MEMORANDUM FOR SGOZ
ATTN: CAPT NATHANIEL S NYE

FROM: 59 MDW/SGVU

SUBJECT: Professional Presentation Approval

1. Your paper, entitled Improving Stress Fractures Diagnosis: Algorithm and Clinical Prediction Rule presented at American Medical Society for Sports Medicine, Texas, 16-20 April 2016 with MDWI 41-108, and has been assigned local file #16150.

2. Pertinent biographic information (name of author(s), title, etc.) has been entered into our computer file. Please advise us (by phone or mail) that your presentation was given. At that time, we will need the date (month, day and year) along with the location of your presentation. It is important to update this information so that we can provide quality support for you, your department, and the Medical Center commander. This information is used to document the scholarly activities of our professional staff and students, which is an essential component of Wilford Hall Ambulatory Surgical Center (WHASC) internship and residency programs.

3. Please know that if you are a Graduate Health Sciences Education student and your department has told you they cannot fund your publication, the 59th Clinical Research Division may pay for your basic journal publishing charges (to include costs for tables and black and white photos). We cannot pay for reprints. If you are 59 MDW staff member, we can forward your request for funds to the designated wing POC.

4. Congratulations, and thank you for your efforts and time. Your contributions are vital to the medical mission. We look forward to assisting you in your future publication/presentation efforts.

LINDA STEEL-GOODWIN, Col, USAF, BSC
Director, Clinical Investigations & Research Support

Warrior Medics – Mission Ready – Patient Focused
Evaluating an Algorithm and Clinical Prediction Rule to Improve Diagnostic Accuracy and Management of Pelvic and Lower Extremity Bone

Improving Stress Fracture Diagnosis: Algorithm and Clinical Prediction Rule

10. IS THIS MATERIAL SUBJECT TO ANY LEGAL RESTRICTIONS FOR PUBLICATION OR PRESENTATION THROUGH A COLLABORATIVE RESEARCH AND DEVELOPMENT AGREEMENT (CRADA), MATERIAL TRANSFER AGREEMENT (MTA), INTELLECTUAL PROPERTY RIGHTS AGREEMENT ETC.? 

NOTE: If the answer is YES then attach a copy of the Agreement to the Publications/Presentations Request Form.

11d. PLATFORM PRESENTATION (At civilian institutions: name of meeting, state, and date of meeting.)
American Medical Society for Sports Medicine, Texas, 16-20 April 2016

12. EXPECTED DATE WHEN YOU WILL NEED THE CRD TO SUBMIT YOUR CLEARED PRESENTATION/PUBLICATION TO DTIC.

NOTE: All publications/presentations are required to be placed in the Defense Technical Information Center (DTIC).

DATE
April 13, 2016

13. 59 MDW PRIMARY POINT OF CONTACT (Last Name, First Name, M.I., email)
Nye, Nathaniel S. (nathaniel.nye.1@us.af.mil)

14. DUTY PHONE/PAGER NUMBER
671-4087

15. AUTHORSHIP AND CO-AUTHOR(S) List in the order they will appear in the manuscript.

<table>
<thead>
<tr>
<th>LAST NAME, FIRST NAME AND M.I.</th>
<th>GRADE/RANK</th>
<th>SQUADRON/GROUP/OFFICE SYMBOL</th>
<th>INSTITUTION (If not 59 MDW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nathaniel S.</td>
<td>O-3</td>
<td>559 THLS/559 MDG/SGOZ</td>
<td>Nellis AFB</td>
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<tr>
<td>Mary T.</td>
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<td>559 THLS/559 MDG/SGOZ</td>
<td>USUHS</td>
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<tr>
<td>Carl J.</td>
<td>O-4</td>
<td></td>
<td>The Orthopaedic Center</td>
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<tr>
<td>Bryant J.</td>
<td>O-3</td>
<td>559 THLS/559 MDG/SGOZ</td>
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<tr>
<td>Anthony I.</td>
<td>O-5</td>
<td></td>
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<tr>
<td>Barry P.</td>
<td>N/A</td>
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</table>

I CERTIFY ANY HUMAN OR ANIMAL RESEARCH RELATED STUDIES WERE APPROVED AND PERFORMED IN STRICT ACCORDANCE WITH 32 CFR 219, AFMAN 40-401 IP, AND 59 MDW 41-108. I HAVE READ THE FINAL VERSION OF THE ATTACHED MATERIAL AND CERTIFY THAT IT IS AN ACCURATE MANUSCRIPT FOR PUBLICATION AND/OR PRESENTATION.

