# Lower Extremity (LE) Stress Fracture Cliff

### Branch Baseline

Stress fractures commonly involve the bones of the lower extremities and are a well-recognized etiology for skeletal pain in military recruits, athletes, and other young individuals. They occur under conditions of unaccustomed or accelerated physical activity, and develop in seemingly normal diaphyseal bone in those with an apparent susceptibility to this type of pathology (Zwas, 1987)

There is no initial bone break in stress fracture. They develop gradually over a period of days and weeks due to repeated excessive stress which causes mechanical disturbance of the cortical osseous trabeculae. When the stress is discontinued, bone replacement occurs with osteoblastic formation. Persistent physical activity results in continued stress tractions and bone resorption leading to complicated severe stress fractures with microfractures or complete fractures (Zwas, 1987).

### Incidence Data Included in the Model

The model imports the following incidence information from the IMM database: incidence data category, space adaption status, incidence data, incidence and occurrence distribution data and incidence data characteristics. Data category defines the type of data available for incidence calculations (i.e. raw data vs. fixed data). Space adaptation identifies medical events that onset occurs in the first 5 days of flight and does not reoccur. Incidence values vary by data category and define the number of medical events per person-year or medical events per person-at-risk for each medical condition. Incidence values can be modified by crew characteristics such as gender. Modifying characteristics are noted below and incidence values are listed individually for each characteristic. Distributions are assigned to medical events incidence values and occurrences in the model. For each crew member in a given trial, the incidence and number of occurrences of each medical condition are randomly selected from these probability distributions. Detailed descriptions of the distributions are included in the IMM Technical Description Document.

| **Incidence** | |
|---|---|
| Data Category: | Fixed |
| Space Adaptation: | No |
| Incidence Type: | Rate |

| **Distribution Data** | |
|---|---|
| Incidence: | Fixed |
| Occurrence: | Poisson |

| **Female Data Characteristics** | |
|---|---|
| Fixed Rate: | 0.067 |

| **Male Data Characteristics** | |
|---|---|
| Fixed Rate: | 0.042 |

**Incidence Comments**

After more than 40 years of space travel, it is assumed that fractures have not occurred during missions in low Earth orbit nor in the immediate post flight time frame. (Sibonga, 2008)Lacking phenomenological space data, we searched terrestrial studies. A prospective study conducted in Australia evaluated the incidence rate of stress fractures among competitive track and field athletes the stress fracture incidence was found to be 20.4% in men and 21.7% in women (Bennell, 1996).

When the stress fractures rates were adjusted for total training hours men experienced 0.54 and women 0.86 stress fractures per 1000 training hours (0.00054 and 0.00086 events/hour). This difference was not statistically significant (P=.82) (Bennell, 1996). The study was not sufficiently powered to detect a statistically significant difference in stress fracture incidence rates. However, this difference may be of clinical significance. (Snyder, 2006)

On the International Space Station (and previously on Mir), crew members are required to exercise for 2½ hours per day (half of this time is used for setup and post-exercise personal hygiene). This is not done in one block but divided into two sessions, usually one session aerobic (cardiovascular) and the other anerobic (muscle-loading/conditioning). (International Space Station, 2000); (International Space Station, 2000)

Assuming 1.5 hours per week of treadmill exercise on a 6 months ISS mission resulted in a total training time of 78 hours per year. IMM estimated the incidence:

Males (0.00054 events/hour)(78 hours/year) = 0.042 events/person-year

Females (0.00086 events/hour)(78 hours/year) = 0.067 events/person-year.

