The primary purpose of this peer-reviewed journal is to provide a formal publication option for research completed by MSUCOM students, residents and faculty. SMRJ's mission is to advance medicine and medical education through the timely publication of peer-reviewed clinically-oriented research, clinically-relevant basic science research, healthcare quality research, and medical education research from MSUCOM and the osteopathic medicine community, with the ultimate goal of improving patient care and the education of patients and care providers. SMRJ is the official scholarly publication of the Statewide Campus System (SCS) of MSUCOM. It provides a forum for communicating research findings, clinical practice observations, philosophic concepts, and other biomedical and medical education advances to MSUCOM medical students, residents, fellows and faculty, and any other interested readers.

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I’m very proud to present this inaugural edition of the Spartan Medical Research Journal. It is a part of Michigan State University’s core purpose as a land-grant institution to conduct research that benefits people across the state of Michigan and beyond, and we fully support that mission through entities like the Statewide Campus System and initiatives like this publication.

This journal is a manifestation of the MSU College of Osteopathic Medicine’s commitment to providing osteopathic medical students, residents, faculty members, alumni and other medical investigators with a high-quality, peer reviewed publication that will further our knowledge on key topics related to improving human health and life. The Statewide Campus System is an outstanding vehicle for supporting individuals who want to build on their abilities to examine important issues in health and well-being and its faculty and staff are committed to facilitating studies like those presented here.

Just as osteopathic medicine does not focus on one aspect of the body, the MSU College of Osteopathic Medicine is not focused on one aspect of learning. Enabling doctors – and future doctors -- to hone their research skills is an important part of the educational process and the science of medicine and we fully support the work that is presented in this publication.

I congratulate all of the authors whose diligence and hard work are showcased in this issue of the Spartan Medical Research Journal. The topics that are addressed in this issue are outstanding examples of scholarship that is furthering our knowledge on important issues in medicine and health care. From original research papers to brief reports to case studies, the variety and subject matter contained in this first edition give me great hope for the future of this publication—and for the future of osteopathic medicine.

Sincere thanks to the faculty and staff members in the MSU College of Osteopathic Medicine’s Statewide Campus System for their efforts to produce an outstanding new outlet for scientific investigations at Michigan State University.

William Strampel, DO
Dean, MSU College of Osteopathic Medicine
Welcome to Our First Issue

Welcome to the first issue of the Spartan Medical Research Journal, or SMRJ as it says in or web address. As noted inside the cover of this issue, the purpose of this online peer-reviewed journal is to provide a convenient, formal publication option for research produced by Michigan State University COM students, residents, fellows and faculty. And, as illustrated by the article on page 65 of this issue, we will accept submissions from outside MSUCOM. This journal is the scholarly publication of the MSUCOM Statewide Campus System, staffed by SCS personnel.

Naturally, a venture such as this does not get very far without the help of a large number of people, most especially our panel of reviewers. Many thanks to those who reviewed these initial manuscripts. We are still recruiting reviewers from all medical specialty areas to be members of the Editorial Board. If you have an interest in participating as a reviewer, please contact the Chief Editor.

It has been three years since I wrote the first formal proposal for the establishment of this journal, and I have been acting as the Chief Editor during this development phase. During this period I have formulated the policies, procedures and format for SMRJ, based on a great deal of investigation into established journal protocols, such as the Uniform Requirements of the International Committee of Medical Journal Editors. From the beginning the intent has been to have a publication that follows the practices and procedures of a high quality journal.

Now that this endeavor has finally come to fruition, it is time for me to step aside and turn the reins over to a new Chief Editor, as I enter into retirement. Having returned a few years ago to medical education at MSU, where I began my professional career 45 years ago, it is time to move on to the next phase of my life. Your new Chief Editor will be William Corser, PhD, RN. Best wishes to him and the rest of the SMRJ staff. If you have comments or suggestions, please contact Dr. Corser; we do accept Letters to the Editor.

Please enjoy this first issue.

Cheers!

Eric D. Zemper, PhD, FACSM
Chief Editor
From the SCS Director

Scholarly activity is critical for the continual improvement of clinical care, and the Statewide Campus System of MSUCOM is committed to research and scholarly activity as an integrating focus of its educational programs. SCS has emphasized research with the provision for financial aid for residents’ original research, the establishment of the SCS Annual Research Day, the Research Training Course, the Teach for Quality Fellowship for Faculty, and research consultation for faculty and residents. The next step is the publishing of an electronic journal for the dissemination of research by faculty, residents, and students. This journal provides a forum for research across the SCS but also invites submissions from outside the SCS to encourage the publication of scholarly activity.

The Statewide Campus System is a consortium of community based training institutions affiliated with the MSU College of Osteopathic Medicine. As a part of a major research intensive university, scholarly activity is integral to our identity. The SCS juxtaposes the strengths of a research intensive university with quality community-based care. Our training unashamedly focuses on the preparation of health providers who will serve in the community-based setting and improve that standard of care as reflective practitioners. The Spartan Medical Research Journal demonstrates that valid and vital research can occur in the community-based setting and provide an important contribution to the greater scholarly dialogue across the health professions.

As you examine the contents of this first edition, you will find original research, brief reports and case reports. The content of this issue deals not only with clinical care but systems based research for the quality improvement of care. Medical education research for the improvement of training of future physicians gives new perspective in making residency training more effective.

We continue to grow our emphasis on scholarly activity and the dissemination of research for faculty, residents, and students. We hope that you will find this research journal helpful in the improvement of your practice and the delivery of training at your site. We also hope that you will participate in this scholarly dialogue by volunteering as an editor or a contributor for future editions.

We dedicate the first edition to Eric Zemper, PhD. Eric has brought this first edition forward from a seminal vision three years ago. He has been an advocate for scholarly activity across the SCS, and his research consultation will be missed at the SCS. We hope that his fingerprints will continue on this journal as he helps with the editing of future editions.

Cordially,
Jon Rohrer
Associate Dean, SCS
Prevention of Tendon Subluxation in Dequervain's Tenosynovitis Release Using Retinacular Repair

Brandon J. Horn DO1, Robert Zondervan OMS-IV1, Gail Shafer-Crane PhD2 and Erich Hornbach1

1Department of Orthopedic Surgery, McLaren-Greater Lansing Hospital, Lansing, MI
2Division of Human Anatomy, Michigan State University, East Lansing, MI

Corresponding Author: Brandon Horn DO; brandonjhorn@gmail.com

ABSTRACT

HORN, BJ, R ZONDERVAN, G SHAFER-CRANE, E HORNBACH. Prevention of tendon subluxation in Dequervain's tenosynovitis release using retinacular repair. Spartan Med. Res. J. Vol. 1, No. 1, pp. 1-14, 2016. This study compared the incidence of tendon subluxation in patients of a single surgeon undergoing Dequervain’s release with and without retinacular repair. The study reviewed 31 patients that underwent standard Dequervain’s release without retinacular repair and 49 that underwent Dequervain’s release with retinacular repair. Each subject’s functional status was assessed using the Patient-Rated Wrist/Hand Evaluation. Subjects were compared against age, gender, handedness, tendon subluxation, return to work duration, and surgical laterality. Tendon subluxation is an infrequent complication affecting patients undergoing Dequervain’s release. This complication has a higher incidence in younger females and demonstrates no predilection for hand dominance. The efficacy of retinacular repair is suggested by good Patient-Rated Wrist/Hand Evaluation outcome scores and should be considered as an adjunct to prevent tendon subluxation. This is a level 4 study. Key Words: Dequervain’s tenosynovitis, retinacular repair, tendon subluxation, complication

INTRODUCTION

Dequervain’s disease is characterized by stenosis tenovaginitis of the first dorsal compartment of the wrist. It is a debilitating disease affecting both males and females, but with a significantly higher prevalence in the female population.1 The incidence of Dequervain’s tenosynovitis has been studied and reported to have a range of 0.31-0.94 per 1000.1-3 A study using the working population in the Loire region of France segregated Dequervain’s tenosynovitis as a specific diagnosis and reported that over 2 years incidence of Dequervain’s tenosynovitis was found to be 12 per 1000, with 2.1% of females presenting with this diagnosis, compared to 0.7% (11/1,566) men.4 For all four of the reported studies, the diagnosis of Dequervain’s tenosynovitis included pain and inflammation of the first dorsal compartment tendons.

Symptomatic relief from Dequervain’s disease has been attempted through conservative and invasive treatments.5 After failing conservative attempts, surgical
Dequervain's Tenosynovitis Release

procedures have historically involved release of the first dorsal compartment and septum, followed by debridement of synovitis. However, this procedure is not without risk, and complications include nerve injury, tendon subluxation, and inadequate release of the compartment.

The complication of tendon subluxation after surgical release of Dequervain’s disease has only been described in case reports. Prevention of the complication has been attempted intraoperatively by releasing the first dorsal compartment sheath along its dorsal margin, thus leaving the volar flap intact to prevent subluxation of the tendon. Alternatively, z-plasty of the first dorsal compartment has been described as a preventive measure.

Despite these preventive techniques, the senior author (E.H.) encountered 12 cases of tendon subluxation after Dequervain’s release during a 10-year period. The complication was observed in patients within his practice and from referral. In all 12 cases that were observed, the patients reported painful tendon subluxation and limited hand dexterity, necessitating revision surgery.

Tendon subluxation is surgically treated through a brachioradialis flap and/or an extensor retinaculum reconstruction. While these restorative treatments have been shown to have positive outcomes, efforts should be focused on the prevention of tendon subluxation from Dequervain’s release.

For the purposes of this study, it was hypothesized that patients undergoing Dequervain’s release that included preventive retinacular repair would have a decreased incidence of tendon subluxation. This hypothesis was tested through a retrospective review of the primary author’s cases of patients undergoing Dequervain’s release without retinacular repair and those undergoing a described technique for retinacular repair. A decrease in tendon subluxation incidence in the retinacular repair population will support the adoption of this novel technique to reduce Dequervain’s release complications.

METHODS AND TECHNIQUES

Approval from the Michigan State University Institutional Review Board was obtained before undertaking this study (IRB# 14-430 Category: EXPEDITED 5, 7; approval date May 14, 2014). A retrospective review was conducted to identify patients who underwent Dequervain’s release by a single surgeon during a 10-year period (May 2002 to November 2013). Patients were included in the study if they underwent a Dequervain’s release and met a minimum follow up time of at least 6 months. A total of 80 patients were identified. Of those, there were 31 that underwent Dequervain’s release without retinacular repair and 49 underwent Dequervain’s release with retinacular repair. Subjects were excluded from our study if they were lost to follow up and functional status was not assessed using the Patient-Rated Wrist/Hand Evaluation.
Patients qualified for surgery based on physical exam findings of tenderness along the first dorsal compartment tendon sheath and positive Finkelstein exam. Patients were also given two serial steroid injections prior to surgery and conservative management attempted. Conservative management included activity modification and prescription NSAID trial. If they failed conservative management, they were taken for Dequervain’s release without or with retinacular repair. All patients underwent the same procedure described in the surgical technique described below with variable repair of the extensor retinaculum. They were seen in follow up at 2 weeks, 4 weeks, 6 weeks, and 6 months. Every patient underwent the same postoperative protocol described below.

Patients that underwent Dequervain’s release with retinacular repair underwent a subsequent phone interview between 6/1/14 and 6/7/14. Data were collected on patient handedness, return to work, and a PRWHE test was verbally administered to assess pain and function of the wrist.

**SURGICAL TECHNIQUE FOR RETINACULAR REPAIR.** Dequervain’s release is performed under monitored anesthesia care with local infiltration of 1% lidocaine. A proximal arm tourniquet is used and longitudinal skin incision is made beginning 1 cm proximal to the radial styloid and extending proximally along the dorsoradial aspect of the distal forearm for 3 to 4 cm (Figure 1). Branches of the radial sensory nerve are identified by gentle-blunt transverse dissection. The extensor retinaculum is incised between the volar and dorsal 2/3 of first dorsal compartment longitudinally (Figure 2). The first dorsal compartment is carefully explored for the tendon of the extensor pollicis brevis (EPB), and the multiple tendon slips of the abductor pollicis longus (APL). The fibroosseous canal is examined for septation and extra aberrant tendons. After exploration and retraction of EPB, a search is made volarly for an intra-compartmental septum and removed if present. Synovectomy is performed along each of the tendon sheaths (Figure 3). At this point, if no retinacular repair is performed, incision site skin edges are approximated and closed using 5-0 nylon. In patients undergoing retinacular repair, the Idler technique is implemented.12

4-0 chromic simple stitches are used to approximate the volar and dorsal retinacular flaps with a 3-4 mm gap (Figure 4). Testing of tension of repair is performed by rotating a Freer elevator 360 degrees under the retinacular flap, if unable to completely rotate the retractor, then repair is reperformed (Figure 5). Skin incisions are subsequently approximated and closed with 5-0 nylon. Sterile dressings and a thumb spica splint are applied.

**POST OPERATIVE PROTOCOL.** Post operatively the patients are kept in thumb spica splint for 2 weeks until seen at the 2-week visit. Patients are then placed in a removable thumb spica splint. The patient is instructed to remove the splint 6 times a day to allow thumb ulnar deviation to 40 degrees and 20 degrees flexion/extension for the first two weeks. During the third and fourth weeks, patients are instructed to remove
Dequervain's Tenosynovitis Release

the splint six times per day and perform gentle circumduction. Range of motion is increased to maximum ulnar deviation at that time. Thumb radial deviation is encouraged during the fifth and sixth week and light loading of the wrist is allowed with interval removal of the thumb spica. After six weeks, the patients are allowed to return to full activity and thumb spica is completely removed. This is also the point that full duty is allowed at work.

STATISTICS. Chart reviews and telephone interviews were conducted for data collection. The goals of this study were to compare age, gender, and identify tendon subluxation between study groups. The group undergoing retinacular repair was also assessed with Patient-Rated Wrist/Hand Evaluation (PRWHE) and identified for handedness, surgical laterality, and duration for return to work.

Study data is presented as values with percentages for categorical variables or mean values ± standard deviation for continuous variables. Comparison of age between study groups was made using Student’s t-test. Comparisons of categorical variables (gender and tendon subluxation) were made using Fischer’s exact test. In the revision population, descriptive statistics were calculated for PRWHE and return to work. Handedness and surgical laterality were compared using Fisher’s exact test. For all statistical tests the level of significance was set at p < 0.05. Statistical analyses were performed using MATLAB 7.12 R2011a (Natick, MA).

RESULTS

Of the 80 patients included in the study, 39% (31/80) underwent Dequervain’s release without retinacular repair and 61% (49/80) underwent Dequervain’s release with retinacular repair (Table 1). The average age overall for the study population was 55.6 ± 13.4. The average age for patients undergoing Dequervain’s release without and with repair was 47.8 ± 12.8 and 60.9 ± 11.2, respectively. The patients with repair were significantly older than those without (p < 0.001).

The overall study population was comprised primarily of females with males only accounting for 3.2% (1/31) and 8.2% (4/49) of the populations without and with retinacular repair, respectively. No significant gender difference was identified between the two study groups (p = 0.35).

Tendon subluxation was identified in 2.5% (2/31) of the patients without retinacular repair. This complication was not observed in patients with retinacular repair. However, the difference between the two populations did not reach statistical significance (p = 0.47).

