendation:** Antibiotic selection should be culture-specific, if possible. No clear evidence exists to suggest that longer duration of therapy (12-16 weeks) is superior to shorter duration (4-6 weeks). In addition, there is no evidence to support that intravenous (IV) antibiotic treatment is superior to oral treatment.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
What is the recommended suppressive antibiotic therapy for the treatment of chronic osteomyelitis after fracture fixation while the implant cannot be removed?

RESEARCHED BY:

Patzakis, Michael MD, USA
Tetsworth, Kevin MD, Germany
Costa Salles, Mauro J MD, Brazil
Literature:

- Metanalysis 0, Prospective/Randomized 2, Retrospective 19
- When managing early post-operative infections following osteosynthesis, rifampicin (rifamycins) is effective in suppressing gram positive organisms and Ciprofloxacin (fluoroquinolones) is effective in suppressing gram negative organisms.
Recommendation: Suppressive therapy with culture-specific antibiotics is aimed at allowing fracture healing prior to implant removal and definitive infection management.

Level of Evidence: Limited
What is the optimal timing of surgical debridement in open fractures?

RESEARCHED BY:

Caba, Pedro MD, Spain
Literature:

- Metanalysis 1, Prospective/Randomized 2, Retrospective 5
- Urgent debridement is essential in the initial treatment of open fractures, but the cutoff time is not known. There is no evidence supporting the six-hour rule. There are moderate evidence supporting that delayed debridement beyond eight hours could have an impact on infectious complications, especially in high-grade open tibia fractures.
**Recommendation:** It is not possible to establish a clear cut-off for optimal timing of open fracture surgical debridement after injury. Administration of antibiotic prophylaxis and adequacy of debridement is more important than time to debridement. However, we recommend debridement as soon as the patient and operative conditions are optimal.

**Level of Evidence:** Limited
**T-24 (Former T-44)** What is the recommended volume of irrigating fluid in the ED for open fractures?

**RESEARCHED BY:**

- Abuodeh, Yousef MD, Qatar
- Kallel, Sofiene MD, Tunisia
- Chang, Gerard MD, USA
Literature:

- Metanalysis 0, Prospective/Randomized 0, Retrospective 11

- Only 1 human clinical study related to the volume of irrigation for open fractures in the emergency room. Nevertheless, in the emergency room setting, irrigation of the wound with enough volume until all grossly visible contamination and debris is removed seems, at the very least, an appropriate amount.
**Recommendation:** In the emergency room setting, open fractures should be irrigated sufficiently to remove all visible contamination and debris prior to applying dressings.

**Level of Evidence:** Consensus

A. Agree 75%
B. Disagree 15%
C. Abstain 10%
T-25 (Former T-43) What is the recommended volume and composition of irrigating fluid in the OR for open fractures and post-traumatic wounds?

RESEARCHED BY:
Fram, Brianna MD, USA
Tornetta III, Paul MD, USA
Natoli, Roman MD, USA
Literature:

• Metanalysis 0, Prospective/Randomized 1, Retrospective 18

One identified randomized controlled trial comparing different osmolality irrigating agents of distilled or boiled water and isotonic saline did not have clearly defined outcome measures or follow-up criterion, but reported 25.5% overall infection rate without significant difference between the irrigation solutions.
Recommendation: Irrigation in open fractures may be performed with normal saline and gravity flow irrigation. 3-9L is a reasonable volume. Bactericidal washes with agents like chlorhexidine or povidone-iodine have not been adequately studied in orthopedic trauma patients but basic science studies raise concern they may damage tissues.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
What is the most appropriate management of early (prior to complete wound healing) infection after fracture fixation with stable fixation?

RESEARCHED BY:

Conway, Janet MD, USA

Morgenstern, Mario MD, Switzerland
Based on the available evidence and our experience, the most acceptable treatment strategy in trauma patients with early post-operative infection is proper debridement, antibiotic therapy (IV followed by oral), and retention of the stable hardware in place.
Recommendation: The most acceptable treatment strategy for trauma patients with early postoperative infection is to perform irrigation and debridement, administer culture-specific antibiotic therapy (local, intravenous [IV] followed by oral), ensure adequate soft tissue coverage, and retain stable implants in place.

Level of Evidence: Moderate
T-27 (Former T-34) What is the most appropriate management of early (before complete wound healing) infection after fracture fixation with unstable fixation?