**Information Regarding Prevention**

**Selection criteria**Disqualifying conditions in the musculoskeletal category include:Traumatic, inflammatory, degenerative, congenital and metabolic disorders, or disease of any bone, joint, muscle or supporting structure that interferes with the performance of duties; chronic arthritis with functional disability that interferes with the performance of duties; benign tumors or cysts, single or multiple, sufficiently large to interfere with performance of duties, or to create a fracture potential. Osteochondromatosis or multiple cartilaginous exostoses that interfere with performance of duties; Joint instability e.g. recurrent subluxations or dislocations of an articulation;. Intra-articular loose bodies, osteocartilaginous or metallic foreign objects, in any joint that interfere with performance of duties; Non-union of fractures; mal-union of fractures that interferes with performance of duties. Less than functional range of motion and stability of all joints. A total range of motion of the wrist of 70 degrees dorsal extension plus 80 degrees palmar flexion: ulnar deviation 45 degrees plus 15 degrees radial deviation. Pronation of the hand to 90 degrees and supination to 80 degrees. Chronic or recurrent bursitis, tendinitis, and synovitis sufficient to interfere with the performance of duties. Conditions requiring special consideration by the MSMB include: history of osteochondromatosis or multiple cartilaginous exostoses that have been successfully surgically excised; history of joint instability that has been medically or surgically corrected; history of intra-articular loose bodies in any joint surgically removed with no residual; any fracture in which hardware, e.g. rod, plate, pin or screw, was used for fixation, if the fixation devices remain in place, will require orthopedic consultation; Minor deviations from the range of motion of the wrist; Osteopenia will require endocrine evaluation and possibly other specialized scanning techniques. The WHO definition of osteopenia is based on a DEXA measurement of Bone Mineral Density of total lumbar spine less than 0.937gm/cm2 or femoral neck less than 0.738 gm/cm2, or greater trochanter of the femur less than 0.602 gm/cm2. T-score: -1.0 to -2.5 SD. Osteoporosis. The WHO definition of osteoporosis is based on a DEXA measurement of Bone Mineral Density of total lumbar spine less than 0.772 gm/cm2 or femoral neck less than 0.572 gm/cm2 or greater trochanter of the femur less than 0.451 gm/cm2. T-score: Lower than -2.5 SD. (NASA, 2007); (International Space Station Program, 2009)

**Contingency measures**NASA requirements and documents support safety first. However, injuries result from an accident and there are no real medical preventive measures available.

**Other**It is if concern how fracture healing is effected in microgravity. Two published studies on bone physiology in a microgravity environment suggest that fracture healing will be abnormal. The first looked at cultured human mesenchymal stem cells (hMSC) in modeled microgravity. The study revealed that modeled microgravitiy inhibits the osteoblastic differentiation of hMSC and induces the development of an adipogenic lineage; changing the make up of bone (Zayzafoon, 2004). The second was Russian manuscript that describes abnormal fracture healing in rats with fibula fractures flown on Cosmos-2044 (Kaplansky, 1991).

Therapeutic ultrasound has been shown to accelerate the healing of acute fractures, but evidence for its efficacy in stress fractures is mixed. One double-blinded, randomized controlled trial showed no benefit in 43 tibial stress fractures (Rue, 2004). One double blinded randomized trial, in Indian soldiers found US treatment dramatically reduced the time until return to full duty (mean treatment duration 15 days versus 75 and 24 days versus 39 respectively). These protocols used 1 Watt/cm2 of ultrasound energy for five and ten minutes a day respectively at the fracture site, in addition to usual conservative therapy {Yadav, 2008 4294 /id.

Dr. Yi-Xian Qin, from the National Space Biomedical Research Institue (NSBRI), is developing new technology which he calls Scanning Confocal Acoustic Navigation (SCAN). The device would provide diagnostic and therapeutic capabilities. It uses SCAN for diagnosis and also delivers a low-intensity pulsed ultrasound for treatment. (Thomas, 2009).