For the retinacular repair population, PRWHE scores, handedness, and return to work are described in Table 2. In this population 44.4% (20/45) received surgery ipsilateral to the dominant hand, 41.5% (17/41) and 75% (3/4) in right and left hand dominant patients, respectively. The difference between surgical laterality and handedness did not reach statistical significance (p = 0.31) (Table 3).
DISCUSSION

This study investigated two distinct populations of patients who underwent surgical treatment for Dequervain’s tenosynovitis. In the patient population that underwent a Dequervain’s release without retinacular repair, two cases of tendon subluxation were observed. Both patients had painful symptomatic tendon subluxations and required revision reconstruction of the first dorsal compartment. Patients that were in the second group that underwent a Dequervain’s release with retinacular repair had no reports of tendon subluxation. It is important to note that although this difference did not reach statistical significance, it suggests retinacular repair may be a viable preventive measure, and warrants further study. Given the study’s incidence of subluxation, a sample population of 364 patients would be needed (182 in each treatment group) to detect a statistical difference with a power of 80%. Considering the 80 Dequervain’s release procedures that were included in this study took over 8 years to collect, it would take approximately 35 years to accrue the required sample size. The time needed to create such a large sample size for a single surgeon in a specific procedure would be prohibitively long, which supports future studies of Dequervain’s tenosynovitis using multiple sites/surgeons.

Even though the complication of tendon subluxation is rare and has only been identified in case reports, patient’s that do present with this complication suffer from pain and loss of thumb function with tendon subluxation and ultimately require revision surgery. The addition of retinacular repair by the senior author (E.H.) was seen as a proactive measure, which requires minimal additional time or effort, yet has the potential to prevent subluxation.

Our study identified gender as a significant factor in the occurrence of Dequervain’s tenosynovitis. When combining those without and with retinacular repair, 94% (75/80) were female ($p < 0.05$). This is consistent with the results seen by Wolf et al. who reported women having a significantly higher rate of Dequervain’s tenosynovitis at 2.8 cases per 1000 person-years, compared to men at 0.6 per 1000 person-years.\(^1\) Age greater than 40 also was a significant risk factor, with this age category showing a rate of 2.0 per 1000 person-years compared to 0.6 per 1000 in people under 20 years of age. Although assessment of age as a risk factor cannot be performed with our population data, our patient average age (56.6 ± 13.4) is consistent with the previously reported age of greater risk. This supports increased age and work demands as possibly associated with an increased occurrence of Dequervain’s tenosynovitis.

Limitations to this study are that it is not prospective and randomized. Patient demographics between groups were partially matched, with a significant difference in age between groups. Another limitation to the study was the follow up of 6 months; we were not able to confirm that tendon subluxation did not occur after 6 months. However, tendon subluxation that has been described occurred within 1-2 months of surgery, and
not later.\textsuperscript{8} The two patients from this study that presented with subluxation had symptoms within the first month after surgery.

Hand dominance has not been previously identified as a factor causing Dequervain’s tenosynovitis.\textsuperscript{1} Our data also shows that hand dominance is not a factor in predicting operative side. However, we did observe an increased incidence of Dequervain’s tenosynovitis in the contralateral hand of RHD patients, while in LHD patients the incidence was higher in the ipsilateral hand, an unexplained finding that warrants further investigation.

Following Dequervain’s release with retinacular repair, PRWHE assessments demonstrate minimal functional limitations and minimal pain with associated activities. This is important because although our results for the prevention of tendon subluxation with repair do not reach statistical significance, no patients in the repair group experienced subluxation. This study suggests Dequervain’s release with retinacular repair may be a viable preventive measure for tendon subluxation and to reduce the need for repeat surgery.

The authors declare no conflict of interest.

The authors report no external funding source for this study.

Submitted for publication August 2015
Accepted for publication March 2016

REFERENCES
### Table 1. Population Demographics and Tendon Subluxation Complications

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>Without Repair</th>
<th>With Repair</th>
<th>p</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>80 (100%)</td>
<td>31 (38.8%)</td>
<td>49 (61.3%)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mean Age, years (SD)</td>
<td>55.6 (±13.4)</td>
<td>47.8 (±12.8)</td>
<td>60.9 (±11.2)</td>
<td>&lt; .001</td>
<td>Student's</td>
</tr>
<tr>
<td>Male (%)</td>
<td>5 (6.3%)</td>
<td>1 (3.2%)</td>
<td>4 (8.2%)</td>
<td>0.35</td>
<td>Fischer</td>
</tr>
<tr>
<td>Subluxation (%)</td>
<td>2 (2.5%)</td>
<td>2 (4.2%)</td>
<td>0 (0.0%)</td>
<td>0.47</td>
<td>Fischer</td>
</tr>
</tbody>
</table>

Comparisons of age, gender, and tendon subluxation between patients undergoing Dequervain’s release without and with retinacular repair.

### Table 2. Retinacular Repair Follow-up Patient Data.

**With Repair**

<table>
<thead>
<tr>
<th>Variable</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean PRWE‡ (SD)</td>
<td>1.93 (±3.85)</td>
</tr>
<tr>
<td>Right Handedness (%)</td>
<td>41 (91%)</td>
</tr>
<tr>
<td>Return To Work (%)</td>
<td></td>
</tr>
<tr>
<td>When released</td>
<td>14 (31%)</td>
</tr>
<tr>
<td>With restrictions</td>
<td>14 (31%)</td>
</tr>
<tr>
<td>Retired</td>
<td>17 (38%)</td>
</tr>
</tbody>
</table>

Data from phone interviews status post retinacular repair. Four of the original 49 patients were lost to follow-up and not included in this data.

‡Patient rated wrist evaluation (PRWE) is a questionnaire to measure wrist pain and disability. It is scored out of 100 with 0 being the best outcome.
Table 3. Surgical Laterality and Patient Handedness in the Retinacular Repair Group

<table>
<thead>
<tr>
<th>Handedness</th>
<th>Surgical Site</th>
<th>RHD</th>
<th>LHD</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ipsilateral</td>
<td>17</td>
<td>3</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Contralateral</td>
<td>24</td>
<td>1</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>4</td>
<td>45</td>
<td></td>
</tr>
</tbody>
</table>

p = 0.31

Fischer exact test comparing site of surgery with right and left hand dominant (RHD and LHD) patients (e.g., contralateral surgical site in a LHD patient indicates a right sided surgery).
Dequervain’s Tenosynovitis Release

Figure 1: Demonstration of the longitudinal skin incision for Dequervain’s release.
Figure 2: Demonstration of the incision in the extensor retinaculum between the volar and dorsal 2/3 of the first dorsal compartment longitudinally.
Figure 3: Demonstration of removal of excess synovium from the tendon sheaths.
Figure 4: Demonstration of the retinacular repair with 3-4 mm gap.
Figure 5: Demonstration of testing of tension of repair performed by rotating a Freer elevator 360 degrees under the retinacular flap.
The Relationship between In-Training Examinations and Simulation Assessments in an Emergency Medicine Residency Program

Sheri L. Clarke PhD¹ and Ali Eydgahi PhD²

¹Director of Medical Education, McLaren Greater Lansing Hospital, Lansing, MI
²School of Engineering Technology, Eastern Michigan University, Ypsilanti, MI

Corresponding Author: Sheri L. Clarke, PhD; sheri.clarke@mclaren.org

ABSTRACT

CLARKE, SL, A EYDGAHI. The relationship between in-training examinations and simulation assessments in an emergency medicine residency program. Spartan Med. Res. J. Vol. 1, No. 1, pp. 15-25, 2016. Context: Historically, the assessment of medical resident knowledge and skill has occurred through annual in-training examinations and faculty observation during real patient encounters. To improve patient care and the learning environment, medical educators have begun creating simulation experiences for medical residents to perform procedures without using real patients. However, simulation curricula and accompanying assessment techniques have not been standardized. Using a longitudinal record review, in-training examination scores were compared to annualized simulation assessment scores to see if there is any relationship between the assessment types. Methods: This project was a retrospective eight-year study from a single residency program. The scores were collected from 102 resident academic records from 2007 to 2015 for the annual American Board of Emergency Medicine in-training examination and the resident's annual simulation assessment. Complete data sets were analyzed to determine if a relationship exists between the assessment methods. Then the averages were compared for only the first three years for all students and for all four years for osteopathic residents as they have an additional fourth year of training. Results: This study showed a lack of relationship between the two assessment types when reviewing three years of data. When the fourth year data is considered, there was a significant relationship between the assessment types. Conclusions: The performance scores for both types of assessment provide independent information on the resident progress in training. Therefore, they should both be reviewed and considered to appropriately measure the resident's performance. The significance of the fourth year of training for osteopathic residents requires further study. Key Words: Emergency Medicine; in-training examination; simulation; assessment

INTRODUCTION

Assessment of medical residents’ knowledge and skill level is often done through subjective evaluations by faculty and by using objective standardized written examinations. In traditional residency training, clinical training occurs with faculty observation of real patient encounters. While this practice may be an effective
educational technique for training the next generation of physicians, it puts patients at risk.¹

To improve patient care and the learning environment, medical educators need to expand beyond traditional training and assessment methods.² Simulation allows residents to practice and improve their technical skills while working on their cognitive development in a safe and non-threatening environment.³ Residency programs across the country are already using hybrid training models in which both simulation and traditional training are employed.

Annual in-training examinations are the historical way to assess trainee medical knowledge, whereas simulation is the newest assessment technique that encompasses both medical knowledge and clinical skills. It is necessary to determine whether these assessment tools equally identify competency or provide different independent scores that should both be considered in the assessment of competency for each trainee.

There is a large amount of literature that address standardized assessments in multiple medical specialties, but no literature was found that addresses simulation scores and their relationship to standardized written examinations.⁴⁻²³ A summary of the most relevant literature is provided in Table 1. In Table 1, numbers represent corresponding papers listed in the references section, * denotes strong positive relationship, + shows relationship, - represents no relationship, and # indicates that poor performance on one assessment is predictive of poor performance on the other. As indicated in Table 1, the impact of the use of simulation technology for assessment has not been sufficiently explored.

This study provided an analysis of the in-training examination scores and the annualized simulation scores to determine if there is any relationship between these assessment methods. The focus of the study was only on emergency medicine residents in a single program.

METHODS

This project was a retrospective study using a quantitative research method. The focus of this project was on a dually accredited residency program, which consists of osteopathic and allopathic residents. The residency program has an average of 34 residents with 10 new residents added to the program each year. This study included a sample of 102 individual residents from 2007 to 2015. The study was designed as the census of a single residency program in Lansing, Michigan to ensure that all residents in the selected sample had received the same training, used the same trainers and simulation center for all of their training, and had similar patient experiences. To improve the sample size, the study was longitudinal, with data collected for each resident in the program over an eight-year period. The institutional review board for the sponsoring hospital approved the study in affiliation with the university where this was part of a larger project for a doctoral student dissertation. Test scores were collected
from the residents' academic records for the annual American Board of Emergency Medicine (ABEM) in-training examination and the residency program’s annual simulation assessment. The score identified for each individual was the percentage of questions answered correctly with 100 being the maximum possible score.\textsuperscript{24} The in-training examination is valid, as it is a national standardized assessment that was designed to assess a resident’s knowledge of learning objectives set by the ABEM.\textsuperscript{25} The scoring for the examination is reliable, as it is a standardized examination administered by the ABEM.

The simulation scores were collected using evaluation tools that were developed by the residency program faculty eight years ago. Multiple simulation scenarios and multiple assessments of similar scenarios have been combined to create an annual simulation score for each year in the program. Each of these scores were listed as a percentage of correct answers with a maximum of 100 points.

The evaluation scores were assigned by one of five faculty members. The faculty has demonstrated high intra-rater and inter-rater reliability over the past eight years (unpublished data). The faculty member that moderates the simulation session scores the resident. All scores and video of the simulation are reviewed and verified by a second faculty member prior to being entered into the database. The simulation assessments are presumed to be valid because they were developed by board certified attending physicians in Emergency Medicine to assess the ABEM learning objectives. The scores are presumed to be reliable because they represent eight years of data collection, where each resident has been evaluated with the same tools through multiple observations over multiple years.

In order to review and analyze the assessment methods for a relationship, the data points were separated into subsets of data. These data were identified by year of training using post graduate year (PGY). Because this was a dually accredited program, osteopathic residents who were dually enrolled in the American Osteopathic Association (AOA) and Accreditation Council for Graduate Medical Education (ACGME) had four years of data, while all other residents enrolled only in the ACGME program had three years of data. Therefore, differences in the training years were also considered by examining only the first three years of training, as well as the full data set for the osteopathic residents. Data was identified as In-Training Examination (ITE-1, ITE-2, ITE-3, ITE-4), Simulation (Sim-1, Sim-2, Sim-3, Sim-4), Average of all scores (AvgITE and AvgSim), and the first three year average of all scores (AvgITE\textsubscript{x3} and AvgSim\textsubscript{x3}).

Canonical correlation was determined to be the appropriate method for analysis as it uses correlation coefficients and weighted sums for all potential interactions to determine significance of relationships between all data subsets in a single analysis.\textsuperscript{26} For this type of study, using canonical correlation has several benefits over using multiple regression. It allows the researcher to review relationships with fewer calculations, but it also decreases the risk of Type I error by decreasing the number of
regression equations required for analysis. Variables can be either metric or nonmetric and must have at least 10 measurements per subset in order to have an acceptable sample size. It is important to note that the correlation method does not support claims of cause and effect. It just determines whether or not the variables have a relationship. In order to infer causality, further experimental studies would need to be completed.

In this study, the scores of all participants were collected to create data sets for each individual trainee. Complete data sets were analyzed in StatGraphics Software, using canonical correlation to determine if a relationship exists between the assessment methods. The averages were then compared using two sample comparisons in the statistical software.

RESULTS
The simulation scores (Sim1, Sim2, Sim3, and Sim4) and in-training examination scores (ITE1, ITE2, ITE3, and ITE4) were reviewed using canonical correlation analysis. There were 14 identified complete cases within this data. Four reviews of the variables were completed with a P-value of 0.5 and higher as shown in Table 2. This was interpreted as having no statistically significant relationship between the data sets for DO residents.

A second analysis using simulation scores (Sim1, Sim2, and Sim3) and in-training examination scores (ITE1, ITE2, and ITE3) was performed to compare only the first three years of scores to make sure non-osteopathic residents are included in the analysis. There were 50 identified complete cases within this data. Three reviews of the variables revealed a P-value of 0.29 and higher as demonstrated in Table 3. This can be interpreted as having no statistically significant relationship between the data sets.

The average Simulation score (AvgSim) and the average in-training examination score (AvgITE) were analyzed using two sample comparison methods to determine if they were significantly different. This is a comparison of all four years of data points. A summary of the data comparison is presented in Table 4. The report showed a Standard Skewness for AvgSim of -2.94, which indicates non-normal distribution and that comparisons based on standard deviation may not be valid.

