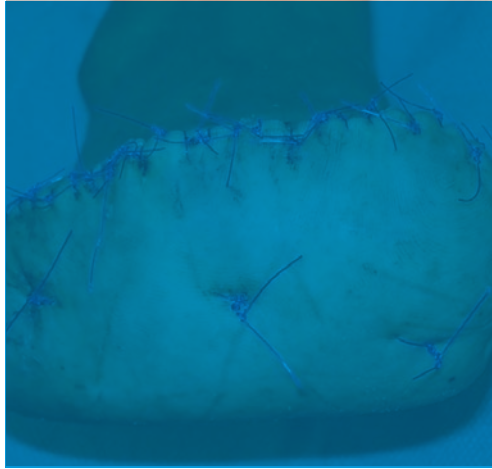
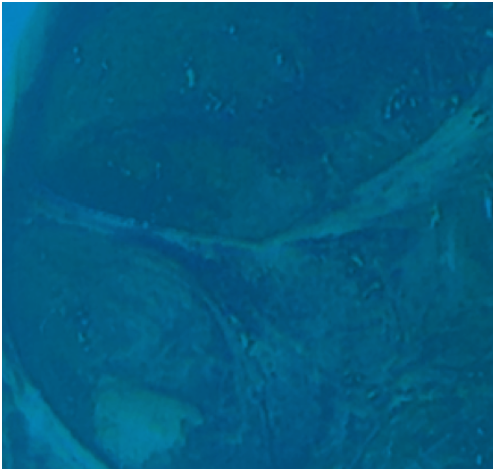




ST. VINCENT CHARITY
MEDICAL CENTER

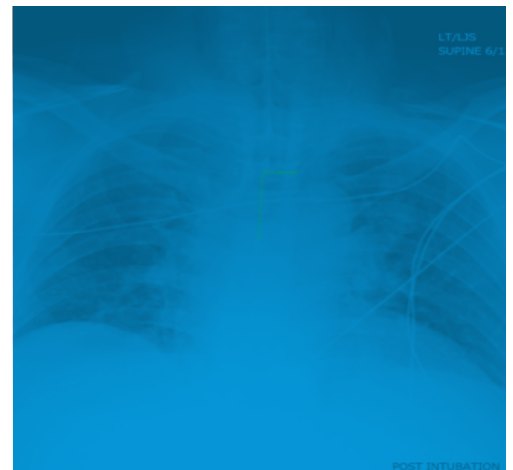
JOURNAL

VOL. 1 ISSUE 7 | WINTER 2017



IN THIS ISSUE

- **Transmetatarsal amputation** p.3
- **Depression in heart failure** p.6
- **Hospice care** p.8
- **Leriche's syndrome** p.12
- **Boorhaave's syndrome** p.14
- **Advance directives** p.16
- **Carbon fiber fixation** p.20



EDITOR IN CHIEF

Keyvan Ravakhah MD MBA FACP

RESIDENT EDITORS

**Nana Yaa Koram MD MPH
Narsimha Keetha MD
Ramyashree Tummala MD**

ISSUE CONTRIBUTORS

Keyvan Ravakhah MD MBA FACP
Program Director, Department of Internal Medicine,
St. Vincent Charity Medical Center