16. AUTHOR'S PRINTED NAME, RANK, GRADE
Nathaniel Nye, Capt, O-3

19. APPROVING AUTHORITY'S PRINTED NAME, RANK, TITLE
Asha Mandhare, Maj, 559 THS Flight Commander

17. AUTHOR'S SIGNATURE
Nye, Nathaniel S. 1244411682

18. DATE
March 30, 2016

20. APPROVING AUTHORITY'S SIGNATURE
Mandhare, Asha K. 1120419763

21. DATE
March 30, 2016
The presentation is approved.

Please add Disclaimers to presentations, both the Word Document and P0werpoint presentation. Once added, presentation is approved.

"The views expressed are those of the [author(s)] [presenter(s)] and do not reflect the official views or policy of the Department of Defense or its Components"
IMPROVING STRESS FRACTURE DIAGNOSIS:  
Algorithm and Clinical Prediction Rule

Nye NS, Pawlak MT, Covey CJ, Webber BJ, Buehler AI, Boden BP

155th Medical Group, JBSA-Lackland, TX 78236
2Uniformed Services University, Bethesda, MD 20814
3The Orthopaedic Center, Rockville, MD 20850

Keep the Pipeline Flowing
Disclaimer

- No financial relationships
- The views expressed are those of the authors and do not reflect the official views or policy of the Department of Defense or its Components
Stress Fractures in Air Force BMT

Strengthening the Foundation of Warrior Health

- FY2012-2014: 1,218 stress fx
  - Approximately 400 cases per year
- FY14:
  - 459 Stress fractures
  - 414 had a bone scan
    - Only 25 had MRI
  - 1071 bone scans ordered → 38.7% positive rate
  - Of 414 positive bone scans:
    - 5.8% were negative in symptomatic location, but positive in asymptomatic location
    - 21% of MRI’s performed average of 6 days later were negative

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Developed Algorithm & CPR

Strengthening the Foundation of Warrior Health

• ACR: x-rays indicated as first line imaging in all cases
• MRI more sensitive and specific than bone scan
• Developed threshold to begin a workup
• Incorporates 1 wk of “triage by time” before advanced imaging


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Diagnosis and initial management of bone stress injury (BSI) in Trainee Health

BSI Score ≥4 including ≥1 exam finding?

Yes

Consider imaging and treatment according to suspected differential diagnosis; follow up in ≤7 days if pain persists.

No

1. Order x-rays
2. Restrict impact activities (TDR)
3. Give crutches /NWB if walking painful OR suspected HRSI
4. If suspected HRSI AND walking painful or antalgic, obtain MRI ASAP (prefer ≤72 hrs). Bone scan may be used if suspect multiple fx
5. Avoid NSAIDs

BSI SCORE:

Risk Factors (1 pt each):
- Poor baseline aerobic fitness (>14:00 on OWOT 1.5-mile run)
- Female gender
- ≥2 missed periods in last 6 months
- Prior stress fracture
- Known vitamin D deficiency
- Eating disorder or caloric insufficiency
- Pes cavus (high arches)

Symptoms (1 pt each):
- Gradual onset pain (atraumatic)
- Pain worsens during activity
- Mostly dull, aching pain
- Recent increase in activity
- Night pain

Exam (1 pt each):
- Bone focially tender to palpation
- Pain with hip int. rotation (suspected femoral neck injury)
- Painful hop test (caution if suspected fem. neck stress injury)
- Painful fulcrum test
- Painful tuning fork test
- Antalgic gait

High risk:
- Femoral neck,
- Anterior cortex tibia,
- Medial malleolus,
- Navicular, talus,
- Proximal 2nd or 5th metatarsal, patella, great toe sesamoids

Low risk:
- Pubic rami, sacrum, femoral shaft, tibial plateau, posteromedial tibial shaft, fibula, 2nd-4th metatarsal shaft, calcaneus

1. Continue/initiate NWB if walking painful OR HRSI
2. If femoral neck, same-day VIPER referral
3. All others, VIPER referral within 2 duty days

Yes

Imaging positive for BSI? (MRI findings on any sequence)

1. Follow up in ≤7 days
2. If BSI Score still ≥4 including ≥1 exam finding, repeat x-rays and order MRI if not already done

Alternative pathology identified?