This indication of non-normal distribution led to a further analysis using Mann-Whitney U-test and Kolmogorov-Smirnov test as shown in Table 5. The Mann-Whitney U-test provides a way to compare the medians of the data sets on ordinal data. In this test a P-value of 0.02 indicated a statistically significant difference between the medians at a 95% confidence level. Then the samples were run through a Kolmogorov-Smirnov test to compare the distributions of the two samples. A P-value of 0.036 indicated a statistically significant difference between the two distributions at a 95% confidence level. These findings mean that the samples are not from similar groups, confirming that there is no relationship between the two groups, but not confirming or denying a relationship between assessment types.
Next, the three year average Simulation score (AvgSimx3) and average in-training examination score (AvgITEx3) were reviewed to be consistent with the three year curriculum of the allopathic and international medical graduate residents. The three year data is only inclusive of complete data sets for the first three years of simulation and in-training examinations. A summary of the data comparison is shown in Table 4. The report showed a similar Standard Skewness for AvgSimx3 of 2.28, which indicates non-normal distribution and can invalidate comparisons based on standard deviation. This led to a comparison of medians using the Mann-Whitney U-test. In this test, a P-value of 0.142 indicated there is no statistically significant difference between the medians at a 95% confidence level. Then, the samples were run through a Kolmogorov-Smirnov test to compare the distributions of the two samples. A P-value of 0.09 indicated no statistically significant difference between the two distributions at a 95% confidence level. It should be noted that the three year average had a very different comparison result from the four year average as demonstrated in Table 5.

DISCUSSION

For this single residency program, the data suggest there is no relationship between the performance of residents on the ABEM in-training examination and the program's proprietary annual simulation assessment. However, when considering the first three year average scores, the samples are not significantly different, indicating a relationship between the scores. It appears that the first three years of training have similar assessment scores and the two assessment types are similar in nature. When the fourth year of training is added for the osteopathic residents, the scores are significantly different and no longer are related. The osteopathic residents' scores are significantly different from those of the other residents, due to an additional year of training.

There has been a long discussion in the emergency medicine field as to whether the training should be three or four years.32 This additional year appears to make a significant difference in the relationship between the two assessment types. This could be important information for educators that are making decisions on whether emergency medicine training should be three or four years long.

CONCLUSION

This study showed a lack of relationship between the two assessment types of in-training examination and the annual simulation assessment when reviewing three years of data. The fourth year data for the osteopathic residents raised further questions. When it was considered in the analysis, it showed that there were significant differences between the osteopathic residents and all other residents. When only the first three years of training was reviewed, there appeared to be no real difference between the different medical school types.
This raises a question as to why the fourth year data would make such a difference in the analysis. The authors believe that this can be explained by the fact that an additional year of data at the highest level of training is increasing the average scores for the osteopathic residents. If the resident was not providing higher scores in the fourth year, there would not be such a difference in the three and four year averages. Therefore, the performance scores for both types of assessment should be independently reviewed and considered to appropriately measure the resident’s performance. When the fourth year osteopathic data is considered, there is suddenly a significant relationship between the assessment types.

This research was limited to a single residency program over eight years of data collection. It was also limited to a specific simulation process that a single program has developed and implemented. Further research opportunities would include reviewing the same data from another program or multiple programs that have either similar or different simulation assessments.

In order to do further investigation on this topic, it may be beneficial to review individual resident performance in these assessments. Historically, those that do well on written examinations are thought to be more successful residents. Many times, board eligibility examination scores are used to filter applications when applying for residency. However, there are many people that have difficulty with written examinations, but excel in their field. Further research could follow individual residents to determine if those that demonstrate more knowledge on written examinations are the best at applying their knowledge in simulation.

The study has provided new information on the need to consider simulation assessment as an independent metric when reviewing resident performance. Many educators assume that those that do well in medical knowledge also do well in the application of that knowledge. This study has indicated that a direct relationship between the two assessment types does not exist in emergency medicine for this single residency program’s curriculum.

Another implication of this study, and any further research developed from it, is that it may assist in determining the best length of training for emergency medicine residency programs. Currently, the AOA requires a four year training program with an internship year and three years of emergency medicine training. The ACGME allows for either a three or four year length of program. With the unification of the AOA and ACGME accreditation systems, emergency medicine programs throughout the country may make significant changes in the training program length. For this particular dually accredited program, the plan is to eliminate the additional year of training for osteopathic residents as it unifies the accreditation of the programs. Does that additional year of training provide invaluable education, or are those physicians comparable to those with three years of training that spend the fourth year as an attending physician? That is the next question to answer. In order to answer that
question, it would require a controlled study to analyze the simulation and in-training examination scores of the fourth year residents against the scores of the three year trained first year attending physicians. This would require a randomized sampling of residents and recent graduates across the country. It would require a significant investment in a standardized simulation assessment for all participants and a partnership with the American Board of Emergency Medicine in order to communicate with the attending physicians and collect the data necessary for comparison.

The authors report no external funding source for this study.

The authors declare no conflict of interest.

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Prior abstract: This study was presented at the Eastern Michigan University Graduate Research Conference, November 20, 2015.

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22. Thundiyil J, Modica R, Salvatore S, Papa L. Do United States Medical Licensing Examination (USMLE) scores predict in-training test performance for emergency


Table 1. Relationships Identified in the Literature for Different Types of Assessments

<table>
<thead>
<tr>
<th></th>
<th>COMLEX-1</th>
<th>COMLEX-2</th>
<th>IN-TRAINING</th>
<th>BOARD CERTIFICATION</th>
<th>PERFORMANCE IN RESIDENCY</th>
<th>BOARD REVIEW/CONFERENCES</th>
<th>SIMULATION</th>
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<td></td>
<td>15* 16* 18+ 19+ 20+ 5-22- 9# 11# 21#</td>
<td>15* 8+ 10+</td>
<td>12+ 17-</td>
<td></td>
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<tr>
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<td>16* 18* 20* 5+ 19+ 22- 11# 21#</td>
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<td>17-</td>
<td></td>
<td></td>
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<tr>
<td>USMLE-3</td>
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<td></td>
<td>16* 18+</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>IN-TRAINING</td>
<td></td>
<td></td>
<td>16* 15* 8+ 10+ 13+</td>
<td></td>
<td>12+ 6- 14-</td>
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<tr>
<td>CLINICAL PRODUCTIVITY</td>
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<td>13- 13-</td>
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<td></td>
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<td>FACULTY ASSESSMENT</td>
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<td>INDIVIDUAL EDUC PLAN</td>
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<td></td>
<td></td>
<td>23+</td>
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<td>SIMULATION</td>
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Table 2. Canonical Correlation Analysis for Simulation and In-Training Examination Data Sets (All four years of data)

<table>
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<th>n=14</th>
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<th>Canonical Correlation</th>
<th>Wilks Lambda</th>
<th>Chi-Square</th>
<th>D.F.</th>
<th>P-Value</th>
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<td>0.245451</td>
<td>11.9396</td>
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<tr>
<td>2</td>
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<td>0.52252</td>
<td>5.51727</td>
<td>9</td>
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<td>3</td>
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<td>0.5055</td>
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Table 3. Canonical Correlation Analysis for Simulation and In-Training Examination Data Sets (Three years only)

<table>
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<th>D.F.</th>
<th>P-Value</th>
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Table 4. Summary Statistics for Average Simulation and In-Training Examination Scores

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<th>All scores collected</th>
<th>Complete data sets only</th>
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<tr>
<td></td>
<td>Avg Sim</td>
<td>Avg ITE</td>
</tr>
<tr>
<td>Count (n)</td>
<td>94</td>
<td>102</td>
</tr>
<tr>
<td>Average</td>
<td>68.88</td>
<td>71.61</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>9.82</td>
<td>5.75</td>
</tr>
<tr>
<td>Coeff. of variation</td>
<td>14.3 %</td>
<td>8.0%</td>
</tr>
<tr>
<td>Minimum</td>
<td>34.0</td>
<td>55.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>92.0</td>
<td>86.0</td>
</tr>
<tr>
<td>Range</td>
<td>58.0</td>
<td>31.0</td>
</tr>
<tr>
<td>Stnd. skewness</td>
<td>-2.939</td>
<td>0.195</td>
</tr>
<tr>
<td>Stnd. kurtosis</td>
<td>5.562</td>
<td>0.137</td>
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Table 5. Median and Distribution Analysis for Average Simulation and In-Training Examination Scores from Table 4

<table>
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<th>Median Analysis Mann-Whitney U-test</th>
<th>Distribution Analysis Kolmogorov-Smirnov test</th>
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<tr>
<td>P-value</td>
<td>Significantly Different</td>
</tr>
<tr>
<td>Avg Sim / Avg ITE (All scores collected) (n=51)</td>
<td>0.0212178</td>
</tr>
<tr>
<td>Avg Sim x3 / Avg ITE x3 (Complete data sets for first three years only) (n=64)</td>
<td>0.142311</td>
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<table>
<thead>
<tr>
<th>P-value</th>
<th>Significantly Different</th>
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<tr>
<td>Avg Sim / Avg ITE (All scores collected) (n=51)</td>
<td>0.0364329</td>
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<tr>
<td>Avg Sim x3 / Avg ITE x3 (Complete data sets for first three years only) (n=64)</td>
<td>0.0998673</td>
</tr>
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</table>

P-value of less than 0.05 means that data sets are significantly different at 95% confidence level.
Development of a Quality Improvement/Patient Safety Curriculum to Increase Emergency Medicine Resident Scholarly Activity

Nik Butki DO¹, Martina Ghiardi DO¹ and William Corser PhD, RN²

¹ McLaren Oakland Hospital Emergency Medicine Residency Program
² Michigan State University College of Osteopathic Medicine, Statewide Campus System

Corresponding Author: William Corser, PhD, RN; Bill.Corser@hc.msu.edu

ABSTRACT
BUTKI, N, M GHIARDI, W CORSER. Development of a Quality Improvement/Patient Safety Curriculum to Increase Emergency Medicine Resident Scholarly Activity. Spartan Med. Res. J. Vol. 1, No. 1, pp. 26-39, 2016. Context: There currently is no standard method for teaching Quality Improvement/Patient Safety (QIPS) content to prepare resident physicians planning QIPS projects. As part of the 2015-2016 MSU Statewide Campus System Teach for Quality (Te4Q) learner cohort, the first two authors from the McLaren Oakland Hospital Emergency Medicine (EM) residency program developed a structured multi-phase QIPS curriculum. The curriculum was developed to help a cohort of seven second-year EM residents feel more confident to design and conduct their own QIPS projects. Methods: After institutional review board project approval was obtained, the first two authors evaluated both the pre and post-curriculum confidence survey scores of enrolled EM residents during May, 2016 as part of their Te4Q program participation. Results: Residents completed a 15-item QIPS confidence survey before and after completing the QIPS curriculum. The mean pre-curriculum score was 3.00 (SD 1.53) on a scale from 0 to 10, indicating that the average sample respondent felt a lower level of comfort concerning their ability to design and conduct a prospective QIPS project. The mean post-curriculum confidence score from residents increased to 6.71 (SD 1.25) on a 0 to 10 scale, over double an increase from the pre-workshop score on this item. Using a series of non-parametric Wilcoxon Matched Pairs Signed Rank Test procedures suitable for smaller samples, statistically significant increases in pre- to post-curriculum differences were shown for composite confidence scores (Z = 2.207, p = 0.027), as well as for five of the 12 individual confidence items (p-values ranged from 0.023 to 0.046). Conclusions: These initial results certainly indicate that a structured ongoing QIPS curriculum may have the potential to improve EM residents’ confidence levels to design and implement QIPS projects with faculty. The impact of these types of curricula for EM and other types of residents needs to be more rigorously examined in more tightly controlled GME settings with larger samples to gauge what types of resident learners will more likely benefit from such educational offerings across the nation. Key Words: quality improvement, patient safety, scholarly activity
INTRODUCTION

A growing awareness of the importance of conducting Quality Improvement/Patient Safety (QIPS) projects in healthcare environments was emphasized in the 2000 Institute of Medicine publication *To Err is Human: Building a Safer Health System.*[^1] This group of healthcare experts cited evidence showing that hospital medical errors were associated with between 44,000 to 98,000 annual patient deaths. In a related move, the Accreditation Council for Graduate Medical Education (ACGME) has incorporated systems-based practice competencies that require residency programs across the nation teach residents “an awareness of and responsiveness to the larger context and system of health care, as well as the ability to call effectively on other resources in the system to provide optimal health care” and have residents “participate in identifying system errors and implementing potential systems solutions.”[^2]

During recent years, the broader term “scholarly activity” also has been used by the ACGME in different accreditation documentation to describe both QIPS and research-oriented projects, as well as other types of professional development activities in graduate medical education (GME) settings.[^3]^[4]

However, currently there is still no standard GME method to provide QIPS project content to residents preparing to plan and conduct such projects.[^5]^[8] In order to address this deficiency, the first two authors (comprised of one faculty [NB] and one senior resident [MG]) from the four-year McLaren Oakland Hospital Emergency Medicine residency program developed an EM-specific QIPS curriculum. These authors developed the curriculum as members of the 2015-2016 *Teach for Quality* (Te4Q) program[^9] offered by the Michigan State University (MSU) Statewide Campus System in East Lansing, Michigan.[^10]

Originally, the Association for American Medical Colleges had developed the Te4Q program to train university-based faculty teams in single institutions to provide residents with key QIPS content and skills. This was the first time that the Te4Q program had been offered to a statewide network of community-based attending faculty members. Each of the 19 participants from 13 different residency settings was affiliated with one of the 37 healthcare systems served by the MSU Statewide Campus System consortium. The elements of this modified Te4Q program for the cohort of community-based learners have already been described in another paper by the third author and colleagues.[^11]

PROJECT PURPOSE

The overall purpose of this project was to develop a setting and clinical specialty-specific curriculum to train a cohort of second-year EM resident physicians at McLaren Oakland Hospital in Pontiac, MI. The desired outcome of the curriculum was to help each resident develop an individual QIPS project by the end of their second residency...
QIPS Curriculum for EM Residents

year (i.e. June, 2016). This article will review the McLaren Oakland authors’ curriculum development process, report their promising pre-post workshop evaluation results, and discuss potential modifications for the implementation of similar training curricula in other GME settings. The first two authors (NB & MG) had earlier identified that the manner in which QIPS content had been routinely delivered to all earlier-year EM residents in this setting had been both inconsistent and unevaluated. Although the QIPS curriculum described in this paper had already been incorporated into the GME offerings assigned for each second-year EM residents, residents’ choice to complete pre- and post-curriculum surveys was optional.

EM CURRICULUM DEVELOPMENT

The overall goals of the QIPS curriculum were to: 1. improve EM residents’ confidence in using key QIPS project-related skills to develop an initial project and utilize these skills in their future EM practices after graduation; 2. meet the scholarly activity ACGME accreditation metrics and increase the number of dissemination products of EM residents and faculty within this Michigan residency program; and 3. eventually improve the overall quality and safety of care delivered to over 35,000 annual patients in the McLaren Oakland Emergency Department.

The specific objectives of the customized curriculum were to: 1. train a group of EM residents to: a) identify feasible QIPS project topics, b) design their respective projects using the Plan-Do-Study-Act (PDSA) format, c) conduct their project, and d) measure project outcomes. The McLaren Oakland faculty authors leaders developed the curriculum based on Te4Q modules and the QIPS curricular development work by Dr. Brian Wong and colleagues.

The curriculum included five overall activities:

1. QIPS Content Workshop. This first workshop was designed and presented in July, 2015 by the McLaren Oakland authors in consultation with onsite colleagues and the Statewide Campus System project “coaches.” The initial four-hour workshop and the other curricular activities were incorporated into the pre-existing educational activities of the residency program. This first workshop introduced the basic concepts of QIPS, provided examples of QIPS projects appropriate for EM practice settings, and worked through a “cause and effect” or “fishbone” diagram with residents. The faculty and coaches also later demonstrated use of the PDSA cycle for proposed projects, and helped residents identify potential project measures and gain an appreciation for the frequently necessary processes for institutional review board (IRB) approval.