RESEARCHED BY:

Bautista, Maria P. MD, Colombia

Pesantez, Rodrigo MD, Colombia

Zalavras, Charalampous MD, USA
Literature:

- Metanalysis 0, Prospective/Randomized 0, Retrospective 22
- No conclusive evidence reporting on the management of early infection with unstable fixation was found. Therefore, our recommendation is based on clinical experience and basic knowledge of implant-related infection and management of infected non-union.
**Recommendation:** The most appropriate management of early (prior to complete healing) infection after fracture fixation with unstable fixation consists of surgical debridement with removal of fixation implants, fracture stabilization, antibiotic therapy, and soft tissue coverage, if needed.

**Level of Evidence:** Consensus

- A. Agree 100%
- B. Disagree 0%
- C. Abstain 0%
T-28 (Former T-30) What is the appropriate timing of conversion to internal fixation following external fixation? How is this altered by pin site infection?

RESEARCHED BY:

Fram, Brianna MD, USA
Tornetta III, Paul MD, USA
Literature:

- Metanalysis 0, Prospective/Randomized 1, Retrospective 13
- There is minimal data on whether internal fixation in the setting of pin site infection increases the rate of deep infection. Early timing of soft tissue coverage appears to have the strongest effect on reducing deep infection rates.
Recommendation: Timing of conversion should be based on patient characteristics including concurrent injuries and premorbid health and function, as well as injury features and location. One-stage conversion appears to have similar or even lower infection rates compared to two-stage conversion. Early conversion is preferred, in absence of pin site infection.

Level of Evidence: Limited
What are the alternatives to segmental resection in septic non-union?

RESEARCHED BY:

Suda, Arnold MD, Germany

Quinnan, Stephen MD, USA

Gleason, Brendan MD
Literature:

- Metanalysis 2, Prospective/Randomized 0, Retrospective 24
- Literature to support the success of these alternative treatments to segmental resection in septic non-union is lacking.
**Recommendation:** All dead bone and soft tissue should be removed. Surgical alternatives to segmental resection include bone grafting, unroofing, decortication, distraction osteogenesis, or intramedullary reaming to address the site of osteomyelitis.

**Level of Evidence:** Limited
T-30 (Former T-38) What is the optimal management (Masquelet technique, bone transfer) of post-infective bone defects in different long bones (tibia, femur, humerus, etc.)? How does this vary by type of defect (conical vs. cylindrical)?

RESEARCHED BY:

Conway, Janet MD, USA

Quinnan, Stephen MD, USA
Literature:

- Metanalysis 3, Prospective/Randomized 2, Retrospective 40
- Three meta-analysis and two prospective studies saw no difference in outcomes in between cylindrical and conical defects.
Recommendation: The type of defect (cylindrical versus conical) was not determined to be relevant to the treatment method. Instead, optimal management of partial versus full segmental defects is relevant. Each long bone requires different preferred methods of stabilization.

Level of Evidence: Moderate
What is the optimum waiting time for bone grafting in staged management of septic nonunion?
Literature:

- Metanalysis 0, Prospective/Randomized 1, Retrospective 35
- No studies assess the optimum timing of bone grafting in the management of septic nonunion, current case series recommend an interval of 7-8 weeks while most studies range between 6-12 weeks following debridement.
**Recommendation:** The interval between first and second stages should be dependent upon infection control and the status of the local soft tissue of the individual patient, rather than any specific time. Therefore the precise time is unknown, but current recommendations are, if conditions are favorable, the second stage can be performed between six and twelve weeks after the first stage. This recommendation may not apply to the Masquelet technique.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
When should hardware be removed when treating SSI (surgical site infection) in Orthopedic trauma?
Literature:

- Metanalysis 0, Prospective/Randomized 2, Retrospective 10

  Methodical approach addressing pathogen, host factors, and bony and soft tissue deficiencies. Performing a thorough debridement, dead-space management, and soft tissue and bony reconstruction.
Recommendation: The decision to retain or remove hardware differs widely and must take into account extent of the infection, and stability of the hardware. A methodical approach that addresses the pathogen, host factors, and bony and soft tissue deficiencies is required, and includes thorough debridement, dead-space management, and soft tissue and bony reconstruction using principles of the reconstruction ladder.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
T-33 (Former T-51) Which surgical treatment (plate, nail, external fixator) for open tibial shaft fractures results in lower rate of infection?