No

Yes

MRI positive for BSI on any sequence?

Yes

Continued clinical concern for BSI?

No

Treat alternative pathology if identified; May refer to VIPER or return to training with follow up as needed
Diagnosis and initial management of bone stress injury (BSI) in Trainee Health

**BSI SCORE:**

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- Pain with hip int. rotation (suspected femoral neck injury)
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- Painful fulcrum test
- Painful tuning fork test
- Antalgic gait
Validating clinical prediction rule: Methods

Strengthening the Foundation of Warrior Health

- All patients evaluated with BSI score
- Outcome of interest: ICD-10 code for stress fx
  - >30 days follow up
- A BSI score ≥4 with ≥1 positive physical exam finding established the threshold to begin diagnostic evaluation and activity restriction
- Test characteristics for various BSI score cutoffs were calculated

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Results

132 diagnosed with a stress fracture

BSI score cutoff of ≥4+PE yielded
- 84.9% sensitivity (95% CI: 77.3-90.3)
- 43.0% specificity (95% CI: 38.1-48.1)
- 89.5% negative predictive value (NPV) (95% CI: 84.0-93.3)
- 1.49 positive likelihood ratio (LR+) (95% CI: 1.33-1.67)

A BSI score cutoff of ≥3+PE did not increase NPV

A BSI score of ≥7+PE was more specific (78.5%, 95% CI: 74.0-82.4) and had LR+ of 2.28 (95% CI: 1.77-2.96).
Frequency of bone stress injury score in USAF recruits with and without stress fracture diagnosis

Strengthening the Foundation of Warrior Health

![Chart showing bone stress injury score frequency with and without stress fracture](chart.png)
# Validation of bone stress injury score to predict clinical diagnosis of stress fracture

**Strengthening the Foundation of Warrior Health**

<table>
<thead>
<tr>
<th>BSI score cut-off (% at or above cut-off)</th>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
<th>PPV, %</th>
<th>NPV, %</th>
<th>LL+</th>
<th>LL-</th>
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</thead>
<tbody>
<tr>
<td>BSI ≥3 and positive physical exam (68)</td>
<td>86</td>
<td>38</td>
<td>32</td>
<td>89</td>
<td>1.4</td>
<td>0.37</td>
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<tr>
<td>BSI ≥4 and positive physical exam (64)</td>
<td>85</td>
<td>43</td>
<td>33</td>
<td>89</td>
<td>1.5</td>
<td>0.35</td>
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<tr>
<td>BSI ≥5 and positive physical exam (55)</td>
<td>79</td>
<td>53</td>
<td>36</td>
<td>88</td>
<td>1.7</td>
<td>0.4</td>
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<tr>
<td>BSI ≥6 and positive physical exam (42)</td>
<td>62</td>
<td>65</td>
<td>37</td>
<td>84</td>
<td>1.8</td>
<td>0.58</td>
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<tr>
<td>BSI ≥7 and positive physical exam (28)</td>
<td>49</td>
<td>78</td>
<td>43</td>
<td>82</td>
<td>2.2</td>
<td>0.65</td>
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Discussion

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- A score threshold of $\geq 4 + PE$ provided an effective screen
- Subthreshold scores ruled out stress fractures quite accurately in this population
- A score of $\geq 7 + PE$ showed utility for ruling in stress fracture.
- The algorithm and BSI score provide useful guides for clinical decision-making
- Do they reduce unnecessary testing or surveillance bias?

Keep the Pipeline Flowing
<table>
<thead>
<tr>
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<th>FY 2014</th>
<th>FY 2015</th>
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<tr>
<td>Number of stress fractures</td>
<td>459</td>
<td>362</td>
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<tr>
<td>Bone scans ordered (% positive)</td>
<td>1071 (38.9)</td>
<td>86 (97.7)</td>
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<tr>
<td>X-ray + bone scan</td>
<td>325</td>
<td>75</td>
</tr>
<tr>
<td>X-ray + MRI</td>
<td>25</td>
<td>205</td>
</tr>
<tr>
<td>X-ray + bone scan + MRI</td>
<td>85</td>
<td>18</td>
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<tr>
<td>X-ray only</td>
<td>20</td>
<td>80</td>
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Keep the Pipeline Flowing
• SCREENING STUDY
• STIR & T1
• Both in 2 orthogonal planes
• Reduces scan time from 50-60 to 15 minutes
• Not recommended after another screening study (fast MRI, bone scan)
References