**Incidence Level of Evidence (LOE)**

The IMM level of evidence appropriate assessment of the quality of the IMM input data. Since IMM incorporates input data from a wide variety of sources including astronaut population, terrestrial or analog populations, and external models, an innovative approach to assess the quality of input data was required. Information obtained from the astronaut population and/or space flight is the more relevant so it is assigned the highest level of evidence and less relevant data sources are assigned a lower level of evidence.

| Citation | LOE Value | LOE Category |
|---|---|---|
| Bennell, 1996 | 4 | Incidence |
| International Space Station, 2000 | 2 | Incidence |
| International Space Station, 2000 | 2 | Incidence |

## Alternative Incidence Data

**Analog populations**

The service area of the Central Military Hospital in Helsinki covers 75% of the conscripts in Finland. Over the study period, between March 1997 and April 2004, all patients concerned were performing their military training as conscripts of the Finnish Defence Forces. The total exposure time for the population at risk during the study period was 85,318 conscript-years in the studies II and III, and 104,340 conscript-years in the study IV. The study included 4 different groups (I to IV). (Niva, 2006)

The purpose of Study I was to investigate the occurrence of asymptomatic bone stress injuries by clinical and MRI follow-up, their clinical significance, and whether they progress to stress fractures in recruits undergoing intensive physical training. The elite-unit military recruits (I) were examined by clinical and MRI follow-up before commencement of the intensive training period, at 6 weeks from commencement, and on completion of the 5-month training program. In three original articles (II-IV) based on MRI, the incidence, location, nature, and patterns of bone stress injuries in the knee, the femoral bone, and the ankle and foot in physically active military conscripts during their military service were described. In all studies (I-IV), the MR images with bone stress injury findings were evaluated with respect to bone stress injury location and bone stress injury type, and bone stress injuries were graded from endosteal marrow edema (Grade I) to callus in cortical bone (Grade V).(Niva, 2006)

The incidence of bone stress injuries was relatively high compared to previous studies. Depending on the location of the bone stress injuries, 1-2/1000 developed as a clinically significant bone stress injury of the lower extremity (Study II knee 1.03/1000, Study III femoral 1.99/1000 and Study IV ankle and foot 1.26/1000). For statistical analysis In all studies the limit for significance was set equal to 0.05 (Niva, 2006). The incidence midpoint of 0.001-0.002 is 0.0015 person-years encompassing different areas of the lower extremity.

During Army basic training in the United States lower extremity overuse injuries associated with running, marching, and other lower-extremity load-bearing activities accounted for up to 75% of injuries among men and 78% of injuries among women. Stress fracture rates were 0.002 (1/389) for men and 0.02 (7/342) for women. Stress reactions rates were 0.004 (2/389) and 0.03, (11/342) respectively. Cumulative incidence of stress fractures and stress reactions was 0.8% in men and 5.0% in women. Male U.S. Army Infantry trainees undergoing a 12-week period of basic training experience a cumulative incidence of injury of 46% (24), about 15 injuries per 100 person-months. (Knapik, 1997); (Hauret, 2010)

An epidemiologic prospective cohort study of 152,095 conscripts, including 2345 (1.5%) females, was conducted. Localized pain in the pelvis, hip, thigh, or knee resulted in an orthopedic surgeon's consultation and subsequent MRI examination at the Central Military Hospital, Helsinki, Finland. During the study period, between 1998 and 2004, 319 bone stress injuries of the pelvis, hip, thigh, or knee were identified in our cohort; thus, the incidence of MRI-detected bone stress injury was 311 (95% CI: 277-345) per 100,000 person-years. Because the risk factors for bone stress injuries in the different anatomic locations (sacrum, ramus, collum, femoral shaft, patella, femoral, or tibial condyle) showed no statistically significant differences in our sample, they were considered a single entity in the analysis. Females had a markedly increased risk for bone stress injuries, and this association maintained its significance in the adjusted multivariable model. Age was a significant risk factor for bone stress injuries in both univariate and multivariable analyses. Older conscripts (aged 21-29 yr; median, 22 yr) had 2.1 (95% CI: 1.4-3.1) times the risk of bone stress injury compared with conscripts aged 17-19 in the multivariable model. The significant risk factors for bone stress injury in the univariate models included poor muscle strength and poor performance in the 12-min run test, indicating that the risk of bone stress injury increased with lower physical fitness. (Mattila, 2007)

### Treatment and Outcomes

Based on the best evidence available best and worst case percentage ranges are assigned. The medical condition is divided into three clinical phases in all three clinical phases a functional impairment is assigned. The clinical phase I and II's functional impairments remain for the duration for that respective clinical phase. The function impairment in clinical phase III represents final impairment for this medical condition and remains for the rest of the mission. Other mission end states include evacuation and loss of crew life.