RESEARCHED BY:

Ferreira, Nando MD, South Africa
Published literature on infections rates for open tibial shaft fractures treated by various different fixation methods, plate fixation and monolateral external fixation have significantly higher infection rates when compared to circular external fixation or intramedullary nailing.
Recommendation: There is little to no difference in terms of infection rates for Gustilo-Anderson grades I – II treated by either Circular External Fixator, Unreamed intramedullary nail or reamed intramedullary nail. For Gustilo-Anderson IIIA-B fractures, Circular External Fixation appears to provide the lowest infection rates when compared to all other fixation methods.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
T-34 (Former T-49) When performing intramedullary fixation, what is the evidence regarding reaming versus non-reaming and association with infection?

RESEARCHED BY: Swiontkowski, Marc F MD, USA

Shope, Alexander J MD, USA
Literature:

• Metanalysis 2, Prospective(Randomized 4, Retrospective 5

There is no conclusive evidence linking IM reaming with increased rates of infection when compared to non-reamed techniques.
**Recommendation:** Based on the current evidence, there is no difference in infection rates following intramedullary fixation of long bone fractures using a reamed or non-reamed technique.

**Level of Evidence: Moderate**
T-35 (Former T-2) Are antibiotic coated rods and plates acceptable, versus cement only implants?

RESEARCHED BY:

Alt, Volker MD, Germany

Watson, J. Tracy MD, USA
Literature:

• Metanalysis 0, Prospective/Randomized 0, Retrospective 6

• Antibiotic coated rods (ACR) and antibiotic coated plates (ACP) are biomechanically stable, and may allow better bone healing compared to other biomechanically unstable drug carries.
**Recommendation:** Antibiotic-loaded PMMA (AL-PMMA) spacers can be considered as established treatment concept for local antibiotic delivery in osteomyelitis and implant-associated infections. Antibiotic coated rods (ACR) and antibiotic coated plates (ACP) can also be a value in specific indications, mainly infected non-unions, in order to address both local delivery of antibiotics and biomechanically stable fixation of the non-union site to allow for possible spontaneous bone consolidation.

**Level of Evidence:** Limited
T-36 (Former T-32) What is the ideal composition of antibiotic-impregnated intramedullary nails?

RESEARCHED BY:

Citak, Mustafa MD, Germany

Haasper, Carl MD, Germany

Zalavras, Charalampos MD, USA

Manrique, Jorge MD, Colombia

Reyes, Francisco MD, Colombia
Literature:

- Metanalysis 0, Prospective/Randomized 0, Retrospective 22
- Current literature recommends at least 2 grams of vancomycin and 2.4 grams of an aminoglycoside be added each pack (40 grams) of polymethylmethacrylate cement.
Recommendation: The ideal composition of antibiotic-impregnated intramedullary nails is unknown. We consider that the core should consist of a rigid structure such as an Ender’s intramedullary (IM) nail, Ilizarov threaded rods, IM locked nails, carbon fiber nails or sectioned pins or guidewires. We recommend that at least 2 grams of vancomycin and 2.4 grams of an aminoglycoside be added to each pack (40 grams) of polymethylmethacrylate cement. If a specific microorganism is isolated, targeted antibiotic therapy should be included.

Level of Evidence: Consensus

A. Agree  86%
B. Disagree  10%
C. Abstain  5%
T-37 (Former T-31) What is the ideal composition of antibiotic impregnated spacers/beads in post-traumatic infections? Is preoperative microbial identification necessary?

RESEARCHED BY:

Marais, Leonard MD, South Africa
Literature:

- Metanalysis 1, Prospective/Randomized 0, Retrospective 19

Available data suggests that PMMA spacers, empirically impregnated with 2 grams of vancomycin per 40 mg of PMMA (with or without gentamycin), may result in quiescence of infection in a high percentage of cases with an acceptable associated rate of bony union.
Recommendation: There is currently limited evidence with regards to the ideal composition of antibiotic impregnated PMMA spacers or beads in post-traumatic infections and the need for pre-operative identification of the causative organism. Available data suggests that PMMA spacers, empirically impregnated with 2 grams of vancomycin per 40 mg of PMMA (with or without gentamycin), may result in quiescence of infection in a high percentage of cases with an acceptable associated rate of bony union. Preoperative microbial identification is of unclear utility.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
T-38 (Former T-16) Should antibiotic cement rods be left permanently in situ?