2. Resident-Faculty Think Tank Planning Sessions. During July and August, 2015, (i.e., two and four week intervals after the initial QIPS workshop) residents met with faculty again to discuss and evaluate each resident’s project idea(s). During the sessions residents each presented the perceived merit of their developing project designs, described the main components of their projects, as well as their initial plans.
for evaluating and disseminating project outcomes. Participants chose their “final” project topic following this think tank session and were paired with an attending faculty physician based on the attending’s areas of expertise. The third session, conducted during the fourth post-workshop week, included support from Statewide Campus System QIPS specialists, who helped participants identify project-related resources, provided topic-pertinent journal articles, and provided them with individualized written project feedback.

3. **PDSA Implementation.** During the next six months the residents met/communicated virtually with one another and/or in small groups with the McLaren Oakland authors, assigned attending faculty and two Statewide Campus System coaches to monitor the progress of their projects, troubleshoot identified barriers, modify projects if needed, and discuss future dissemination venues (e.g., poster sessions, conferences, publication in journals) for their completed project results.

4. **Follow-Up Project Workshop.** This two-hour follow-up workshop took place during January 2016, six months after the initial content workshop, and was designed and facilitated by the McLaren Oakland authors to assess participant progress and assist with PDSA-cycle issues.

5. **Final Project Review.** This final phase of the total curriculum will be completed in August 2016, and will entail review of residents’ final QIPS project design.

**METHOD**

After McLaren Oakland IRB project approval was obtained, the authors evaluated the pre- and post-curriculum survey data from the seven enrolled EM residents for the McLaren Oakland authors to fulfill the requirements of their own Te4Q program participation. This report provides the analytic results of these mid-, pre- and post-curriculum surveys.

**SAMPLE:** The 2015-2016 class of second-year emergency medicine residents (n = 7) at McLaren Oakland Hospital participated and completed both pre- and post-curriculum confidence level surveys.

**MEASURES AND TIMEFRAME:** Prior to the first QIPS Content Workshop, residents completed a 15-item *Resident Confidence in using Quality Improvement Methods* (RCQIM)\(^{14}\) survey questionnaire. This survey, partially derived from the validated Oyler et al. 2008 tool,\(^ {15}\) asked respondents to rate on an 11-point Likert scale, from 0=Not Comfortable to 10=Very Comfortable, their overall personal comfort level to design and implement a prospective QIPS project. Respondents also were asked to rate their confidence concerning 12 specific aspects of developing and conducting a QIPS project on a different 4-point Likert scale, from 0=Not at all Comfortable to 3=Extremely Comfortable (see Figure 1).

During the follow-up project workshop, residents were again asked to complete an identical copy of the RCQIM. To help inform future curricular refinements, the
residents also were invited to complete an additional on-line seven-item Survey Monkey\textsuperscript{16} questionnaire to evaluate their satisfaction with the QIPS curriculum. These items included:

Were you satisfied with the course content, neither satisfied nor dissatisfied with it, or dissatisfied with it?

Were you satisfied with your instructors’ teaching, neither satisfied nor dissatisfied with it, or dissatisfied with it?

How well-organized was this course?

How easy is it to get the resources you need to conduct your research at the hospital?

What suggestions do you have for improving this QIPS curriculum program?

What were your least favorite experiences during the QIPS curriculum program? and

Please provide any additional concerns, improvements, or comments you have regarding the course.

DATA ANALYSIS: Preliminary descriptive statistical and graphs confirmed that the distributions of RCQIM composite (i.e., 0 to 10) and individual item (0 to 3) scores were non-parametric (i.e., not normally distributed), as might be expected from a smaller sample in a single residency program. In response, a series of non-parametric Wilcoxon Matched Pairs Signed Rank Test procedures\textsuperscript{17} were conducted by the third author using SPSS Version 22 analytic software.\textsuperscript{18} These tests were completed to compare differences in composite and individual item and composite pre- and post-curriculum resident confidence scores for potential statistical significance, observing a 0.05 p-value significance level.

RESULTS

Descriptive Statistics

PRE-CURRICULUM SURVEYS: A total convenience sample of seven EM residents completed the 15-item RCQIM confidence survey both before and after the QIPS content workshop. Respondents also were asked to report whether they possessed any prior experience with any QIPS project(s). Only one respondent (14.3% of sample) indicated they had completed any QIPS project experiences. With regard to the RCQIM overall confidence item, the sample mean was 3.00 (SD 1.528) (on the 0 to 10 scale), indicating that the average respondent felt a lower level of comfort concerning their ability to identify, design, and/or conduct a QIPS project (see Table 1).

The composite pre-curriculum RCQIM confidence scores obtained from the 12 individual survey items also were quite low, averaging 16.57 (SD 4.20) on a possible scale from 0 to 36, but ranged from 12 to 25 per individual respondent. From these individual RCQIM items, the lowest average score was obtained for the item concerning Identifying best practices and comparing these to local practices/skills (mean 1.00, SD 0.577, on a 0 to 3 scale). Several items shared the same mean (1.114): Ability to write
a clear AIM statement; Developing a structured plan to test a proposed change; and **Identifying how data is linked to specific QIPS processes.** The highest average pre-curriculum response was obtained for *Using small cycles of change*, which still only averaged 1.86 (SD 0.690) on a 0 to 3 scale. Additional higher than average items were *Making changes in a system* and *Identifying if a change leads to improvement*, both with Means of 1.78, SD 0.833 (see Tables 1 and 2).

**POST-CURRICULUM SURVEYS:** Overall post-curriculum (i.e., six months after the QIPS content workshop) confidence responses from residents averaged 6.71 (SD 1.254) (on a 0 to 10 scale), over double the mean of 3.00 for this pre-workshop survey item. This improvement suggests the average respondent became significantly more confident in designing and conducting a future selected QIPS project. The composite post-curriculum RCQIM scores also increased considerably, averaging 23.87 (SD 4.64) out of possible scores from 0 to 36, an increase of 7.3 points, but still ranged widely from 17 to 30. In terms of RCQIM composite score improvements, only one resident reported feeling no change in their confidence levels, with the remainder of respondents increasing from 4 to 18 points in their composite confidence scores (see Figure 3).

For the individual post-curriculum RCQIM survey items, the lowest average scores were obtained for the following two items: *Using a PDSA model as a systematic framework* and *Identifying how data is linked to a specific process* (both with a mean of 1.71; SD 0.756 and 0.488, respectively). The highest post-workshop survey item responses were for *Writing a clear problem statement* and *Applying best professional knowledge*, both with a mean 2.29 and SD of 0.756 on a possible 0 to 3 scale (see Table 1).

**MID-CURRICULUM SURVEY COMMENTS:** To evaluate how their initial QIPS curriculum had been received by the EM residents, an online SurveyMonkey survey was administered, with results summarized below.

1. **Satisfaction with Curriculum Content** (5 responses): Responses ranged from Extremely Satisfied to Neither Satisfied nor Dissatisfied.
2. **Satisfaction with Instructors’ Teaching** (5 responses): Responses ranged from Extremely Satisfied to Neither Satisfied nor Dissatisfied.
3. **Organization of Course** (5 responses): Responses ranged from Extremely well-organized to Moderately well-organized.
4. **Ease of Resource Obtainment** (5 responses): Responses ranged from Extremely easy to Moderately easy.
5. **Suggestions for improving program** (2 responses): a. Continue to have check-ins/deadlines, b. Easy to let QI projects get put on back burner, c. Nothing, and d. I think facilitators did a great job keeping residents informed.
Inferential Data Analyses
Using SPSS Version 22 software, pre- and post-workshop RCQIM composite comfort ratings levels were shown to have increased significantly ($Z = 2.207, p = 0.027$), as did five of the 12 individual confidence items (these significant p-values ranged from 0.023 to 0.046; see Table 2). These test statistics were obtained using a series of Wilcoxon Matched Pairs Signed Rank Test non-parametric procedures that are particularly suitable for smaller samples that are not normally distributed. 17

LIMITATIONS
These initial project results should be viewed within the context of several clear limitations. The results are based on an extremely small convenience sample of EM residents in a single mid-Michigan EM residency program setting. The project was very likely underpowered to detect meaningful sample subgroup differences (e.g., male residents versus female residents) relative to pre- and post-curriculum score differences that may have been detected with a larger multi-program sample. It also should be acknowledged that measured increases in residents’ QIPS project confidence scores may have been skewed by some degree of Hawthorne/observer effect, since respondents obviously knew that they (and their scores) were being watched by McLaren Oakland faculty.

CONCLUSIONS
These initial findings clearly suggest that a structured multi-phase QIPS educational curriculum has the potential to improve EM residents’ confidence levels to design and implement selected QIPS projects with faculty. At this point, the authors are generally satisfied with the post-curriculum confidence level increases measured during this study. Each resident project has obtained IRB approval, although the authors have concluded that it is likely still too early to evaluate the final curriculum outcomes until all projects have been completed. The impact of these types of curricula for EM and other residents needs to be more rigorously examined in more tightly controlled GME settings with larger samples to tease out what specific types of curricular activities might prove to be most effective for diverse resident learners across the nation.

In hindsight, the authors plan to make the following adjustments in their next curriculum offering:
1. More clearly delivering integrated workshop activities geared to the survey items of selected evaluation measure(s);
2. Purposefully working to address system-level barriers for residents during the earlier months of their project. The McLaren Oakland authors and others have concluded that such barriers (e.g., unclear processes related to access of project data, difficulty obtaining project related resources) can delay many residents’ progress with their projects. 11,19-22
3. The number of QIPS workshops should probably be increased to three sessions from the original two, with each session two to four hours in length. The authors concluded that more time was required to help residents develop project planning skills such as working with: a) a statistician to develop appropriate evaluation and analytic methods; b) experienced project design or QIPS department personnel to develop feasible projects; and c) medical librarians to identify pertinent literature related to best practices in their selected area.

Anecdotally, the time spent assisting residents to clearly formulate a PDSA statement, and providing them ready access to consultation with campus-based QIPS experts, seemed to play a significant role in improving residents' project-related confidence.

The measured improvements seen during this project suggest that the targeted design and delivery of such QIPS educational curricula in similar community-based GME settings is warranted. Ideally, similar QIPS project curricula will be developed in other settings as GME officials sort out the best means of effectively meeting more rigorous ACGME accreditation standards in residency programs across the nation.

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The authors declare no conflict of interest.

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14. Miller K and Knight L. Quality Improvement (QI) to the max: A study on the effects of a structured QI curriculum on resident confidence in using QI methods. Department of Pediatrics, University of South Carolina School of Medicine/Palmeto Health Children’s Hospital. Columbia, SC.

### Table 1. Descriptive Statistics of RCQIM Scores (N = 7 Second-Year Emergency Medicine Residents)

<table>
<thead>
<tr>
<th></th>
<th>Pre-Curriculum Mean (SD) (range)</th>
<th>Post-Curriculum Mean (SD) (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Overall Comfort Level to Design and Implement a QIPS Project (range 0 to 10)</td>
<td>3.00 (1.528) (1-5)</td>
<td>6.71 (1.254) (5-9)</td>
</tr>
</tbody>
</table>

| II. Composite Confidence Scores (range 0 to 36) | 16.57 (4.198) (12-25) | 23.86 (4.741) (17-30) |
| III. Individual Confidence Scores (range 0 -3) |                          |                    |
| 1. “Writing a Clear Aim Statement” | 1.14 (0.378) (1-2) | 2.29 (0.756) (1-3) |
| 2. “Apply Best Professional Knowledge” | 1.57 (0.535) (1-2) | 2.29 (0.756) (1-3) |
| 3. “Use Measurement to Improve Skills” | 1.57 (0.535) (1-2) | 1.71 (0.488) (1-2) |
| 4. “Studying Selected Process” | 1.57 (0.535) (1-2) | 2.00 (0.816) (1-3) |
| 5. “Make Changes in a System” | 1.29 (0.488) (1-2) | 1.86 (0.378) (1-2) |
| 6. “Identify whether Change led to Personal Skills Improvement” | 1.71 (0.690) (1-3) | 2.00 (0.000) (2-2) |
| 7. “Using Small Cycles of Change” | 1.86 (0.690) (1-3) | 2.00 (0.577) (1-3) |
| 8. “Identify Best Practices and Compare to Local Practices/Skills” | 1.00 (0.577) (0-2) | 2.14 (0.378) (2-3) |
| 9. “Implement a Structured Plan to Test Change” | 1.14 (0.690) (0-2) | 2.00 (0.577) (1-3) |
| 10. “Use PDSA Model as Systematic Framework” | 1.43 (0.535) (1-2) | 1.71 (0.756) (1-3) |
| 11. “Identifying how Data is Linked to Specific Process” | 1.14 (0.378) (1-2) | 1.71 (0.488) (1-2) |
| 12. “Building Next Improvement upon Prior Success/Failure” | 1.29 (0.756) (1-3) | 2.14 (0.690) (1-3) |
## Table 2. Pre and Post-Curriculum RCQIM Scores (N = 7 Second Year Emergency Medicine Residents)

<table>
<thead>
<tr>
<th>I. Overall Comfort Level to Design and Implement a QIPS Project (range 0 to 10)</th>
<th>Pre-Curriculum Mean Score</th>
<th>Post-Curriculum Mean Score</th>
<th>Difference</th>
<th>Z Score</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.00</td>
<td>6.71</td>
<td>+ 3.71</td>
<td>2.214</td>
<td>0.027</td>
</tr>
</tbody>
</table>

| II. Composite RCQIM Scores (range 0 to 36) | 16.57 | 23.86 | + 7.29 | 2.207 | 0.027 |

| III. Individual Confidence Item Scores (range 0 -3) | 1.14 | 2.29 | + 1.15 | 2.070 | 0.038 |

| 1. “Writing a Clear Aim Statement” | 1.57 | 2.29 | + 0.72 | 1.518 | 0.129 |
| 2. “Apply Best Professional Knowledge” | 1.57 | 1.71 | + 0.15 | 0.577 | 0.564 |
| 3. “Use Measurement to Improve Skills” | 1.57 | 2.00 | + 0.43 | 1.414 | 0.157 |
| 4. “Studying Selected Process” | 1.29 | 1.86 | + 0.57 | 2.000 | 0.046 |
| 5. “Make Changes in a System” | 1.71 | 2.00 | + 0.29 | 1.000 | 0.317 |
| 6. “Identify whether Change led to Personal Skills Improvement” | 1.86 | 2.00 | + 0.14 | 0.577 | 0.564 |
| 7. “Using Small Cycles of Change” | 1.00 | 2.14 | + 1.14 | 2.271 | 0.023 |
| 8. “Identify Best Practices and Compare to Local Practices/Skills” | 1.14 | 2.00 | + 0.86 | 1.890 | 0.059 |
| 9. “Implement a Structured Plan to Test Change” | 1.43 | 1.71 | + 0.28 | 0.707 | 0.480 |
| 10. “Use PDSA Model as Systematic Framework” | 1.14 | 1.71 | + 0.57 | 2.000 | 0.046 |
| 11. “Identifying how Data is Linked to Specific Process” | 1.29 | 2.14 | + 0.85 | 2.121 | 0.034 |