The IMM checks medical resource availability once the number of medical events and scenarios has been established. If there is not sufficient essential resources called out in the CliFF, then the medical condition will go down an untreated best or worst case scenario pathway.

The table below summarizes the treated and untreated best and worst case scenarios.

| | **Clinical Phase I Diagnosis & Initial Treatment[1]** | | **Clinical Phase II On-going Treatment / Convalescence[2]** | | **Clinical Phase III Recovered / Mission End State[3]** | | |
|---|---|---|---|---|---|---|---|
| | **FI* (%)** | **Duration (hrs)** | **FI* (%)** | **Duration (hrs) (Min - ML - Max)** | **FI* (%)** | **EVAC** (%)** | **LOCL** (%)** |
| ISS-based Treatment (best case scenario %: 77 - 100) | 100 | 2 | 0 - 10 | 504 - 1260 - 2016 | 0 | 0 | 0 |
| ISS-based Treatment (worst case scenario %: 0 - 23) | 100 | 2 | 2 - 19 | 2016 - 2184 - 2352 | 0 - 10 | 0 - 2 | 0 |
| Untreated Best Case | N/A | N/A | 2 - 19 | 504 - 1260 - 2016 | 0 - 10 | 0 | 0 |
| Untreated Worst Case | N/A | N/A | 12 - 34 | 2016 - 2184 - 2352 | 2 - 34 | 0 - 100 | 0 |

[1]Clinical Phase I: Clinical phase I covers only the initial assessment of the affected crew member to define his or her medical condition, and completion of appropriate initial treatment to stabilize the crew member. While the affected crew member is being assessed, he or she is not able to perform any assigned tasks, thus Functional Impairment during this phase is considered 100%. In the untreated case, there is no diagnosis performed or treatment given, therefore Functional Impairment and Duration will always be "not applicable".

[2]Clinical Phase II: On-going Treatment and Convalescence- During clinical phase II, the affected crew member is receiving any appropriate follow-on treatment for his or her medical condition to allow the crew member to recover as much as he or she is able to recover in the ISS environment. Clinical phase II also encompasses relapses or reoccurrences of the same original medical condition in clinical phase I necessitating additional treatment or recovery time due to unsuccessful primary treatment response. The duration in Clinical Phase II is expressed in minimum, most likely (ML) and maximum hours. This was updated for future capabilities in IMM but is currently not being used by the model.

[3]Clinical Phase III: Recovered/Mission End State- Clinical phase III is reached once the affected crew member has recovered from the medical condition as much as he or she is able to recover in the ISS environment. This may or may not be recovery from the given medical condition to the full extent possible. If this "recovered" state results in an evacuation or loss of the crew member, this will be noted in the mission end state results.

*Functional Impairment (FI) is a measure of the affected crew member's health and performance ability.

**Two mission end state results are addressed in the CliFF: 1) Evacuation (EVAC) - crew and patient are evacuated from the spacecraft due to the medical condition, and 2) Loss of crew (LOCL) - death of affected crew member due to medical condition. EVAC is considered as an end state result if any of the following criteria are met: 1) potential LOCL, 2) potential significant permanent impairment, or 3) potential intractable pain. Probability distributions are assigned for each range of values within the Table of Treatments and Outcomes.

Refer to the Integrated Medical Model Technical Document for more information on how risk is reported by the IMM, Crew Health Index (CHI) and Quality Adjusted Mission Time calculations.

Definition and Probability of Best and Worst Case Scenario: (includes definitions of best and worst case scenarios and identifies the probability of those scenarios.)

**Scenario Comments**

The **best case scenario** is defined as a Grade 1 to 3 (Arendt, 2003)stress fracture, which causes mild to moderate symptoms and does not require casting or surgical treatment.