RESEARCHED BY:

Alt, Volker MD, Germany
Current literature suggests that if the antibiotic cement rods is used as a locked implant for both local delivery of antibiotics and provision of stable biomechanical conditions for consolidation of the non-union site it can be left in place.
**Recommendation:** If the antibiotic cement rod (ACR) is used as a temporary non-locked implant for infection control it should be removed and replaced by a biomechanically stable, e.g. locked intramedullary nail. If the ACR is used as a locked implant for both local delivery of antibiotics and provision of stable biomechanical conditions for consolidation of the non-union site it can be left in place.

**Level of Evidence:** Limited
T-39 (Former T-15) Should all infected non-unions be treated in specialized septic centers?

RESEARCHED BY:

Malizos, Konstantinos (Kostas) MD, Greece
Literature:

• Metanalysis 0, Prospective/Randomized 2, Retrospective 26
• Current literature lacks high level evidence evaluating this particular issue.
Recommendation: The current literature, although rich in case series and observational studies, does not lend support to the recommendation that “specialized septic surgery centers” should care for infected non-unions. However, because of the complexities of infected non-unions, care in the specialized centers may yield the best possible outcome.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
T-40 (Former T-11) Is there a minimum number of complex osteomyelitis procedures a surgeon should perform annually to ensure proper outcomes?

RESEARCHED BY:

Gutierrez, Vicky MD, Nicaragua
Literature:

• Metanalysis 1, Prospective/Randomized 0, Retrospective 5

  In the literature reviewed, there is no evidence to answer the question. Recommendation provided is inconclusive.
**Recommendation:** There is no literature supporting the minimum number of complex osteomyelitis procedures a surgeon should perform annually to ensure proper outcomes. Higher volume referral centers, centers of excellence, and multidisciplinary teams for the treatment of complex osteomyelitis have been shown to improve outcomes.

**Level of Evidence:** Consensus

- **A. Agree**
- **B. Disagree**
- **C. Abstain**

76% agree, 14% disagree, 10% abstain.
Who are the essential members of the multidisciplinary team required to manage infected fractures and non-unions?

RESEARCHED BY:

Metsemakers, Willem-Jan MD, Belgium

Leal, Jaime A
Literature:

- Metanalysis 0, Prospective/Randomized 0, Retrospective 22

  Current literature lacks high level evidence to determine the ideal multidisciplinary team, But there is increasing evidence that teamwork and collaboration among healthcare workers are essential to improve patient outcomes.
Recommendation: Members of the multidisciplinary team managing infected fractures and non-unions require expertise in bone reconstruction, soft tissue reconstruction, microbiology, antibiotic treatment, and advanced imaging. It is important to note that the exact members of the group and other specialist required will eventually depend on patient needs and local preferences.

Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain
T-42 (Former T-1) Is there evidence to support certain types of flap coverage (muscle rather than fasciocutaneous flaps for example) after open tibial fractures?

RESEARCHED BY:

Malizos, Konstantinos (Kostas) MD, Greece

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Literature:

• Metanalysis 0, Prospective/Randomized 0, Retrospective 21

  Current literature seems to support that early coverage is associated to better outcomes. Local flaps are less predictable in high energy trauma. The type of flap should be tailored based on the extent and the depth of the soft tissue defect and the location of the fracture.
Recommendation: Different types of flap coverage after open tibial fractures have essentially equivalent and comparable outcomes in terms of flap survival, bone healing, stress fracture, infection, chronic osteomyelitis, and donor site morbidity. Local flaps should be considered in low energy trauma, when available. The type of flap should be tailored based on the extent and the depth of the soft tissue defect and the location of the fracture. In high energy fractures of the tibia, muscle flaps may offer a more reliable reconstruction with fewer flap failures and fewer re-operation rates.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
What is the appropriate timing for flap coverage of open fractures and traumatic wound defects?

RESEARCHED BY:

Lowenberg, David MD, USA
Literature:

- Metanalysis 2, Prospective/Randomized 0, Retrospective 10
- Numerous independent case series’ by well-experienced microsurgeons have also shown no difference in outcome in regard to timing of free flap placement.
**Recommendation:** The optimal time is when the wound has been appropriately cleaned and converted to a “living wound". Early flap coverage is preferred, ideally within 3-7 days, when patient and wound are suitable.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
T-44 (Former T-18) Should open fracture wounds be closed primarily or closed secondarily? If closed primarily, which ones and under what criteria?