* Series of Wilcoxon Matched Pairs Signed-Rank Tests

Statistically Significant Differences at Alpha of less than 0.05 are listed in **Bold font**
Figure 1. Pre- and Post-Workshop Survey Instrument

Quality Improvement (QI)
Pre-Test Self-Assessment

Resident Name: _________________________________

1. Have you had any previous experience in quality improvement? Yes No

2. In general, how comfortable are you in your ability to design and implement a QI project?

<table>
<thead>
<tr>
<th>Not Comfortable</th>
<th>Somewhat Comfortable</th>
<th>Pretty Comfortable</th>
<th>Very Comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Do you know what a PDSA cycle is? Yes No

4. How comfortable are you in your ability to design and implement a QO project?

   a. Writing a clear problem statement
   b. Applying the best clinical knowledge
   c. Using Measurement to improve your skills
   d. Studying the process
   e. Making changes in a system
   f. Identifying whether a change leads to an improvement in your skills
   g. Using small cycles of change
   h. Identifying best practices and comparing these to local practices/skills
   i. Implementing a structured plan to test a change
   j. Using the PDSA model as a systematic framework for trial and learning
   k. Identifying how data is linked to specific processes
   l. Building your next improvement upon prior success or failure

Adapted from: Miller K, Knight L. “Quality Improvement (QI) to the Max. A study on the effects of a structured QI curriculum on resident confidence in using QI methods.” (2014). Department of Pediatrics, University of South Carolina School of Medicine/Palmetto Health Children’s Hospital, Columbia, SC.
Figure 2. Comparisons of Pre- and Post-Curriculum QIPS Project Composite Confidence Scores
(N=7 Emergency Medicine Residents)

Figure 3. Pre- to Post-Workshop QIPS Project Confidence Score Changes
(N = 7 Emergency Medicine Residents)
Brief Report

Billing Implications of Emergency Medicine Resident Physicians’ Laceration Length Estimates

Joseph Sherer DO 1, Roya Caloia DO, MPH 1, William Corser PhD, RN 2 and Kevin Tishkowski DO1

1 ProMedica Monroe Regional Hospital, Emergency Medicine Residency Program, 2 Michigan State University College of Osteopathic Medicine, Statewide Campus System

Corresponding Author: William Corser, PhD, RN; Bill.Corser@hc.msu.edu

ABSTRACT
SHERER J, R CALOIA, WCorsER, K TISHKOWDSKI. Billing Implications of Emergency Medicine Resident Physicians’ Laceration Length Estimates. Spartan Med. Res. J. Vol. 1, No. 1, pp. 40-52, 2016. Context: Lacerations are a common occurrence in urgent care and emergency room settings. The types of lacerations repaired in these settings range from superficial and linear to deep and stellate. Healthcare professionals are required to describe these wounds in documentation and part of that description is length. In a busy clinical setting, many providers use a visual estimation of wound length for documentation. The purpose of this exploratory pilot study was to systematically examine the factors (e.g., sex, residency year, prior laceration training) associated with overall accuracy of five laceration length estimates made on a series of five identically-marked linear dummy torso sutured lacerations by a convenience sample of Emergency Medicine (EM) resident physicians. Before the study, the authors hypothesized that laceration estimates from later-year residents and/or those with more prior laceration training would be more accurate. Methods: The EM residents who attended a statewide educational session were encouraged to participate in the study by independently entering information concerning their a) personal characteristics, and b) five laceration length estimates from five dummy torso sutured lacerations onto hard copy forms during break and lunch periods of the daylong conference. The use of any types of measurement devices was prohibited. Results: A total non-probability convenience sample of 107 participants (93 EM resident physicians and 14 medical student attendees) from 14 different Michigan-based EM residency programs completed a 10-item survey during the educational conference. Results for both composite and individual actual-to-estimated (AE) laceration differences varied widely within the sample, with up to 58.9% of laceration over estimates hypothetically having resulted in overbilling of payers for the laceration repair. Conclusions: The considerable range in laceration estimates obtained from these EM clinicians indicate the complexity of attempting to estimate lacerations without measuring devices, as well as the potential for over-billing under such conditions. Larger resident samples recording laceration length estimates, with testing of potential interaction effects on AE patterns, are needed in the future to provide additional evidence concerning this aspect of EM billing. Key Words: Laceration estimates, emergency department billing, emergency medicine

INTRODUCTION
Lacerations that require surgical repair are a common occurrence in urgent care and emergency room settings.1 The types of lacerations repaired in such settings can range from superficial and linear to deep and stellate wounds. Healthcare professionals
such as physicians and nurses are routinely required to describe these wounds in medical record documentation in terms of their length. In busy Emergency Medicine (EM) clinical settings, however, many providers perform a visual estimation of wound length for surgical wound management and insurer documentation. Information concerning EM wound assessments also may be pertinent when phone referrals are made to other specialist providers often expected to evaluate the likelihood of associated nerve, vessel, and ligament or tendon involvement.

Several studies to date have demonstrated the complexity of this clinical phenomenon in EM settings. For example, Peterson, Stevenson and Sahni investigated the predictive influences associated with laceration estimates of fifty EM physicians using a series of seven photographic wound images. Each participant in this study was asked to enter their respective size estimate from the images provided. In this particular study, a high incidence of estimate error and inter-observer variability was noted between males and females. Overall, male physicians were more likely to overestimate the size and length of wounds, while female providers tended to underestimate characteristics of the same set of wound images.

In 2012, a fairly similar project was conducted by Umbrello et al. with 190 patients in a pediatric emergency department. Each laceration was visually evaluated by both a resident physician or mid-level provider (i.e., nurse practitioner or physician assistant) as well as an attending EM physician before formal measurements with a measuring device were made. In this study, there were no statistically significant differences in laceration length estimates demonstrated between attending physicians and other types of providers (p=0.583). Notably, however, over 8% of lacerations were misclassified in terms of their lengths, with 20% of facial lacerations billed incorrectly and upcoded. Lacerations that had occurred elsewhere on children’s bodies were downcoded in approximately 27% of cases.

Another smaller study in 2014 enrolled 32 EM physicians (nine attending and 23 residents) and 16 nurses. All providers in this sample tended to overestimate the actual length of seven lacerations on pig’s ears and feet. Notably, both physicians and nurses were more likely to make estimates within the accuracy parameters (i.e., greater than or less than 0.5 cm off) observed by the study team for shorter length lacerations regardless of provider sex or physician-nurse status.

The complex process of learning these types of medical skills begins in medical school, ideally becoming more fully developed during residency. Misestimating lacerations has billing implications and failing to demonstrate improvement during residency could reflect residency training weaknesses.

**STUDY PURPOSE**

The purpose of this exploratory pilot study was to systematically examine the factors associated with overall actual-to-estimated (AE) differences of five identically-
marked dummy torso sutured lacerations from a convenience sample of EM resident physicians. Respondents from different EM residency programs affiliated with the Michigan State University Statewide Campus System confidentially provided their laceration estimates during a regularly scheduled daylong statewide resident meeting. Before the study, the authors had hypothesized that laceration estimates from later-year residents and/or those with more prior training would be more accurate.

In addition to self-recorded linear laceration estimates, residents were asked about: a) current year of residency, b) sex, c) whether or not they had received any prior laceration length training, d) the estimated number of years since last laceration length training (if applicable), e) approximate number of lacerations they saw each month, and e) the name of their EM residency program.

**METHOD**

The study obtained campus-based institutional review board approval before any data collection was begun. A total of between 200 and 300 EM residents generally attend monthly statewide resident meetings, and data collection was scheduled for the November 2015 educational session. Those EM residents who attended this session were encouraged by the first author to participate in the study by independently and directly entering information on a hard copy survey form.

Information concerning participants’ personal characteristics, and their laceration length estimates from five identical dummy torsos was collected during break and lunch periods. Interested residents were directed by the first author to three study tables that had been set up outside of the main conference room. No measuring devices of any type were allowed during respondents’ data entry as they confidentially entered their study data.

The first two authors (JS and RC) had precisely measured the actual length of each dummy torso laceration before the educational session. The six dummy torsos were marked with absolute linear lacerations of the following sizes: a) 3.0 cm, b) 8.0 cm, c) 13.0 cm, d) 21.0 cm, and e) 31.0 cm.

The final project data set was entered by the first author into a password protected data set. The third author then securely received and stored an electronic copy of the raw data set and created a cleaned working study data set for analyses. Calculations were completed for each respondent’s AE laceration differences for each of their five laceration measurements.

After data set cleaning, a series of descriptive statistical analyses were completed before doing inferential analyses, to identify possible subgroup AE measurement error differences by the selected resident characteristics, observing a p-value significance level of 0.05. AE difference data were used to calculate the proportion of times in which residents had misestimated lacerations that could
hypothesically result in under-billing or overbilling while observing Current Therapeutic Technology (CPT) parameters.\textsuperscript{6}

The CPT code set is maintained by the American Medical Association through the CPT Editorial Panel. The CPT code set describes medical, surgical, and diagnostic services and is designed to communicate uniform information about medical services and procedures among physicians, coders, patients, accreditation organizations, and payers for administrative, financial, and analytical purposes. CPT codes are similar to \textit{International Classification of Disease Coding} (ICD-9 and ICD-10) coding,\textsuperscript{7} although they specify the services rendered, rather than the patients’ diagnosis. Laceration repairs in the Emergency Department are billed according to CPT Codes.

Lacerations are billed a \textit{standard amount}, which is then adjusted using a \textit{geographical corrector}, meaning that the actual amount billed will vary from region to region within the United States. Lacerations are billed based on length and complexity of repair (i.e., simple, intermediate, complex). The lacerations are billed according to the following length increments: 0-2.5 cm, 2.6-7.5 cm, 7.6-12.5 cm, 12.6-20 cm, 20.1-30 cm, and > 30 cm.

A \textit{simple laceration} is defined in CPT Codes (12001 – 12021) as a wound that is superficial without significant involvement of deeper structures and requiring a simple one layer closure.

An \textit{intermediate repair} (codes 12031 – 12057) includes layered closure of one or more of the deeper layers of subcutaneous tissue and superficial (non-muscle) fascia in addition to the skin (epidermal and dermal) closure. Single-layer closure of heavily contaminated wounds that require extensive cleaning or removal of particulate matter also constitute intermediate repairs.

A \textit{complex repair} (codes 13100 – 13160) includes the repair of wounds requiring more than layered closure, such as traumatic lacerations or avulsions, extensive undermining, stents, or retention sutures. A complex repair code is the most complicated surgical repair that a physician will perform on the integumentary system. The physician would have to perform more than layered closure in order to bill for such a complex repair.

In order to correctly code and bill a laceration repair, the documented length of the laceration must be accurately measured, along with the complexity of the repair.

\textbf{RESULTS}

\textbf{Descriptive Statistics}

All study analyses were conducted using SPSS version 22 analytic software.\textsuperscript{8} A total non-probability convenience sample of 107 EM resident physicians (this total including 14 medical student attendees) completed the 10-item survey questionnaire that had been created by the first two authors for this study. Seventy-two (67.3\%) of total respondents were male and 28 (26.2\%) respondents reported having received
some form of past laceration estimate training. Those respondents who reported having received prior training estimated they had received such training an average of about two and a half years earlier, although this ranged from zero to eight years before the time of survey. Responding residents were enrolled in 14 different Michigan-based EM residency programs, and estimated they had seen a monthly average of 7.96 (SD 5.04) lacerations in clinical practice, although this number did range considerably from two to 30. Other respondent characteristics are listed in Table 1.

Data Cleaning and Analyses

After data cleaning was completed with over 95% complete data, a series of descriptive statistics were generated. The cleaned data were examined for distributional patterns of AE laceration length differences. These data then were used to determine whether any laceration estimates may have resulted in laceration repair under-billing or over-billing coding. A series of initial cross-tabulation charts with analysis of variance (ANOVA) procedures were generated to examine for potential significant sample subgroup (e.g., males vs. females, less or more-experienced) AE differences and correlations.

The overall distribution of individual laceration differences and composite differences (i.e., combined total of AE differences from each respondent) appeared to be quite non-parametric (not normally distributed) using analytic software graphics. The characteristics of six specific outlier respondents (i.e., those with a notably wider range of AE estimate totals) were compared to the rest of the sample, but retained in the final analytic sample since these respondents’ characteristics were similar to the rest of the sample.

Individual AE differences were entered into new data set fields for analyses, including comparisons of: a) year of residency (categorical variable), b) sex (categorical), c) whether or not respondent had received any prior laceration training (dichotomous), and d) categorized monthly estimated numbers of lacerations respondent had seen during recent months. (The distribution of participants across the 14 different reported residency programs was clearly too broad for the authors to include this possible term into analytic models). To capitalize on the broader distribution of the laceration estimates, AE data were included in primary analytic models as both continuous and categorical variable study outcomes.

Finally, a series of six multinomial logistic regression modeling (MLM) procedures were run (one model for total combined AE differences and one model for each of the five individual laceration AE differences) to examine the potential predictive significance of the four selected key categorical factors on AE differences. These types of analytic procedures are especially appropriate for smaller samples in which outcome cell frequencies are lower and not normally distributed.
After conducting several forms of MLM models, it was concluded that none of the selected terms demonstrated statistical significance (p-values were between 0.063 and 0.917) on individual or composite AE outcomes when treated as categorical variables. Notably, no significant differences in AE laceration differences were found between the 57 first- or second-year residents compared to the 27 third- through fifth-year residents when these data were treated in either continuous or categorical form. It does not appear that any of the earlier cited studies examined this factor for possible significance.

Figures 1 through 3 vividly depict some of the most striking study findings when categorized by total net percentage AE differences across the five torso lacerations. For example, Figure 1 demonstrates the significant variations in total AE differences after categorizing by respondents’ residency years. A quick review of this figure certainly seems to indicate that AE underestimate differences (blue and green bars) and overestimate differences (tan and purple bars) varied considerably across residency year total AE difference subcategories.

Similar to one earlier study, Figure 2 depicts how males (albeit more numerous) disproportionately overestimated laceration lengths compared to female respondents across each AE difference category. A review of Figure 3, however, suggests that seeing more monthly ED lacerations in an ED practice setting may be quite variably associated with less severe under- or over-estimate totals.

In the end, the authors concluded that their inability to detect statistically significant sample subgroup AE differences may have been quite likely due to the lack of statistical power from a sample of this size. These final model results also may have been skewed by other unmeasured factors.

**Prospective Under- or Overbilling**

Finally, the authors evaluated what proportion of the respondents’ AE differences could have hypothetically resulted in under-billing or over-billing when observing CPT laceration length parameters. The following proportions of individual laceration estimates likely would have resulted in inaccurate billing claims: a) Laceration One (8.0 cm absolute length) - 49 (45.8% of all estimates), b) Laceration Two (3.0 cm) - 19 (17.8%), c) Laceration Three (13.0 cm) - 56 (52.3%), d) Laceration Four (21.0 cm) - 63 (58.9%), and e) Laceration Five (31.0cm) - 34 (31.8%). Overall, neither the shortest nor longest lacerations were as subject to AE misestimates as those in the middle lengths of lacerations provided to the respondents.