Strengthening the Foundation of Warrior Health


1. Title:
Evaluating an Algorithm and Clinical Prediction Rule to Improve Diagnostic Accuracy and Management of Pelvic and Lower Extremity Bone Stress Injuries

FWH#:

2.0. Principal Investigator (PI):  
<table>
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<tr>
<th>Name</th>
<th>WHASC PI:</th>
<th>Co-PI:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nathaniel Nye</td>
<td>Carlton Covey</td>
<td></td>
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<tr>
<td>Capt/MC</td>
<td>Maj/MC</td>
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Date of IRB Approved CITI Training: 12/13/14  
Branch of Service: USAF  
AD Mil/DoD Civilian/Ctr/Non-DoD Civ: AD  
Department & Base: Trainee Health Surveillance, JBSA-Lackland  
Phone & Pager #: (614) 598-9258  
E-Mail Address: Nathaniel.nye.1@us.af.mil

2.1. Associate Investigators (AIs): None

2.2. Research Assistants (RA) & Coordinators (RCs):

<table>
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<th>Name</th>
<th>AD/DoD Civ/Ctr/Non-DoD Civ</th>
<th>Rank/Corps or Civilian Rating/Title</th>
<th>Date of CITI Training</th>
<th>Phone &amp; Pager #</th>
</tr>
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<tbody>
<tr>
<td>Jill Clark, MBA/HCM, CCRC</td>
<td>CTR</td>
<td>Clinical Research Manager</td>
<td>03/20/14</td>
<td>(702) 653-3298</td>
</tr>
</tbody>
</table>

2.3. The research relevance of this protocol focuses on: [x] Diagnosis [x] Treatment [x] Medical Utilization/Managed Care  
[ ] Prevention  [ ] Medical Readiness  [ ] Other

2.4. Location(s):
   a. Collaborating Facilities: N/A
   b. Air Force Sites seeking Regional IRB: Jill Clark, (702) 653-3298
   c. List study sponsors: N/A

3. Exempt Category: This protocol fits the following Exempt Category:

3.3. Category 32 CFR 219.101(b)(4): This research involves the collection or study of:
   1) existing data,
   2) existing documents,
   3) existing records,

The information will be recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects (e.g., codes).

4.0. Research Plan:

4.1. Purpose: The purpose of this study is to validate a novel clinical prediction rule as part of a diagnostic and initial treatment algorithm for lower extremity stress injuries.

4.2. Hypotheses, Research Questions or Objectives: In patients that present with lower extremity pain, what bone stress injury (BSI) score range correlates with high risk (and low risk) for having a lower extremity stress injury? Our hypothesis is that a BSI score ≥4 (with ≥1 exam finding) will provide a satisfactory threshold for designation of low and high risk groups.
4.3. Significance: Stress fracture incidence among military recruits (43.8 per 1000 person-years) is 18 times higher than among active component service members (2.4 per 1,000 person-years). Lower extremity stress fractures significantly impair military readiness in terms of medical costs, lost training time, medical attrition during training, and early medical discharge. The total cost of all stress fractures in Air Force Basic Military Training in 2009 was over 4.8 million dollars. At this time there is no published clinical prediction rule for the diagnosis and initial management of bone stress injuries. The purpose of this study is to validate the clinical prediction rule as part of the diagnostic/treatment algorithm.

4.4. Military Relevance: A validated clinical prediction rule has the possibility decreasing unnecessary imaging, medical and nonmedical costs, attrition due to stress fracture, and time away from training. It also will help providers with less robust clinical musculoskeletal background to properly diagnose and initially manage patients with bone stress injuries.