The **worst case scenario** is defined as a Grade 4 (Arendt, 2003)stress fracture, which causes moderate to severe symptoms and requires casting or surgical treatment.

For further description of stress fractures grading refer to the CliFF's Appendix B

**Percentages of best case vs. worst case scenario** were obtained from terrestrial data. A retrospective study on a Division I college athletes over a ten year period graded injuries by imaging. Of a total of 61 stress injuries 20 were grade 1 (33%), 9 were grade 2 (15%), 18 were grade 3 (30%), and 14 were grade 4 (23%) (Arendt, 2003). The estimate for worst cases is 0-23%. Thus the best case scenario results in 77-100%

**Best Case Comments**

Lower Extremity (LE) Stress Fracture functional impairments (FI) calculation follows the IMM mild non-space adaptation template. LE Stress Fracture ratings are based on Table 16-1 p 495. LE Stress Fracture ratings are converted to percentage of Whole Person Impairment (WPI). Both are based on Table 16-1, p 495 (American Medical Association, 2008). Complex Regional Pain (LEI) syndrome gradings are based on Table 16-15, p.541 (American Medical Association, 2008). The CRPS (LEI) ratings are then converted to percentage of Whole Person Impairment (WPI), which are based on Table 16-1, (American Medical Association, 2008). Total FI ratings are calculated combining the mentioned WPI values using the Combined Values Chart as indicated in Appendix A, pp 604-606 (American Medical Association, 2008). For further information on the calculation of FI refer to the CliFF Appendix A.

By definition in Clinical Phase I, FI is 100%. Duration to follow procedures specified in ISS checklist, i.e. physical exam, vital signs, oral or intramuscular medications, plus time to deploy the ultrasound unit, up-stow and activate procedure/checklist, and perform the exam, is estimated in 2 hours. Ultrasound (US) is gaining popularity as a diagnostic imaging tool for musculoskeletal conditions. US can display several findings suggestive of stress fracture. These findings include: hematoma, periosteal elevation, hypervascularity, and cortical defect over the area of tenderness (Banal, 2006); (Bodner, 2005).

During Clinical Phase II, FI is estimated in 0 to 10%. }. Grade 1 to 3 stress fractures heal from 3.3 to to 11.4 weeks based on terrestrial data (Arendt, 2003) . Therefore, duration for this scenario has been estimated at 3 to 12 weeks, 504 to 2016 hours. In Clinical Phase III, full recovery is expected and FI is 0%. By definition EVAC and LOCL are not expected for the best case scenario.

**Worst Case Comments**

Lower Extremity (LE) Stress Fracture functional impairments (FI) calculation follows the IMM mild non-space adaptation template. LE Stress Fracture ratings are based on Table 16-1 p 495. LE Stress Fracture ratings are converted to percentage of Whole Person Impairment (WPI). Both are based on Table 16-1, p 495 (American Medical Association, 2008). Complex Regional Pain (LEI) syndrome gradings are based on Table 16-15, p.541 (American Medical Association, 2008). The CRPS (LEI) ratings are then converted to percentage of Whole Person Impairment (WPI), which are based on Table 16-1, (American Medical Association, 2008). Total FI ratings are calculated combining the mentioned WPI values using the Combined Values Chart as indicated in Appendix A, pp 604-606 (American Medical Association, 2008). For further information on the calculation of FI refer to the CliFF Appendix A.

By definition in Clinical Phase I, FI is 100%. Duration is estimated in 2 hours similar to the best case scenario.

During Clinical Phase II, FI is estimated at 2 to 19%. Terrestrially, , the time required before return to activity ranges from 3.3 to 11.4 weeks for grades 1 to 3, and 14.3 weeks for grade 4 (Arendt, 2003). We estimated duration at 12 to 14 weeks, 2016 to 2352 hours.