Anjan Gupta MD FACC

Department of Cardiovascular Medicine,
St. Vincent Charity Medical Center

Anil Pai MD

Department of Internal Medicine, St. Vincent Charity Medical Center

Michael Canales DPM FCFAS

Department of Podiatry, St. Vincent Charity Medical Center

Maureen Heurich DPM

Department of Podiatry, St. Vincent Charity Medical Center

Raktim Ghosh MD

Department of Cardiovascular Medicine,
St. Vincent Charity Medical Center

Nana Yaa Koram MD MPH

Department of Medicine, St. Vincent Charity Medical Center

Ramyashree Tummala MD

Department of Medicine, St. Vincent Charity Medical Center

Mary Esho MD MPH

Department of Medicine, St. Vincent Charity Medical Center

Kulsoom Fatima MD

Department of Medicine, St. Vincent Charity Medical Center

Ashley Mandela DPM

Department of Podiatry, St. Vincent Charity Medical Center

Lloyd Cook MD

Department of Internal Medicine, St. Vincent Charity Medical Center

Mike Fellenbaum

Medical Student (MS1), NEOMED



ST. VINCENT CHARITY
MEDICAL CENTER

The St. Vincent Charity Medical Center family is committed to the healing mission of Jesus. We serve with: a deep respect for the dignity and value of all persons; our practice of quality care; our dedication to the poor; and, our commitment to education. St. Vincent Charity Medical Center, with the commitment of its Caregivers and physicians, will be a leading model for healthcare delivery in Northeast Ohio based on its faith-based mission, dedication to education, commitment to the communities it serves, excellence in the patient experience it provides, focus on surgical services, and partnerships with physicians and other constituencies.

JOURNAL ARTICLES AND AUTHORS

An Approach to transmetatarsal amputation to encourage immediate weight bearing in diabetic patients

Michael Canales DPM FCFAS;
Maureen Heurich DPM; Ashley Mandela DPM;
Mark Razzante DPM

Depression in Heart Failure: A Teachable Moment
Raktim Ghosh MD; Keyvan Ravakhah MD MBA

Hospice Care: Its Place in the Evolving Models of Healthcare
Nana Yaa Koram MD MPH;
Dervilla McCann MD MPH FACC

Leriche Syndrome: A rare complication following anterior approach lumbar spinal surgery
Ramyashree Tummala MD; Ronak Bhimani MD;
Anjan Gupta MD

Boerhaave's Syndrome: The Importance of Early Recognition
Mary Esho MD MPH; Kusuma Kurmayagri MD;
Anil Pai MD

Knowledge of Advance Directives in the Primary Care Clinic at St Vincent Charity Medical Center: A Quality Improvement Project
Kulsoom Fatima MD; Ajay Kumar MD;
Sohilkumar Manvar MD; Syed Naqvi MD;
Neelima Rao MD; Nana Yaa Koram MD MPH;
Lloyd Cook MD

Carbon Fiber Fixation: A Novel Fixation Technology in Foot and Ankle Surgery
Michael Canales DPM FCFAS;
Ashley Mandela DPM; Joshua Fisher DPM;
Bradley Benson DPM; Gurneet Khangura DPM

CONTRIBUTORS

Kulsoom Fatima MD; Ajay Kumar MD;
Sohilkumar Manvar MD; Syed Z. Naqvi MD;
Neelima Rao MD; Nana Yaa Koram MD MPH;
Raktim Ghosh MD; Keyvan Ravakhah MD;
Nana Yaa Koram MD MPH;
Dervilla McCann MD MPH FACC;
Ramyashree Tummala MD; Ronak Bhimani MD;
Anjan Gupta MD; Mary Esho MD;
Kusuma Kurmayagri MD; Anil Pai MD;
Michael Canales DPM FCFAS;
Maureen Heurich DPM; Ashley Mandela DPM; Mark Razzante DPM; Michael Canales DPM FCFAS;
Ashley Mandela DPM; Joshua Fisher DPM;
Bradley Benson DPM; Gurneet Khangura DPM

St. Vincent Charity Medical Center

2351 East 22nd Street | Cleveland, Ohio 44115
216-861-6200 | www.stvincentcharity.com

We want to hear from you. Send your feedback to researchjournal@stvincentcharity.com

FROM THE EDITOR IN CHIEF



With the election of Donald Trump as our next president, the uncertainty about the future of healthcare in the United States of America has become a stronger force. Mr. Trump promised to repeal the Affordable Care Act, also known as Obamacare, and it seems that is OK with almost everyone.

Once in a while we hear some news indicating that he may keep some parts of it, but would get rid of most of it. And so remains the million-dollar question: Is Obamacare good or bad? Well, you might say it depends; on the person, the profession and organization.

Let us focus on organizations, primarily hospitals and organizations that represent large numbers of physicians. What does the American Hospital Association (AHA) think of Obamacare? If it worked for the hospitals, maybe they should support it. Maybe the American Medical Association (AMA) and the American College of Physicians (ACP) should let the average American know what they think of our new healthcare system. The AHA website seems to be supportive of the Affordable Care Act. It makes sense since the addition of 25 million newly insured Americans who can pay their bills has improved the income of most hospitals, while also improving the care provided to these patients. But, there wasn't any formal statement from them announced on any of the national television channels.