4.5. Background and Review of Literature: Stress fractures are common among trainees and present a fiscal and readiness challenge in all branches of the U.S. military. The cumulative incidence of lower extremity stress fractures during entry-level military training ranges from 0.8% to 6.9% for males and 3.4% to 21.0% for females, with the tibia being the prominent site. At Joint Base San Antonio-Lackland, site of all Basic Military Training, the incidence of stress fractures increased 56% from fiscal year 2012 to 2014. This led many of the providers in the Traine Health Clinic to have an increased index of suspicion of stress fractures, which led to many bone scans being ordered to evaluate suspected stress injuries; even in patients that had low risk for stress injury. Many of the bone scans showed positive findings in asymptomatic areas needing further work up and time lost from training. This apparent surveillance bias and overdiagnosis rate associated with bone scans suggested the need for a standardized diagnostic algorithm that all Trainee Health Clinic providers can use. The initial part of any good algorithm is proper patient selection. At this time there is no clinical prediction rule in the literature for diagnosing significant bone stress injuries. We developed the bone stress injury (BSI) score to help identify moderate to high-risk individuals to help expedite the workup of bone stress injury. The BSI, and corresponding algorithm, also will identify low risk individuals that may not need full radiographic workup and time away from training. Proper identification of each of these cohorts can help guide early and proper treatment for those who need it to prevent catastrophic injury as well as return all trainees to duty as soon as possible. Models for predicting rehabilitation time and return date, which have been described in the context of collegiate and professional sports, would likely have a profound impact on military readiness if found to be applicable in military training environments. Recent literature has confirmed that MRI is the most sensitive and specific modality to diagnose significant bone stress injuries. Plain radiographs are highly specific (88-96%) but poorly sensitive (12-56%). Bone scans are highly sensitive but has limited specificity for stress fractures since tumor, infection, inflammation, or trauma can all cause increase in radiotracer uptake. Many existing algorithms for evaluation and treatment of stress fractures do not contain clinical prediction rules and/or rely primarily upon bone scan. This is the impetus for our initial study of choice (after plain radiographs) to be MRI to evaluate potential significant bone stress injury.

4.5.1. Bibliography:


4.6. Research Design and Methods: A total of 500 (250 male and 250 female) USAF basic military trainees and technical training students who have completed the BSI score will be selected. All data will be gathered and de-identified by Juste Tchandja, PhD, MPH, and sent to the Principal Investigators for analysis.
The care provided to patients enrolled and data collected for this study do not deviate from usual care/usual data collection according to written policy of the 559th Medical Group. The study design is a retrospective analysis of an existing data set. Because individuals become eligible for inclusion in the data set at the time of presentation for medical care, prospective cohort statistical measures will be employed for analysis.

Medical providers at the Trainee Health Clinic are intermittently given refresher training on the stress injury diagnostic algorithm (attachment 1), and reminded of the importance of completeness of records, accurate BSI score calculation, and precisely following the algorithm. They will be reminded that medical judgment cannot always be clearly dictated by an algorithm, however, and that sound judgment may require deviation from the algorithm. Cases that deviated from the algorithm at the level of the clinical prediction rule will be excluded from the main analysis and analyzed separately.

Per written 559th policy, patients presenting to the Trainee Health Reid Clinic complaining of lower extremity pain are administered a simple questionnaire regarding BSI risk factors and symptoms by the medical technician (attachment 2). The provider reviews the questionnaire, obtains additional history and performs the appropriate physical exam, and then fills the patient's relevant findings into the template that is copied into AHTLA. This process was put into place early in 2015 in order to standardize the evaluation and workup of lower extremity pain among trainees.

Since 2013, a stress fracture registry has been maintained by the Trainee Health Surveillance Flight at JBSA-Lackland, in accordance with DoD 6490.002E “Comprehensive Health Surveillance,” AFI 48-105 “Surveillance, Prevention, and Control of Disease and Conditions of Public Health or Military Significance,” and AETC 48-103 “Training Health and Human Performance Program” (specifically para 3.5.3.2.1). The registry captures all basic military trainees and technical training students at JBSA-Lackland who are diagnosed with a stress fracture. This registry includes demographic data, date of diagnosis, imaging modalities used, location of symptoms, concordance/discordance of imaging with symptoms, presence of a fracture line, incidence of displaced fracture, cases referred to orthopedics, and cases requiring surgery.