RESEARCHED BY:

Lowenberg, David MD, USA

O'Toole, Robert MD, USA
Literature:

• Metanalysis 0, Prospective/Randomized 0, Retrospective 14

• The best evidence in support of this practice is provided by two recent case-controlled studies that attempt to address the issue of selection bias and have adequate sample size and event rates to have reasonable statistical power.
**Recommendation:** Primary wound closure of many open fracture wounds appears to be a safe and likely beneficial strategy in the modern setting of improved debridement techniques, better methods of fracture stabilization, and improved utilization of early systemic antibiotic administration. It appears safe for lower grade open fractures and a subset of higher grade open fractures when the wound is deemed appropriate for primary closure on a clinical basis.

**Level of Evidence:** Moderate
T-45 (Former T-22) What are the evidence-based recommendations for the use of Negative Pressure Wound Therapy in open fractures and traumatic wounds?

RESEARCHED BY:

Caba, Pedro MD, Spain

Klement, Mitchell MD, USA
Literature:

• Metanalysis 2, Prospective/Randomized 2, Retrospective 9

• While there is evidence supporting the safety and efficacy of NPWT over exposed metal for a period of time without infectious complications, there are no published studies investigating this in open fractures.
**Recommendation:** Negative pressure wound therapy (NPWT) is an appropriate dressing in the short term management (<7 days) of complex traumatic wounds over open fractures prior to definite soft tissue closure. NPWT is not superior to traditional dressings and has increased cost.

**Level of Evidence:** Moderate
What are predictors of the need for allogeneic blood transfusion in periprosthetic fractures?

RESEARCHED BY:

Kenny, Paddy MD, Ireland
Kvederas, Giedrius MD, Lithuania
Yazdi, Hamidreza MD, Iran
Literature:

- Metanalysis 0, Prospective/Randomized 0, Retrospective 9
- There is a paucity of data on the impact of predictors on need for allogeneic blood transfusion (ABT) in periprosthetic fractures.
Recommendation: Predicting factors for ABT are: revision arthroplasty, preoperative anemia, increasing age, higher comorbidity index, lower BMI, female gender, longer surgical time and hip surgery.

Level of Evidence: Limited
T-47 (Former T-14) Is there a role for hyperbaric oxygen therapy and other non-antibiotic methods for the treatment of chronic osteomyelitis/implant infections?

RESEARCHED BY:

Marais, Leonard MD, South Africa
Literature:

- Metanalysis 1, Prospective/Randomized 0, Retrospective 12
- While initially there was some enthusiasm about the use of HBOT in refractory osteomyelitis, this appears to have waned somewhat with only one case series published since 2004.
Recommendation: There is limited evidence for the efficacy of hyperbaric oxygen in the treatment of post-traumatic bone infections.

Level of Evidence: Limited
T-48 (Former T-9) Is rate of infection different in patients who undergo hip arthroplasty for acute femoral neck fracture?

RESEARCHED BY:

Saxena, Arjun MD, USA
Literature:

- Metanalysis 0, Prospective/Randomized 1, Retrospective 6
- It appears that the rate of infection is higher in patients undergoing arthroplasty surgery for the treatment of acute femoral neck fracture.
**Recommendation:** There appears to be a higher incidence of infection in patients undergoing arthroplasty for acute femoral neck fracture compared to elective primary arthroplasty. The reported rate of infection has a wide range; prospective studies should be performed to determine the true rate of PJI in this subset of patients.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
T-49 (Former T-35) What is the most appropriate outcome measurement (clinical, radiographic, laboratory, etc.) for management of early infection after fracture fixation?

RESEARCHED BY:

Haasper, Carl MD, Germany
Citak, Mustafa MD, Germany
Obremskey, William T MD, USA
Egol, Kenneth MD, USA
Literature:

- Metanalysis 0, Prospective/Randomized 1, Retrospective 36
- Fracture healing seems to be the most appropriate outcome measurement for the management of early infection after fracture fixation.
**Recommendation:** Fracture healing and infection control seem to be the most appropriate outcome measurements for the management of early infection after fracture fixation. Secondary, treatment success following infection management after fracture fixation is best assessed using a combination of the patient’s clinical picture and laboratory examinations such as tissue cultures, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP).

**Level of Evidence: Consensus**

- A. Agree (70%)
- B. Disagree (10%)
- C. Abstain (20%)