CNN, NBC, CBS, Fox and other news channels did not mention any support or concern from them. The AMA website is even worse. As usual they are so political that if you visit their website you will find nothing for or against Obamacare. Their statement says they are ready to engage on health care reform. What that means, I have no clue. The ACP website was maybe a little bit better; their president sent a letter to their 148,000 members stating their commitment to equal access to care for almost everybody. But again, theirs is a voice that almost nobody hears.

I think the time for everyone to be political is over. One of the reasons Mr. Trump was elected as our next president is because he is not a politician and people are tired of political ways. So, my advice to our leader organizations is, please make up your mind, come up with some clear answers, and tell the public and government what you stand for before it is too late.

Keyvan Ravakhah MD, MBA FACP

Editor in Chief



An Approach to Transmetatarsal Amputation to Encourage Immediate Weight Bearing In Diabetic Patients

By **Michael B. Canales DPM FCFAS, Chief of the Division of Podiatry, St. Vincent Charity Medical Center, Podiatric Surgical Residency; Maureen E. Heurich DPM, St. Vincent Charity Medical Center, Podiatric Surgical Residency; Ashley M. Mandela DPM, Resident, Post-Graduate Year 3, St. Vincent Charity Medical Center, Podiatric Surgical Residency; Mark C. Razzante DPM MA, St. Vincent Charity Medical Center, Podiatric Surgical Residency**

ABSTRACT

Transmetatarsal amputation remains the standard treatment for the unsalvageable diabetic foot; however, this operation is often complicated by wound dehiscence, ulceration, the need for additional surgery and tendon balancing. This technique provides an uncomplicated suturing method for closure of the standard transmetatarsal amputation. A drill hole is created through the first, second and fourth metatarsals which facilitates added stability to the plantar flap of the residual metatarsals and the patients are encouraged to begin protected weight bearing as early as the first postoperative day. The security of the flap promotes immediate weight bearing which could result in less postoperative complications of transmetatarsal amputations. Early weight bearing not only encourages tendon rebalancing but improves angiogenesis through capillary ingrowth.

KEY WORDS: diabetes, amputation, early weight bearing, limb salvage, transmetatarsal

INTRODUCTION

Transmetatarsal amputation (TMA) is a common and effective procedure for limb salvage in the diabetic population. The value of this amputation level is the improved efficiency and functionality of gait. A functional limb is imperative for limb preservation and overall mortality of a diabetic patient [1].

The mortality rate of diabetics significantly increases with more proximal levels of amputation [2]. Brown et al., compared five-year mortality rates in patients with transtibial amputations, partial calcanectomies and total calcanectomies, Chopart's amputations, transmetatarsal amputations and noted that transmetatarsal amputations have the lowest five-year mortality rate at 30% [3]. Functionality and a sound frame of mind are the primary goals when

| continued on p.4

choosing a procedure for limb preservation. In a study by Anthony et al., 52 transmetatarsal amputations were performed and only 18% healed after the initial operation. A more proximal amputation was required in 56% of patients and 83% were ambulatory at a median of 18 months of follow up [4].

Wound dehiscence with subsequent infection may lead to a more proximal amputation. Dunkel et al. found that of 289 transmetatarsal amputations, 16.3% suffered a wound dehiscence and 21.8% had stump infections [5]. Higher rates of complications associated with transmetatarsal amputations have been observed in patients with diabetes mellitus and peripheral vascular disease [Fig. 1]. Patients with infection but no underlying peripheral vascular disease were significantly more likely to heal a transmetatarsal amputation [6]. Pollard found that in 101 transmetatarsal amputations, end stage renal disease is a predictor of poor wound healing potential. In the study, 57.4% of the transmetatarsal amputations healed completely; however, 87.1% had postsurgical complications.