During Clinical Phase III, full recovery may or may not occur and FI is estimated at 0-10%. A study including 320 college athletes with stress fractures, determined that all cases were treated conservatively. Two of them required immobilization and 3 with delayed healing required treatment with electromagnetic radiation. These five cases (5/320) were 1.6% of injuries requiring additional treatment (Matheson, 1987). To allow for uncertainty EVAC is estimated at 0-2%. Fractures are a class IIb event, manageable with the HMS but may require return of the astronaut at the next available opportunity for further evaluation and treatment (Johnston, 2008). None of the astronaut corps hospitalizations has been for stress fracture. LOCL is not expected.

**Untreated Best Case Comments**

Lower Extremity (LE) Stress Fracture functional impairments (FI) calculation follows the IMM mild non-space adaptation template. LE Stress Fracture ratings are based on Table 16-1 p 495. LE Stress Fracture ratings are converted to percentage of Whole Person Impairment (WPI). Both are based on Table 16-1, p 495 (American Medical Association, 2008). Complex Regional Pain (LEI) syndrome gradings are based on Table 16-15, p.541 (American Medical Association, 2008). The CRPS (LEI) ratings are then converted to percentage of Whole Person Impairment (WPI), which are based on Table 16-1, (American Medical Association, 2008). Total FI ratings are calculated combining the mentioned WPI values using the Combined Values Chart as indicated in Appendix A, pp 604-606 (American Medical Association, 2008). For further information on the calculation of FI refer to the CliFF Appendix A.

During Clinical Phase II, FI is estimated in 2-19%. Duration is estimated at 3 to 12 weeks, 504 to 2016 hours, similar to the treated best case scenario.

During Clinical Phase III, recovery may or may not occur. FI is estimated at 0-10%. By definition EVAC and LOCL are not expected for this scenario

**Untreated Worst Case Comments**

Lower Extremity (LE) Stress Fracture functional impairments (FI) calculation follows the IMM mild non-space adaptation template. LE Stress Fracture ratings are based on Table 16-1 p 495. LE Stress Fracture ratings are converted to percentage of Whole Person Impairment (WPI). Both are based on Table 16-1, p 495 (American Medical Association, 2008). Complex Regional Pain (LEI) syndrome gradings are based on Table 16-15, p.541 (American Medical Association, 2008). The CRPS (LEI) ratings are then converted to percentage of Whole Person Impairment (WPI), which are based on Table 16-1, (American Medical Association, 2008). Total FI ratings are calculated combining the mentioned WPI values using the Combined Values Chart as indicated in Appendix A, pp 604-606 (American Medical Association, 2008). For further information on the calculation of FI refer to the CliFF Appendix A.

During Clinical Phase II, FI is estimated in 12-34%. Duration is estimated at 3 to 6 weeks, 504 to 1008 hours, similar to the treated best case scenario.

During Clinical Phase III, a splint can be improvised with on board supplies, but there are no analgesics to treat pain. FI is estimated at 2-34%. EVAC is estimated in 0-100%. LOCL is not expected.

**Treatment and Options Level of Evidence (LOE)**

The IMM level of evidence appropriate assessment of the quality of the IMM input data. Since IMM incorporates input data from a wide variety of sources including astronaut population, terrestrial or analog populations, and external models, an innovative approach to assess the quality of input data was required. Information obtained from the astronaut population and/or space flight is the more relevant so it is assigned the highest level of evidence and less relevant data sources are assigned a lower level of evidence.

| Citation | LOE Value | LOE Category |
|---|---|---|
| American Medical Association, 2008 | 3 | FI |
| American Medical Association, 2008 | 3 | FI |
| Johnston, 2008 | 2 | EVAC |
| Matheson, 1987 | 4 | EVAC |
| Arendt, 2003 | 4 | BCWC |

### Additional Comments

**Risk Factors**: Important risk factors for developing stress fractures include a history of prior stress fracture, low level of physical fitness, increasing volume and intensity of physical activity, female gender and menstrual irregularity, diet poor in calcium, poor bone health, and poor biomechanics (deWeber, 2012). Most of which are not really a concern in the Astronaut Corps due to the extensive selection criteria and the training they receive.