**LIMITATIONS**

These initial project results should be reviewed within the context of several clear limitations. These findings are based on data from a smaller self-selected convenience sample of EM residents in a variety of EM residency program settings, although this
CONCLUSIONS

In summary, the considerable range in laceration estimates obtained from this sample of EM resident physicians suggests the complexity of attempting to estimate lacerations without measuring devices. These results also indicate the sizable potential for over-billing of laceration repairs completed in rushed EM clinical care settings.\(^1\) It was unexpected that some of the factors the authors initially had hypothesized might be more significant in resident physician AE differences each fell out of statistical significance in all of the final predictive models.

Still, the wide AE estimate variations shown in this study suggest that controlled studies with larger samples certainly are warranted. This pilot project did apparently involve the largest sample of providers in the EM literature to date. The findings indicate there is significant potential for overestimation or underestimation of laceration lengths on the part of EM providers that will have sizable billing implications in contemporary health care delivery settings. Future studies with larger resident samples and the testing of potential interaction effects on AE patterns are needed. Ideally, the results of this study will provide initial evidence concerning this routine aspect of EM billing and serve to inform the development of graduate medical training modules and workshops.

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The authors declare no conflict of interest.

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REFERENCES


Table 1. Respondent Characteristics (N = 107 Emergency Medicine residents)

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<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
<th>Percent</th>
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</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>72</td>
<td>67.3</td>
</tr>
<tr>
<td>Female</td>
<td>35</td>
<td>32.7</td>
</tr>
<tr>
<td><strong>Has Respondent Ever Received Any Prior laceration training?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>79</td>
<td>73.8</td>
</tr>
<tr>
<td>No</td>
<td>28</td>
<td>26.2</td>
</tr>
<tr>
<td><strong>Year of residency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical student</td>
<td>14</td>
<td>13.1</td>
</tr>
<tr>
<td>PGY-1</td>
<td>34</td>
<td>31.8</td>
</tr>
<tr>
<td>PGY-2</td>
<td>23</td>
<td>21.5</td>
</tr>
<tr>
<td>PGY-3</td>
<td>8</td>
<td>7.5</td>
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<tr>
<td>PGY-4 or PGY-5</td>
<td>19</td>
<td>17.8</td>
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<tr>
<td>Missing</td>
<td>9</td>
<td>8.4</td>
</tr>
<tr>
<td><strong>Number of lacerations seen per month</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two to five</td>
<td>44</td>
<td>41.1</td>
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<tr>
<td>Six to nine</td>
<td>21</td>
<td>19.6</td>
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<tr>
<td>Ten or more</td>
<td>41</td>
<td>38.3</td>
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<tr>
<td>Missing</td>
<td>1</td>
<td>0.9</td>
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Table 2. Sample Laceration Estimate Differences of (n = 107 Emergency Medicine residents)

<table>
<thead>
<tr>
<th>Raw Laceration Estimates</th>
<th>Mean Laceration Estimate Difference</th>
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</thead>
<tbody>
<tr>
<td>Laceration ONE (actual length 8.0 cm.)</td>
<td>Mean 8.46 cm (SD 2.50) Range 2.54 to 17.78</td>
</tr>
<tr>
<td>Laceration TWO (actual length 3.0 cm.)</td>
<td>Mean 3.43 cm (SD 0.97) Range 2.00 to 9.00</td>
</tr>
<tr>
<td>Laceration THREE (actual length 13.0 cm.)</td>
<td>Mean 13.85 cm (SD 4.03) Range 3.00 to 25.40</td>
</tr>
<tr>
<td>Laceration FOUR (actual length 21.0 cm.)</td>
<td>Mean 22.75 cm (SD 6.17) Range 11.00 to 40.64</td>
</tr>
<tr>
<td>Laceration FIVE (actual length 31.0 cm.)</td>
<td>Mean 32.87 cm (SD 9.50) Range 12.00 to 60.96</td>
</tr>
<tr>
<td>Total Net AE * Laceration Estimate Difference</td>
<td>Mean 4.86 cm (SD 21.59) Range -61.00 to 68.70</td>
</tr>
<tr>
<td>Laceration ONE Difference (actual length 8.0 cm.)</td>
<td>Mean 0.49 cm (SD 2.50) Range -5.46 to 9.78</td>
</tr>
<tr>
<td>Laceration TWO Difference (actual length 3.0 cm.)</td>
<td>Mean 0.46 cm (SD 0.95) Range -1.00 to 6.00</td>
</tr>
<tr>
<td>Laceration THREE Difference (actual length 13.0 cm.)</td>
<td>Mean 0.79 cm (SD 4.23) Range -10.00 to 12.40</td>
</tr>
<tr>
<td>Laceration FOUR Difference (actual length 21.0 cm.)</td>
<td>Mean 1.75 cm (SD 6.17) Range -10.00 to 19.64</td>
</tr>
<tr>
<td>Laceration FIVE Difference (actual length 31.0 cm.)</td>
<td>Mean 1.51 cm (SD 10.16) Range -20.00 to 29.96</td>
</tr>
</tbody>
</table>

* AE = Actual-to-Estimated Difference
Figure 1. Variations in Total Actual-to-Estimated Laceration Length Differences by Residency Year (n = 107)
Figure 2. Variations in Total Actual-to-Estimated Laceration Length Differences by Respondent Gender (n = 107)
Figure 3. Variations in Total Actual-to-Estimated Laceration Length Differences by Monthly Number of Lacerations seen by Respondent (n = 107)
Brief Report

Examination of Resident Physician Quality Improvement/Patient Safety Project Confidence Levels from Multiple Programs

Carolyn McGrail DO 1, Josie Urban MPH 1, Brandy Church MA 2, and William Corser PhD 2

1 Authority Health, Detroit, MI
2 Michigan State University College of Osteopathic Medicine, Statewide Campus System

Corresponding Author: William Corser, PhD, RN, Bill.Corser@hc.msu.edu

ABSTRACT

MCGRAIL C, J URBAN, B CHURCH, W CORSER. Examination of Resident Physician Quality Improvement/Patient Safety Project Confidence Levels from Multiple Programs. Spartan Med. Res. J. Vol. 1, No. 1, pp. 53-65, 2016. Context: It is now increasingly recognized that physicians should be engaged in quality improvement/patient safety (QIPS) activities to make their patient care systems perform more reliably and safely. In order to ensure that our nation’s physicians embed this aspect of practice into their work, there also is a growing expectation for effective integration of QIPS training into graduate medical education. This exploratory pilot study was conducted to identify how residents’ personal and residency program characteristics might be related to their perceived confidence to develop and conduct prospective QIPS projects. Methods: A total non-probability convenience sample of 43 DO resident physicians from five residency programs (Family Medicine, Internal Medicine, Obstetrics and Gynecology, Pediatrics, and Psychiatry) at Authority Health were surveyed from 09/28/2015 to 01/06/2016 using online Survey Monkey software. A 38-item survey asked residents about their personal and residency program characteristics, as well as their current overall perceived confidence to develop and conduct QIPS projects. Results: Two model terms that proved non-significant during analyses were residents’ age category and year in residency training. In the final stepwise multinomial regression model, however, three covariates including: a) sex (p=0.045), b) being in a primary care residency program (p=0.038) and c) having had prior QIPS project experience (p=0.049) were each found to be statistically significant predictors of respondents’ perceived comfort level categories. Male residents and those who were in a primary care residency program (i.e., Family Medicine, Internal Medicine or Pediatrics), and/or reported having had prior QIPS project experience, reported significantly higher confidence levels. Conclusions: Somewhat similar to earlier studies, these results suggest the need to incorporate QIPS education for resident trainees across the nation. Ideally, the findings from larger resident studies will enable GME leaders to develop and deliver evidence-based QIPS curricula that are better oriented to resident physicians’ personal characteristics and preferences. Key Words: quality improvement, patient safety, scholarly activity, project confidence
INTRODUCTION

National concerns regarding an improved awareness of patient safety and quality of care within the US health care system have driven expectations for a minimal competence level in quality improvement/patient safety (QIPS) from contemporary physicians. It has been increasingly recognized that physicians should be engaged in QIPS activities to make the systems through which they provide patient care perform more safely and reliably.1-2

In order to ensure that our future physicians embed this aspect of practice into their work, there also is a growing mandate for the effective integration of QIPS training into graduate medical education (GME).3 A broader term used within Next Accreditation System documents has been scholarly activity, referring to both healthcare systems-oriented QIPS projects and formal controlled research studies.4,5

The overall rationale for such integration of QIPS content into GME curricula is a belief that when residents develop and apply project design/conduction skills, they will continue to participate in such activities once they enter post-residency practice.3,5 In this respect, the Accreditation Council for Graduate Medical Education (ACGME) 2013 Common Program Requirements establish that “residents must demonstrate the ability to investigate and evaluate their care of patients, to appraise and assimilate scientific evidence, and to continuously improve patient care based on constant self-evaluation and life-long learning.” 6, p. 11

It is now also considered mandatory by the ACGME that residents learn to “systematically analyze practice using QI methods and implement changes with the goal of practice improvement.” 6 An ongoing challenge for GME leaders and faculty, however, has been the lack of specific curricular frameworks to help residents plan out QIPS projects in diverse community-based residency program settings.7-9

The importance of establishing coordinated scholarly activity (SA) project expectations and timelines for residency programs has been suggested by a growing number of GME experts.3,10 During recent years it also has been proposed that coordinated efforts by GME officials from multiple residency programs and systems may enable them to more efficiently share resources, resulting in more QIPS projects and products.3,11,12

In terms of preparing residents for QIPS project experiences, some authors have reported achieving increased momentum from the establishment of cross-program project teams with shared project interests.13-17 Other GME groups have specifically implemented residency program timelines during which earlier-year residents develop specialty-related project conduction skills to lead their own later-year projects.3,13,18-20

Similar to what the authors have seen in several affiliated healthcare systems, councils or committees have been established in some settings to coordinate resident or faculty-resident project planning.17,21,22 Some GME publications have described
rotations for residents to work individually with healthcare system QIPS department personnel to generate their own subsequent QIPS project ideas.23-26

Since they lacked an institution-wide QIPS curriculum, GME faculty (CM, JU) at Detroit Wayne County Health Authority (Authority Health) in Detroit, MI concluded that it was first necessary to determine their residents’ baseline QIPS project-related confidence levels. The development of this study started as an 18-month Teach for Quality GME project coordinated by the third author (BC). The Association of American Medical College's Teach for Quality program was designed in 2013 to equip clinical faculty to lead, design, and evaluate effective QIPS projects.27 The authors (BC, WC) from the Statewide Campus System 28 (SCS) of the Michigan State University College of Osteopathic Medicine adapted the training program to support a cohort of GME faculty learners through a consortium model of QIPS coaching supports and materials. The overall results of this QIPS-oriented curricular series of 13 developed projects have been reported in another paper available from the authors.22

PROJECT PURPOSE

This exploratory pilot study was conducted to identify how residents' personal and residency program characteristics, demographics, and previous QIPS project experience might influence residents' perceived confidence levels to develop and conduct prospective QIPS projects. The authors' intent is that the results from this project inform future work and integration of QIPS content and mentoring into residents' training at Authority Health and at other individual residency programs. The overall null hypothesis of the study was that there would be no statistically significant differences between subgroup QIPS confidence level responses based on any residents' personal or residency program characteristics.

METHOD

After obtaining IRB approval, a total non-probability convenience sample of 55 resident physicians from five residency programs (Family Medicine, Internal Medicine, Obstetrics and Gynecology, Pediatrics, and Psychiatry) at Authority Health were surveyed by the first two authors (CM, JU) from 09/28/2015 to 01/06/2016 using online Survey Monkey software.29 This software allowed for anonymous survey submissions and easy extraction of raw response data. Prospective respondents were first emailed a survey link through their residency program emails, and later reminded to consider participating in the study through additional emails and by the first two authors (CM and JU) at agency/program staff meetings.

The complete 38-item project survey included a QIPS project confidence portion derived from the 31-item Quality Improvement Confidence Instrument (QICI) developed and psychometrically validated by Hess et al. in 2013.30,31 After respondents were asked seven questions about their personal and residency program characteristics, they
were presented with 31 questions about their perceived confidence in their ability to develop and conduct QIPS projects. Each of the 31 items used a five-point scale ranging from Not At All Confident to Very Confident. The six subscales of the QICI included: 1. Describing the Issue, 2. Building a Team, 3. Defining the Problem, 4. Choosing a Target, 5. Testing the Change, and 6. Extending Improvement Efforts. Respondents also were asked for suggestions of QIPS topics they might be interested in learning more about.

Following completion of data collection, data cleaning was undertaken using SPSS version 22 analytic software to transform nominal response data into numeric form and collapse some diverse variables into categories. A series of descriptive statistics were generated with cross-tabulations, and correlations were calculated among five key selected respondent characteristics the authors hypothesized might influence respondents’ overall QIPS project confidence levels (age, gender, residency year, type of program, previous QIPS experience). Participants also were asked whether they had obtained any prior experience in QIPS-type activities.

Cleaned study data were analyzed using a series of forward stepwise multinomial logistic regression modeling (MLM) procedures. These procedures were used to determine if any statistically significant associations existed between five resident characteristics with adequate frequencies and their respective QIPS project confidence levels. These types of analytic procedures are especially suited for smaller samples in which prospective cell frequencies (e.g., Male Pediatrics or Female Psychiatry resident respondents) are likely to be lower and not normally distributed.

RESULTS

Descriptive Statistics: Of the 55 respondents who started the online survey, a total of 43 (78% of total respondents) completed 95% or more of the entire survey. Twelve (22%) respondents apparently either failed to note that the survey was comprised of additional survey screens or decided they were uninterested in completing the survey. The final analytic sample used for most analyses therefore was comprised of the 43 respondents who had completed most items on the entire survey.

The authors began by comparing the reported personal characteristics of the 12 respondents who failed to complete the QICI section of the survey to the 43 respondents who completed the entire survey tool. Using these fields completed by the totality of the respondent sample, a series of cross-tabulation tests comparing the two sample subgroups failed to show any statistically significant differences between partial-survey and full-survey respondents.

In the final analytic study sample (n = 43), 26 (60%) respondents were female, with respondents’ reported age category split fairly evenly between the 20 to 30 years of age and the 31 years and older categories. Respondents also were approximately
uniformly divided across First-year through Third or Fourth-year residency program year categories.

In order to divide the sample into comparison groups based on type of training program, the authors created a Primary Care category (Family Medicine and Pediatrics) that comprised 54% of the analytic sample. The Non-Primary Care category was comprised of Internal Medicine, Obstetrics/Gynecology and Psychiatry respondents. A total of 18 respondents (42%) indicated that they had participated in some sort of prior QIPS project experience (see Table 1).

Respondents’ Overall QIPS Confidence Levels: Before respondents answered the 31 question QICI survey, they were asked a summary item concerning their overall level of confidence in designing and implementing a QIPS project. Responses on the five-point scale were grouped into three levels: a) Not Comfortable 21 respondents (49%), b) Somewhat Comfortable 16 (37%) and c) Pretty Comfortable or Very Comfortable” 6 (14%).

An initial forward stepwise MLM was conducted comparing the major resident characteristics to prospective QIPS project comfort levels. A two-tailed p-value=0.05 was selected to designate statistical significance. Each model term was entered individually in a stepwise manner to gauge their significance for the three overall comfort level response categories. Those variables initially found to exert non-significant degrees of significance (p-value of greater than 0.100) were removed from the later final MLM model.