4.6.1. Interventions, Observations, or Data Sought: Definition of the primary outcome of interest is any ICD-9-CM code for stress fracture or stress reaction of the lower extremity, to include pelvis and sacrum, but excluding lumbar spine, torso, and upper extremities. Incident cases identified will have charts reviewed (per routine procedure for stress fracture registry) by the research team for secondary outcomes of interest. These include the presence of a fracture line (as reported by radiologist on MRI or x-ray, excluding acute fractures), any displaced stress fracture reported by the radiologist, and attrition for stress fracture (verified through Basic Training Management System). Chart review will also verify that the imaging findings correlate with the location of the patient's symptoms. If the imaging findings are separated from the patient's symptoms by two or more long bones (i.e., femur and tibia, such as when symptoms are located in hip region but imaging positive in the ankle or foot) or are in the contralateral extremity, and the patient did not have symptoms or exam findings in the location indicated on imaging, then the imaging findings will be considered discordant and not counted as an outcome of interest.

To further clarify, the radiologist must report bone marrow edema on any sequence of the MRI to meet our definition of an outcome of interest; periosteal edema alone does not meet our definition of an outcome of interest. If the radiologist does not specify what findings he/she is considering a stress injury, the images will be reviewed by another radiologist to confirm whether bone marrow edema is present (in most cases, this will be LT Col Sheldon). An outcome of interest also includes any focal uptake on bone scan which is described by the radiologist as a possible stress fracture, stress injury, or "stress change," not to include diffuse uptake described as "shin splints" or "thigh splints".

Patients who present to the clinic more than once with lower extremity pain will be administered a BSI questionnaire at each visit. For purposes of this investigation, their charts will be followed for 3 months from the time of their first encounter for lower extremity pain. For patients who have had multiple BSI scores calculated, we will use the most recent score prior to diagnosis for analysis.

4.6.2. Data Collection and Processing: A log will be kept by each medical technician including each patient who presents with lower extremity pain and is administered a BSI questionnaire. On a weekly basis, these logs will be turned into the Trainee Health Surveillance epidemiologist, Juste Tchandja, PhD, MPH, who maintains the stress fracture registry. At the conclusion of the study, all personally identifying information will be removed prior to sending to the Principal Investigators.
4.6.3. Setting: JBSA-Lackland, Texas

4.6.4. Date(s): July 2015 – July 2016

4.6.5. Source of Research Material:

<table>
<thead>
<tr>
<th>Source of Research Material per Participant (Procedures)</th>
<th># Routine Care</th>
<th># Research Driven</th>
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<td>Stress Fracture Registry</td>
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Only records or database entries in existence at the time of study approval will be examined in this study. All data will be recorded by the investigator in such a manner that subjects cannot be identified directly or through identifiers or codes linked to the subjects.

4.6.6. Subjects: Air Force basic military trainees and technical training students at JBSA-Lackland

4.6.7. Inclusion/Exclusion Criteria:
Inclusion: Air Force basic military trainees and technical training students at JBSA-Lackland who present to the Trainee Health Reid Clinic with lower extremity pain and who complete the BSI

Exclusion: No exclusion criteria will be applied. (Of note, all females are administered a pregnancy test upon arrival and all patients with positive pregnancy test are promptly discharged home for civilian medical care).

4.6.8. Instrumentation: N/A

5.0. Human Subject Protection:

5.1. Recruitment and Consent Processes: Approximately 500 (250 male and 250 female) trainees at JBSA-Lackland presenting to the Trainee Health Clinic with lower extremity pain will be selected from their existing medical record. All information obtained by the Principal Investigators will be de-identified. Informed Consent will not be sought from research participants because the research could not practically be carried out if consent was obtained, waiver of consent would not adversely affect the rights and welfare of the subjects and the research involves no more than minimal risk to subjects.

5.2. Benefits: This study may have no direct benefit to participants, however it may benefit future military Trainees by preventing unnecessary radiographic imaging and allowing return to training faster, with or without a bone stress injury

5.3. Risks: There is a risk of inadvertent breach of confidentiality.

5.4. Safeguards for Protecting Information: Data collected will be de-identified prior to review and analysis by the investigator. It will be kept on a government computer assigned to the PI. The computer is password and CAC protected, and the system is firewall protected. There are no planned linkages with external databases, nor is transmission of the data for collaborative use anticipated. Following completion of the study the data will be stored and destroyed in compliance with policies implemented by the WHMC IRB.