### The Resource Table (RT)

| Resource | Units Required Best Case | Units Required Worst Case | Units Available At Start Of Mission | Consumable | Essential | Rationale |
|---|---|---|---|---|---|---|
| Ace bandage 2 inches | 1 | 1 | 1 | No | Yes | For immobilization |
| Ace bandage 3 inches | 1 | 1 | 1 | No | Yes | Elastic bandage (also known as an ACE bandage, elastic wrap or compression bandage) is a "stretchable bandage used to create localized pressure |
| Ace bandage 4 inches | 1 | 1 | 1 | No | Yes | To accommodate length of lower extremity. Given that only one 3" and one 4" ACE bandage are present in the med kit, this condition will require one of each. |
| Hot and Cold Pad | 1 | 1 | 1 | No | No | to reduce inflammation and pain relief on injured extremity |
| Motrin (Ibuprofen) 400mg | 8 | 16 | 500 | Yes | Yes | Pain Management |
| SAM splint - Leg/Arm Splint | 0 | 1 | 1 | No | Yes | to immobilize affected area |
| Toradol (Ketorolac) 30mg/mL, 2mL single dose vial | 0 | 16 | 3 | Yes | Yes | For pain and inflammation |
| Ultrasound gel | 2 | 2 | 17 | Yes | Yes | conductive medium applied to the skin, where the US transducer will be placed |
| Ultrasound machine | 1 | 1 | 1 | No | Yes | diagnosis and evaluation of stress fracture |
| Vicodin HP (Hydrocodone/ Acetaminophen HP) 10 mg/660 mg | 0 | 16 | 30 | Yes | Yes | Pain Relief |

**Resource Comments**

ISS medical checklist includes procedures for extremity splinting, pain relief, and Hot and Cold pack. All resources listed are available on board. (Mission Operations Directorate (MOD), 2011)

**Comparison between the Med Checklist and Urban treatment guidelines**

We did not find terrestrial guidelines for stress fractures. We are referring to the American Association of Orthopaedic Surgeons' (AAOS) standards of care (American Academy of Orthopaedic Surgeons, 2009) and an orthopedic treatment protocol (Zwas, 1987).

The ISS Checklist main focus is emergency immobilization of the joint and pain relief. Terrestrially both Orthopedic protocol and AAOS recommend rest and pain relief as needed. Patients would be referred to surgical treatment in case of complicated or severe stress fracture. A cast may be applied to keep bones in a fixed position and to remove the stress on the involved leg. Casts are a type of external fixation. Some stress fractures require surgery for internal fixation to heal properly. In most cases, this involves supporting the bones by inserting a type of fastener. Pins, screws, and/or plates are most often used to hold the small bones of the foot and ankle together during the healing process. Stress fractures in the fifth metatarsal bone or in the navicular or talus bones take longer to heal.

**Required Resources Level of Evidence (LOE)**

The IMM level of evidence appropriate assessment of the quality of the IMM input data. Since IMM incorporates input data from a wide variety of sources including astronaut population, terrestrial or analog populations, and external models, an innovative approach to assess the quality of input data was required. Information obtained from the astronaut population and/or space flight is the more relevant so it is assigned the highest level of evidence and less relevant data sources are assigned a lower level of evidence.

| Citation | LOE Value | LOE Category |
|---|---|---|
| NASA Mission Operations Directorate (MOD), 2011 | 2 | Resources |

## Level Of Evidence

| Input Data | LOE Average |
| --- | --- |
| Incidence | 2.66666666666667 |
| Functional Impairment | 3 |
| Best Case / Worst Case | 4 |
| EVAC / LOCL | 3 |
| Resources | 2 |
| **QUALITY OF EVIDENCE** | **2.93333333333333** |

| Description | Range |
| --- | --- |
| Excellent | 1-2 |
| Good | 2.1-3 |
| Fair | 3.1-4 |
| Poor | 4.1-5 |

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