Two MLM model terms that were not significant in the initial model were Age Category (confined to two categories since all respondents were either in their twenties or thirties) and Year of Residency Program (three categories). In the final regression model, however, three factors were each found to be statistically significant predictors of respondents’ reported confidence level categories (see Figures 1-2 and Table 2 for final model test statistics) These were: a) Gender (p=0.045), b) being in a Primary Care residency program (p=0.038) and c) having had prior reported QIPS project experience (p=0.049). In summary, males, those residents who were in a Primary Care program, and/or those who reported having had prior QIPS project experiences reported significantly higher levels of QIPS project confidence.

The final model fitting test statistic generated by the analytic software was 0.05, indicating that the set of selected model terms used performed significantly better than an intercept-only model. The McFadden Pseudo R-Square test statistic generated by the software, however, was a fairly modest 0.231. This indicated the three surviving model terms (listed in prior paragraph) explained a relatively small proportion of sample respondents’ confidence levels.33 In other words, other unmeasured resident factors likely may have influenced how this sample of residents responded to this composite confidence item.
As depicted in Table 3, the distribution of the composite QICI and six subscale scores was quite considerable, generally ranging four to fivefold. Using a series of different stepwise linear regression models, however, none of the three resident characteristics that survived in the final MRM models came up as statistically significant influences for either composite or subscale confidence scores. This finding may be conservatively interpreted as an indication that respondents’ confidence scores may have been affected by interactive (i.e., combined factor), and/or non-linear unmeasured relationships within this sample.

Eight residents responded to the open-ended “topics of interest” survey item, citing categorized areas such as: a) basic training regarding QIPS project conduction (n = 5), b) patient wait time (n = 1), or c) delivering more cost effective healthcare (n = 2).

LIMITATIONS
These study results have two major limitations that the authors would like to acknowledge: a) the smaller single-setting convenience sample and b) potential methodological problems of breaking residency programs into Primary Care and Non-Primary Care categories. If the study sample had been larger and derived from multiple settings, other sample subgroup differences may have been observed. It also should be acknowledged that the authors’ decision to categorize certain respondents into a Primary Care category and others into a separate non-Primary Care category was somewhat forced by the distribution of residents across Authority Health’s training programs. Obviously, none of these survey items measured respondents’ actual competency to design or conduct QIPS projects.

CONCLUSIONS
The authors could confidently reject their null hypothesis since the results demonstrated such variation in respondents’ QIPS project confidence levels. Somewhat similar to earlier studies, significantly higher QIPS project confidence levels were obtained from males, primary care residents, and those with some form of prior QIPS project experience. Due to the wide variety of medical skills that many primary care physicians may need to practice, it was not unexpected that primary care respondents would report higher baseline QIPS confidence participating in a new process than their counterparts.

These results suggest the need across residency programs for systematic QIPS education to enable physician trainees to gain confidence to incorporate QIPS project principles into their medical practices. Although the authors’ level of statistical power to detect interactive or smaller subgroup differences was certainly limited in this study, the complex variations found in even this smaller sample may have implications for GME faculty. These results could suggest what QIPS content topics may be more important for suitable residency program curricula. Larger scale follow-up/longitudinal studies are
certainly required to generate more generalizable results for GME settings across the country. Ideally, future studies will enable GME leaders to develop and deliver effective QIPS curricula based on resident physicians' characteristics and preferences.

The authors report no external funding source for this study.

The authors declare no conflict of interest.

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collaborative: Lessons learned to date. (under review, J Amer Osteopath Assn; available from authors)


Table 1. Descriptive Characteristics of Sample (n = 43)

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<tr>
<th>Age Category</th>
<th>N (%)</th>
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<tr>
<td>20 to 30 years old</td>
<td>23 (53.5)</td>
</tr>
<tr>
<td>31 years or older</td>
<td>20 (46.5)</td>
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<table>
<thead>
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<td>Male</td>
<td>17 (39.5)</td>
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<tr>
<td>Female</td>
<td>26 (60.4)</td>
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<td>First Year</td>
<td>11 (25.6)</td>
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<tr>
<td>Second Year</td>
<td>16 (37.2)</td>
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<td>Third or Fourth Year</td>
<td>16 (37.2)</td>
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<th>Type of Residency Program</th>
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<td>Family Medicine</td>
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<tr>
<td>Internal Medicine</td>
<td>8 (18.6)</td>
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<tr>
<td>OB/GYN</td>
<td>3 (7.0)</td>
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<tr>
<td>Pediatrics</td>
<td>12 (27.9)</td>
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<td>Psychiatry</td>
<td>9 (20.9)</td>
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<table>
<thead>
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<th>Primary Care (Family Medicine and Pediatrics)</th>
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<td>Yes</td>
<td>23 (53.5)</td>
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<tr>
<td>No</td>
<td>20 (46.5)</td>
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<th>Prior QIPS Project Experience</th>
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<td>Yes</td>
<td>18 (41.9)</td>
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<tr>
<td>No</td>
<td>25 (58.1)</td>
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Table 2. Significant Predictors of Respondent Comfort Levels Designing and Conducting a QIPS Project (at time of survey) (N = 43) *

<table>
<thead>
<tr>
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<th>Model Fitting Criteria</th>
<th>Likelihood Ratio Tests</th>
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<tr>
<td></td>
<td>-2 Log Likelihood of Reduced Model</td>
<td>Chi Square</td>
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<tr>
<td>Constant</td>
<td>53.365</td>
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<td>Gender (reference group Males)</td>
<td>59.581</td>
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<tr>
<td>Primary Care (ref. group Non-Primary Care)</td>
<td>60.377</td>
<td>7.012</td>
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<td>“Do you have any Prior QIPS Project Experience?” (ref. group “No”)</td>
<td>61.479</td>
<td>8.114</td>
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Bold:  P-values significant at Alpha of p < 0.05.

* Forward Stepwise Multinomial Logistic Regression Models

Table 3. Quality Improvement Confidence Instrument Composite and Subscale Scores *

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<tr>
<th>Subscale Score</th>
<th>N</th>
<th>Minimum Response Received</th>
<th>Maximum Response Received</th>
<th>Mean</th>
<th>SD</th>
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</thead>
<tbody>
<tr>
<td>Composite QICI Confidence Score</td>
<td>43</td>
<td>42</td>
<td>145</td>
<td>95.02</td>
<td>26.769</td>
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<tr>
<td>(possible range from 31 to 155)</td>
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<tr>
<td>Describe the Issue Subscale Score</td>
<td>43</td>
<td>5</td>
<td>20</td>
<td>12.35</td>
<td>3.841</td>
</tr>
<tr>
<td>(4 items) (possible range from 5 to 20)</td>
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<td>Build a Team Subscale Score</td>
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<td>20</td>
<td>13.42</td>
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<tr>
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<tr>
<td>Define the Problem Subscale Score</td>
<td>43</td>
<td>5</td>
<td>25</td>
<td>16.26</td>
<td>4.562</td>
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<tr>
<td>(5 items) (possible range from 5 to 25)</td>
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<tr>
<td>Choose a Target Subscale Score</td>
<td>43</td>
<td>2</td>
<td>10</td>
<td>5.79</td>
<td>2.166</td>
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<td>(2 items) (possible range from 2 to 10)</td>
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</tr>
<tr>
<td>Test The Change Subscale Score</td>
<td>43</td>
<td>7</td>
<td>35</td>
<td>18.49</td>
<td>7.756</td>
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<tr>
<td>(7 items) (possible range from 7 to 35)</td>
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<tr>
<td>Extend Improvement Efforts Subscale Score</td>
<td>43</td>
<td>12</td>
<td>44</td>
<td>28.72</td>
<td>8.09</td>
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<td>(9 items) (possible range from 9 to 54)</td>
<td></td>
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</table>

* Five-point scale ranging from Not At All Confident to Very Confident.
Figure 1. “In general, how comfortable are you in your ability to design and implement a QIPS project?” (stratified by Primary Care versus Non-Primary Care Program)

"In general, how comfortable are you in your ability to design and implement a QIPS project?"
Figure 2. “In general, how comfortable are you in your ability to design and implement a QIPS project?” (stratified by whether or not Respondent reported Prior QIPS Project Experience)
**Case Report**

**Submandibular Gland Epithelial-Myoepithelial Carcinoma with Osseous Metastasis: A First Reported Case and Review of the Literature**

Alexander Manteghi DO¹, Aaron Centric DO¹, Seth Zwillenberg MD¹ and Corrado Minimo MD²

¹ Division of Otolaryngology, Philadelphia College of Osteopathic Medicine, Albert Einstein Medical Center, Philadelphia, Pennsylvania
² Division of Pathology, Albert Einstein Medical Center, Philadelphia, Pennsylvania

Corresponding Author: Alexander Manteghi, DO; alex_manteghi@hotmail.com

**ABSTRACT**

MANTEGHI A, A CENTRIC, S ZWILLENBERG, C MINIMO. Submandibular Gland Epithelial-Myoepithelial Carcinoma with Osseous Metastasis: A First Reported Case and Review of the Literature. Spartan Med. Res. J. Vol. 1, No. 1, pp. 66-72, 2016. Epithelial-myoeoepithelial carcinoma (EMC) is a low grade tumor that comprises 1% of all salivary tumors. Local recurrence is not uncommon, but rarely does this tumor demonstrate distant metastasis. We describe a case of a 53-year old female presenting with an asymptomatic, slowly enlarging left submandibular neck mass. Excision of the left submandibular gland (SMG) revealed epithelial-myoeoepithelial carcinoma with extensive perineural invasion and microscopically positive margins. A subsequent left supraomohyoid neck dissection demonstrated no residual tumor. The patient was stable for one year until a magnetic resonance imaging (MRI) workup for low back pain revealed multiple sclerotic lesions in the iliac crest and lumbar spine, with an iliac crest biopsy demonstrating metastasis. 2.5 year post-operative positron emission tomography-computed tomography (PET-CT) revealed increased [18F]-fluorodeoxyglucose (FDG) avidity in the right iliac crest, pubic symphysis, thoracic and lumbar spine, 9th rib, and sternum concerning for local recurrence and further osseous metastasis. We report the first known case of a submandibular gland EMC with osseous metastasis and highlight the need for prolonged tumor surveillance. **Key Words:** epithelial-myoeoepithelial carcinoma, salivary gland tumor, submandibular gland

**INTRODUCTION**

Epithelial-myoeoepithelial carcinoma is a rare neoplasm, first described in 1972 by Donath et al.¹ It has been reported under a variety of names including adenomyoepithelioma, clear cell adenoma, tubular solid adenoma, monomorphic clear cell tumor, glycogen-rich adenoma, glycogen-rich adenocarcinoma, and clear cell carcinoma.²³ It chiefly occurs in the parotid gland, representing about 1% of all salivary gland tumors.⁴⁻⁶ It is most common in women (60%) with a peak incidence in the sixth and seventh decades of life.⁴⁻⁷ The major salivary glands, and in particular the parotid gland (80%), are the most common sites of occurrence. Submandibular glands comprise 12% of salivary EMCs, respectively.⁷ Clinically, the symptoms are non-specific; a localized, mobile mass is often the only sign. It tends to grow slowly in a
bulky, lobulated fashion, demonstrating necrosis and hyalinization of large tumor nodules, and ranges from 2 to 12 cm in size.\textsuperscript{5} Focal invasion occurs often, and single or multiple recurrences complicate the typically protracted postoperative course. Recurrence has been reported to occur from several months to many years after initial excision. While local relapse is not uncommon, distant metastasis is much rarer with only 17 reported cases, predominantly involving the lungs, but also reported in the brain, kidney, skin, and bone.\textsuperscript{6,8-16} We report the first known case of SMG EMC with distant osseous metastasis, and the third salivary EMC overall with osseous metastasis

CASE PRESENTATION

A 53-year old female with a 25-pack-year tobacco history and alcohol abuse presented to the otolaryngology clinic with complaint of a ten-year course of slow enlargement of the left submandibular region. A left-sided firm, fixed, and painless submandibular mass was noted on palpation. Non-contrast computed tomography demonstrated a 4.5 cm mass without detectable adenopathy of the neck or surrounding tissues (Figure 1). A non-diagnostic fine needle aspiration of the mass was performed, subsequently followed by SMG excision. Permanent pathology revealed epithelial-myoepithelial carcinoma with a multinodular growth pattern (Figure 2). Immunohistochemical stains for p63 highlighted the respective nuclei and cytoplasm of the outer layer of myoepithelial cells. Calponin and cytokeratin staining was also positive. No lymphovascular invasion was noted; however extensive perineural invasion and positive microscopic margins were identified. Radiation versus further surgery was discussed with the patient. She subsequently underwent a left supraomohyoid neck dissection, including resection of overlying skin. Pathology was benign, and all sectioned lymph nodes were negative for malignancy. The patient declined radiation therapy thereafter, but she continued to have regular surveillance examinations; a yearly surveillance PET-CT was unremarkable. Several months after the PET-CT she later had an MRI workup for low back pain, revealing multiple T2-signal intense sclerotic lesions in several lumbar vertebral bodies and the right iliac crest concerning for possible metastasis. A right iliac crest biopsy demonstrated a small tissue focus with cords of myoepithelial cells embedded in desmoplastic fibroconnective tissue. These cords were morphologically similar to the narrowed cords of the primary submandibular tumor and were also immunohistochemically positive for both cytokeratins and p63. The morphology and the immunophenotype were consistent with metastatic EMC. A subsequent 2.5 year post-operative PET-CT demonstrated increased FDG avidity within the tongue and submental region, concerning for local recurrence, in addition to increased FDG avidity in the right iliac crest, pubic symphysis, thoracic and lumbar spine, right 9\textsuperscript{th} rib, and sternum concerning for further distant osseous metastasis. The patient currently is refusing further intervention.
DISCUSSION

As the name “epithelial-myoepithelial” suggests, this tumor is composed of a biphasic cell population: an outer layer of clear myoepithelial cells surrounding an inner lining of eosinophilic, cuboidal epithelial cells. The lumen is often occupied by periodic acid-Schiff (PAS)-positive, eosinophilic material. In most cases the cytologic atypia is mild and the mitotic index is low, but there can be exceptions. Although EMC is well differentiated, it often lacks a capsule and shows a multinodular, locally invasive growth pattern, especially prominent through the perineural spaces, as demonstrated in our case. As such, local recurrence is not uncommon.

There are a number of immunoreactive markers. The epithelial cells stain for cytokeratin. Calponin has been reported to be a sensitive marker of myoepithelial differentiation in salivary lesions. p63 has become a commonly used marker for myoepithelial cells and has been shown to have excellent sensitivity as well. p63 is not entirely specific, as squamous cell tumors have also demonstrated reactivity. Since its distinction as a discrete entity, at least 320 EMCs have been described. The bulk of literature since 1972 has confirmed the tumor to be a low-grade malignancy with documented local recurrence rates ranging from 23% to 80%. Death related to the primary tumor was found in 40% in one case series. Interestingly, only 17 cases of distant metastasis have been documented, predominantly involving the lung, and rarely bone, brain, kidney, and skin. Our case brings the total to 18 distant metastases, and the first case with osseous metastasis from an SMG EMC.

There is no consensus regarding the optimal treatment of this tumor, largely due to its rarity. Wide surgical excision with a clear margin is the treatment of choice because of the tumor’s tendency to infiltrate locally. If the tumor demonstrates adverse features such as close or positive margins, perineural invasion, lymph node metastasis, intermediate/high grade status, or lymphatic/vascular invasion, then adjuvant radiotherapy is recommended with a consideration for concurrent chemotherapy and radiotherapy (Category 2B Evidence). The effect of chemotherapy is uncertain. Seethala et al. showed surgical margin status, angiolymphatic invasion, necrosis, and myoepithelial cell anaplasia to be the most significant predictors of survival.