6.1. Outcome Measures:
- Demographic data: age (at first encounter) and sex
- Independent variable: BSI score
- Primary dependent (outcome) variable: pelvic or lower extremity stress fracture within 3 months of initial BSI, as determined by ICD-9-CM codes of 733.14-.16, 733.93-94, or 733.96-98
- Secondary dependent (outcome) variables:
  1) Fracture line reported by radiologist on MRI or x-ray, excluding acute fractures
  2) Displaced stress fracture
  3) Attrition for stress fracture
- Potential confounding variables:
  1) Time from initial encounter to a primary and/or secondary outcome of interest
  2) Number of medical encounters for lower extremity pain (excluding administrative and physical therapy visits)
6.2. Sample size estimation/power analysis: We previously found that approximately 10% (565/5785) of trainees who presented to the Trainee Health Reid Clinic with lower extremity pain or inflammation over a two-year period were diagnosed with a stress injury (J Athletic Training, in press). We anticipate that trainees who present to clinic with lower extremity pain or inflammation and have a low BSI score (0-3 and any who lack exam findings) will have a lower rate of being diagnosed with stress injury (≤10%), whereas those with high scores (≥4 including ≥1 exam finding) will have a higher rate of being diagnosed with stress injury (≥25%). Assuming a 1:1 ratio between those with “low” and “high” BSI scores, we would require 200 subjects to have 80% power to detect this 15% risk difference at the alpha = 0.05 level. It may be more likely, however, that more trainees will score in the “low” category. Assuming a 3:1 ratio between those with “low” and “high” BSI scores, we would require approximately 250 subjects (62 with low scores and 184 with high scores) to have 80% power to detect this 15% risk difference at the alpha = 0.05 level. We would also like to analyze the clinical prediction rule by sex, so we would like to have enough males and females to stratify by sex, so we will anticipate requiring 500 total subjects (250 males and 250 females) in order to have adequate power to analyze the BSI clinical prediction rule. If current rates of presentation continue, we anticipate having these numbers in 2-3 months.

6.3. Statistical Analysis: Distribution of BSI scores (frequency, one score per patient), and rate and relative risk of stress fracture diagnosis associated with each BSI score will be calculated. To determine the most appropriate number of points (weight) assigned to each element of the BSI score (each is a binary variable which indicates a clinical finding being either present or absent), beta coefficients for each variable in the score will be calculated. Variables with a significantly higher beta coefficient will be assigned 2 or more points, whereas if all variables have a similar beta coefficient (difference less than 5), all variables will be assigned one possible point. Receiver-operator characteristic (ROC) curves will be used to determine the BSI score which provides optimum sensitivity and specificity. Rates and relative risks of secondary outcomes associated with each BSI score will also be calculated. Again, we believe (based on expert opinion only) that a BSI score of ≥4, including ≥1 exam finding, will be the best cut point, and therefore the sample size calculation is based on this.

6.4 Number of Subjects:

<table>
<thead>
<tr>
<th>Number of subjects planned for JBSA</th>
<th>Enrolled in Study</th>
<th>500</th>
<th>to result in</th>
<th>500</th>
<th>completing study</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL NUMBER OF SUBJECTS (nation-wide/study-wide): 500</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

7. Duration of Study: Approximate duration of the study: 1 year
8. Local and External Support Services: None
9. Intramural (GME) and Extramural Funding Support: None
10. Conflict of Interest: None

11. Medical Research Area for the Study:

- Analytical Chemistry
- Cardiovascular Surgery
- Dermatology
- Emergency Medicine
- Histology
- Molecular Biology
- Nursing
- Oncology
- Pathology
- Mental Health
- Other (state): [ ] Radiology/Imaging
- [X] Urology
- [ ] Biochemistry
- [ ] Anatomy
- [ ] Cardiology
- [ ] Dietetics
- [ ] Gastroenterology
- [ ] Immunology/Allergy
- [ ] Neonatology
- [ ] OB/GYN
- [ ] Ophthalmology
- [ ] Pediatrics
- [ ] Neurology
- [ ] Neurosurgery
- [ ] Occupational Medicine
- [ ] Oral/Maxillofacial Surgery
- [X] Orthopedics
- [ ] Pharmacology
- [ ] Physical Therapy
- [ ] Urology
- [ ] Wellness

12. Attachments:
1. BSI AHILTA Template
2. BSI Questionnaire
3. Stress Fracture Algorithm
4. Form F: Waiver of Informed Consent
5. Form I: De-identification certification
6. Form J: HIPAA Authorization Waiver
7. Form A: Signature Form

Version: 1 Dec 2012
Protocol for Clinical Investigation - Exempt