These observations, along with the aggressive nature of our case, lead us to question the assumed low grade malignancy of this tumor. Although the histological features appear to be benign, local recurrence and regional spread occur in an alarming percentage of cases. Distant metastasis, while much rarer, can occur at any point during the clinical course. As an example, the case report of a parotid EMC metastatic to the kidney occurred after 6 local recurrences and 28 years post-parotidectomy. Long-term close follow-up therefore is necessary, even if the tumor appears to be clinically early stage and completely resected.
CONCLUSIONS

• We report the first known case of SMG EMC with osseous metastasis.
• EMC is classically a low grade malignancy, but there is a high likelihood of local recurrence. Rarely does this tumor demonstrate distant metastasis.
• The lung appears to be the most common site of distant metastasis, but bone, brain, kidney, and skin also have been implicated, such that no clear metastatic predilection can be identified.
• A margin-free local excision and a long-term close follow-up are necessary, particularly in younger patients.
• Further effort is needed to establish prognostic markers and determine the value of radiotherapy and chemotherapy.

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Figure 1. Axial computed tomography without contrast demonstrating a non-homogenous 4.5 x 3.0 x 3.0 cm mass in the left submandibular gland.
Figure 2. EMC of the SMG. Glandular structures with a luminal layer of eosinophilic epithelial cells are surrounded by larger polygonal myoepithelial cells. Collapsed cords (left) are also present. (H&E, 40x).
Use of a Defibrillator Magnet to Extract Multiple Ingested Sharp Iron Objects from the Stomach at Laparotomy

Mark W. Jones DO

Department of General Surgery, McLaren Greater Lansing

Corresponding Author: Mark W. Jones, DO; mjoness006@aol.com

ABSTRACT

JONES MW. Use of a Defibrillator Magnet to Extract Multiple Ingested Sharp Iron Objects from the Stomach at Laparotomy. Spartan Med. Res. J. Vol. 1, No. 1, pp. 73-77, 2016. This paper describes a technique for safely removing sharp ingested ferrous-based objects from the stomach at the time of laparotomy. It consists of a case report of a patient with psychiatric issues. He presented to our emergency department on several occasions after eating multiple foreign objects. Due to the large amount of ingested items, they could not be removed via the endoscope, therefore requiring laparotomy. A serious issue presenting to the surgeon and surgical team is puncture of surgical gloves and possible injury to the operating staff’s hands during extraction of sharp objects. This technique describes using a defibrillator magnet placed into a sterile specimen bag that is then inserted into a gastrotomy incision to remove any iron-based ingested sharps. As many ingested sharps such as needles, tacks, nails, screws and pins are ferrous-based, this technique is very useful and efficient. **Key Words:** Ingested; foreign bodies; magnet; laparotomy

CASE PRESENTATION

A 51 yo male psychiatric patient suffering depression and alcohol abuse presented to our emergency department on two separate occasions after ingestion of large amounts of foreign materials. Figure 1 demonstrates an abdominal x-ray on one of his admissions. Presentation, physical exam and x-ray findings were almost identical on both admissions, as were the types of materials ingested. The large number of objects made endoscopic extraction impractical and, since the many sharps that were swallowed included nails and screws, surgical removal was required due to fear of perforation.

A defibrillator magnet (commonly found at the anesthesia station) was placed into a sterile specimen bag that was then inserted into a gastrotomy incision. The bag was tied at its opening to ensure sterility. As the magnet was inserted and pulled from the gastrotomy, the ferrous-based sharps clung to it, facilitating easy and safe removal
(Figure 2). After all of the sharps were removed, the many remaining swallowed pennies were then safely scooped out with a gloved surgical hand. The small intestine was completely examined in surgery and no objects were found to have passed out of the stomach. This also was confirmed by a plain abdominal X-ray done post-operatively. The gastronomy was closed in a standard fashion. The patient had an uneventful post-operative course and was discharged 5 days after surgery.

This maneuver can be repeated as often as needed, and also works for objects that may be in the distal stomach or other harder to reach locations. This patient presented to our hospital two times with the same situation. He required a laparotomy on both occasions and this procedure worked effectively each time.

DISCUSSION

Ingested foreign bodies can be sharp or pointed and pose a significant threat to patients, as well as to surgeons and staff who care for them. Puncture of surgical gloves and injury to the operating staff's hands carries significant exposure issues. Many times these objects are iron-based, such as needles, tacks, nails, screws, pins and razor blades. If endoscopy is unsuccessful or not feasible, close observation may be attempted, often with good results. Conservative treatment usually consists of large amounts of daily fiber, possibly with oral mineral oil. The goal is for the patient to pass the objects without causing perforation or obstruction. Progress can be followed with serial x-rays. In this case the nature and large amount of ingested materials made conservative therapy prohibitive.

There are several papers that discuss the endoscopic use of magnets for removal of ingested iron objects. Fluoroscopic extraction utilizing specialized magnetized orogastric tubes also has been described. This is, however, the first paper we are aware of describing the use of a magnet for the extraction of ferrous-based objects at laparotomy. Many ingested items, especially sharp or pointed ones, are iron-based, making this technique useful in many situations. There is a myriad of other materials that can be eaten in which this technique will not be useful. Care must always be taken, as the true nature of swallowed objects is never known prior to surgery.

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MW Jones

Figure 1: Upright abdominal x-ray demonstrating multiple ingested metallic objects.
Figure 2: Retrieved sharps (nails and screws) clinging to defibrillator magnet at laparotomy.
Malignant Dysrhythmias – Brugada Type 1 Pattern Formation in the Presence of Fever

Joshua Liroff DO, Karyn Gilbert DO, and Brian S. Kim MD

Emergency Department, Henry Ford Allegiance Health, Jackson, MI

Corresponding Author: Brian S. Kim, MD  Brian.Kim@Allegiancehealth.org

ABSTRACT
LIROFF J, K GILBERT, BS KIM. Malignant Dysrhythmias – Brugada Type 1 Pattern Formation in the Presence of Fever. Spartan Med. Res. J. Vol. 1, No. 1, pp. 78-84, 2016. Background: Brugada is a malignant cardiac dysrhythmia characterized by ST elevations in precordial leads V1 to V3. It is an autosomal dominant disease, and patients are usually asymptomatic. Often the initial presenting symptom of this syndrome is syncope or sudden cardiac death (SCD). In patients with this syndrome, the only definitive treatment is the implantation of a cardioverter-defibrillator device (ICD). Previously it has been reported that Brugada type EKG patterns have been observed in patients who have used sodium channel blocking medications/drugs and in patients who are febrile. Case Study: In this case, a 58 year-old male presented to our emergency department with a fever of five days duration and a non-productive cough. The patient was initially diagnosed with bilateral pneumonia, however during the initial workup his EKG demonstrated a Brugada type EKG pattern. The patient did not have any history of cardiac disease, nor was there any history of syncope or SCD in his family. The patient was eventually discharged from the hospital four days after his initial presentation and instructed to follow up with cardiology. Conclusion: Brugada type EKG patterns are known to occur in patients in febrile states and in those patients using certain types of medications. In those patients who present under the above mentioned conditions who are otherwise asymptomatic, the literature does not support the implantation of an ICD. Key Words: Brugada, Brugada syndrome, cardiac arrhythmia, fevers, febrile states, case study

INTRODUCTION
Brugada is a cardiac syndrome characterized by sudden cardiac death, usually in young healthy adults by ventricular dysrhythmias. It is an autosomal dominant disease with mutations in the SCN5A and SCN10A subunits of the SCN gene that encode for subunits of cardiac sodium channels. Typical EKG findings in Brugada Syndrome usually demonstrate a “pseudo right bundle branch block” or “shark fin-like” appearance with ST elevations in precordial leads V1 to V3.$^{1-5}$ Patients with Brugada often are asymptomatic. The syndrome usually manifests itself between the ages of 22-65, and often presents with either syncope or sudden cardiac death (SCD).$^2$ Early recognition of this dysrhythmia is critical in the prevention of SCD,$^6$ as patients can be started on antiarrhythmic therapy or undergo the implantation of a cardioverter-defibrillator device
Malignant Dysthythmias - Brugada Type 1 Pattern

Previously, Brugada type EKG patterns have been observed in patients during febrile states and in those patients who are under the influence of sodium channel blocking agents such as cocaine, class I antiarrhythmics, anesthetics, and tricyclic antidepressants.\textsuperscript{7-12}

In our case study, we present the case of a 58 year old male who initially presented to our emergency department with a fever of five days duration, a maximum temperature of 39.5°C, and a non-productive cough. This case further demonstrates the utility of electrocardiograms in the recognition of possible dysrhythmias in the febrile state.

**CASE**

The patient was a 58 year-old male with a history of hypertension, hyperlipidemia and diabetes, who initially presented to our emergency department complaining of a fever, diarrhea and fatigue. According to the patient, these symptoms had been ongoing for the past 5 days. The patient also had a non-productive cough. The patient denied any chest pain, heart palpitations, shortness of breath, syncope, dizziness, or abdominal pain. The patient denied any previous syncopal episodes or any previous cardiac history including dysrhythmias, previous myocardial infarctions, coronary artery disease, or congestive heart failure. The patient denied any family history of early cardiac deaths or family history of heart disease. Review of the patient’s current medications at the time included atorvastatin, lisinopril-hydrochlorothiazide, and metformin.

The patient was febrile on presentation with a temperature of 39.5°C. He was tachycardic with a heart rate of 110. Patient was hemodynamically stable with a blood pressure of 108/67 mmHg. Crackles were heard at the bases of his lungs bilaterally. The remaining physical exam was unremarkable.

Initially there was concern for sepsis, given his history of fever for five days and diarrhea. An infectious/metabolic workup was performed, as our initial differential diagnosis included pulmonary disease (atelectasis, bronchitis, pneumonia, tuberculosis, empyema, pulmonary embolism), urinary tract infection, bacteremia, gastroenteritis, and viral syndrome. Also, as the patient was complaining of fatigue and had cardiac risk factors, it was important to expand our differential to rule out cardiac causes such as myocardial infarction, myocarditis, and life-threatening dysrhythmias. A complete blood count, electrolyte panel, troponin, EKG, chest x-ray, and blood cultures were obtained. Of note, the patient had an elevated lactic acid of 3.8 mmol/l, a sodium of 128 mmol/l and a white blood cell count of 29.2 k/mm\(^3\). The remaining laboratory studies were unremarkable and within normal physiologic limits, including his potassium, calcium and troponin. Surprisingly, the patient’s EKG demonstrated a type 1 Brugada pattern (Figure 1). This was a new finding, as his previous EKG had shown an incomplete right bundle branch block (Figure 2). Cardiology was consulted and it was recommended an
echocardiogram and a computed tomography (CT) angiogram of the chest be obtained in order to rule out a right ventricular infarct and pulmonary embolism, respectively. Echocardiogram showed a left ventricular ejection fraction of 70% with trace mitral and tricuspid regurgitation. There was no evidence of valvular pathology, hypokinesis, or thrombus. CT angiogram of the chest demonstrated a large opacity in the left lower lobe, and infiltrates in the right upper, middle and lower lobes consistent with pneumonia. There was no evidence of pulmonary embolism. The patient was started on ceftriaxone and azithromycin and admitted to the hospital for further evaluation and treatment for community-acquired pneumonia. The patient was discharged from the hospital four days later. He was started on aspirin and metoprolol per recommendations by cardiology and was instructed to follow up with them in their office two weeks later.

DISCUSSION
This particular case of fever induced Brugada is of significant importance, as it helps emphasize the utility of an EKG as a screening tool to quickly identify possible ST elevated myocardial infarctions or life-threatening dysrhythmias. In this case, although the patient’s differential diagnosis was expansive, his symptoms were of infectious etiology. Obtaining an EKG in his initial workup quickly identified a possible life-threatening dysrhythmia, which helped the clinician direct appropriate resources to this patient’s care.

As mentioned, Brugada is described as a pseudo right bundle branch block with persistent elevation in leads V1-V3. There are three known Brugada-like EKG patterns. In this specific case, the patient presented with a Brugada type-1 pattern, which is characterized by a coved ST segment elevation of at least 2 mm followed by an inverted T-wave in the right precordial leads.\(^1\) Fever has shown to be a causative factor in the development of a Brugada-like EKG pattern.\(^1^3\) As in the case described above, it is believed the patient’s illness contributed to the development of the type 1 Brugada pattern that was observed on his initial EKG upon presentation to the emergency department.

Brugada pattern and Brugada syndrome are distinguished by the presence or absence of symptoms. Those patients without symptoms are said to exhibit a Brugada-like pattern, while those with symptoms and meeting established clinical criteria are considered to have Brugada syndrome. Diagnostic criteria include the presence of a coved ST elevated segment of at least 2 mm in more than one precordial lead plus at least one of the following clinical criteria: documented ventricular fibrillation, polymorphic ventricular tachycardia, family history of sudden cardiac death at less than 45 years of age, family history of type 1 Brugada pattern EKG changes, inducible ventricular tachycardia during electrophysiology studies, unexplained syncope suggesting a tachyarrhythmia, or nocturnal agonal respirations.\(^1^4\)
In those patients with Brugada syndrome, it is recommended that the patient be referred to an electrophysiologist for ICD implantation, which is effective in terminating life threatening ventricular dysrhythmias. Pharmacologic treatment has not been proven thus far to prevent SCD in Brugada syndrome, although there are some studies that show quinidine may be of some benefit. ICD implantation is the only definitive treatment. For those patients with a Brugada-like EKG pattern who are otherwise asymptomatic and do not meet diagnostic criteria, treatment with ICD is not recommended as there is no data to suggest ICD use in these patients. In this particular patient, only the presence of EKG changes, that of a type I Brugada pattern were observed. The patient was asymptomatic and did not meet clinical criteria for the diagnosis of Brugada syndrome. As such, based on current guidelines no treatment was recommended, only cardiology follow-up.

WHY IS THIS CASE RELEVANT?

Brugada syndrome is recognized as a cause of SCD. It is a cardiac dysrhythmia that can deteriorate into a fatal ventricular arrhythmia. Understanding the conditions that can potentiate Brugada syndrome is important for the practicing clinician, but also for the patient. Triggers such as fever, intoxication (alcohol, cocaine, or cannabis), vagal stimulation, electrolyte imbalance, anesthetics (amitriptyline, lithium) and sodium channel blockers are known to potentiate this rhythm. Approximately 25% of all cases of Brugada syndrome are caused by mutations in the cardiac sodium channel gene SCN5A. The mutated sodium channels result in temperature-dependent ionic changes that cause characteristic Brugada EKG patterns during fever.

CONCLUSION

Brugada induced EKG changes have been observed in patients with a fever and in those patients using certain drugs/medications. In those patients with Brugada-like EKG patterns who are otherwise asymptomatic, no further treatment such as ICD implantation or antiarrhythmic medication use is recommended as there is no data available at this time to suggest benefit to these patients.

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Figure 1: Patient’s initial EKG upon presentation to the emergency department showing a type 1 Brugada Pattern. Notice the coved segment ST elevations in V1 and V2.

Figure 2: Patient’s previous EKG obtained from previous visit to emergency department two years earlier.