In a study by O'Brien et al., 1205 transmetatarsal amputations were evaluated and early amputation failure was observed to occur 26.4% of the time. Of these transmetatarsal amputations, reoperation to a more proximal amputation was performed within 30 days [7]. Nguyen et al. observed 33 patients with transmetatarsal amputations, 36% of these patients required a more proximal amputation and the average time to the more proximal amputation was three and one-half months [8].

The literature supports adequate peripheral perfusion and glycemic control in preventing postoperative complications in diabetics. Younger et al. concluded the primary fac-

tor determining healing potential was glucose control, suggesting to never perform elective surgery on diabetic patients with a hemoglobin A1c (HbA1c) over eight unless to save life or limb [9].

Overall, transmetatarsal amputations have been found to be a stable procedure with functional outcomes. Various modifications of the technique have been described. This article will illustrate a technical modification that has encouraged early weight bearing in the postoperative course.

SURGICAL TECHNIQUE

Ancillary tendon balancing procedures may be performed at the discretion of the surgeon. The transmetatarsal amputation is performed in a standard fashion maintaining the appropriate metatarsal parabola for optimal plantar pressure across the distal residual foot. The second metatarsal should remain the longest followed by the first, third, fourth and fifth metatarsals [10]. Metatarsals may be beveled plantarly, medially, and laterally in an effort to reduce bony prominences at discretion of the surgeon [11]. All tendons are gently pulled distally with a hemostat and transected allowing them to retract into the proximal residual foot to rid the distal incision of avascular soft tissue and a potential nidus of infection. Interosseus tissues may be kept longer than the metatarsals as described by Terashi et al or may be excised flush with surrounding bony structures [12].

Once the parabola is confirmed clinically and radiographically, a 0.054" Kirschner wire is passed through the dorsal cortex of the first, second, and fourth metatarsals. The fasciocutaneous flap is then approximated to the metatarsals with a horizontal mat-

tress suture of 2-0 polypropylene (Prolene®, Ethicon, Somerville, NJ) [Fig. 2]. A similar technique is described by Bibbo during the Syme level of ankle disarticulation to further stabilize the heel pad to the plantar tibia [13]. The senior author prefers using a FS-1 needle in lieu of a PS-2 or SH needle for ease of passage through the drill hole. The mattress suture begins externally through the plantar flap, passes through the metatarsal drill hole in a dorsal to plantar direction, and exits parallel to the entrance site of the suture where it is then instrument tied [Figure 2]. The subcutaneous layer may be closed with simple interrupted sutures of 4-0 absorbable Polygalactin 910 (Vicryl®, Ethicon, Somerville, NJ). The final skin layer is approximated with a 4-0 Prolene®. A drain may be placed at the discretion of the surgeon [Fig. 3].

The drain is removed on the first postoperative day. A modified Jones compressive dressing and modified fiberglass total contact cast are applied with the residual foot positioned at 90 degrees to the leg. Protected weight bearing is encouraged on the first postoperative day in the modified total contact cast regardless of triceps surae lengthening, tibialis anterior tendon lengthening, or tibialis anterior transfer [Fig. 4]. The sutures are removed three to six weeks post operatively. The cast is

then bivalved and removed postoperatively to allow inspection of the incision. A compression dressing is applied and the existing fiberglass shell can be reapplied and secured with an elastic bandage (Sterile Matrix Elastic Bandage, Medline, Mundelein, IL) or self-adherent bandage (Coban™ LF, 3M, St. Paul, MN) [Figure 4]. A period of protected weight bearing in this fiberglass shell continues until the sixth postoperative week after which patients are transitioned into a diabetic shoe with toe filler, modified knee-ankle-foot orthosis (KAFO) or ankle foot orthosis (AFO). The postoperative course is demonstrated in the Table.

DISCUSSION

Transmetatarsal amputation is the standard treatment for unsalvageable forefoot ulceration and pathology. Several studies have catalogued a variety of complications, such as ulceration, wound dehiscence, and need for proximal amputation following TMA. This procedure can provide a functional residual foot... Additionally, the security of the anterior flap helps to avoid wound dehiscence which may lead to infection and prolonged non weight bearing. Early weight bearing not only encourages tendon rebalancing but improves blood flow by means of enhanced vasoresponsiveness and increased angiogen-

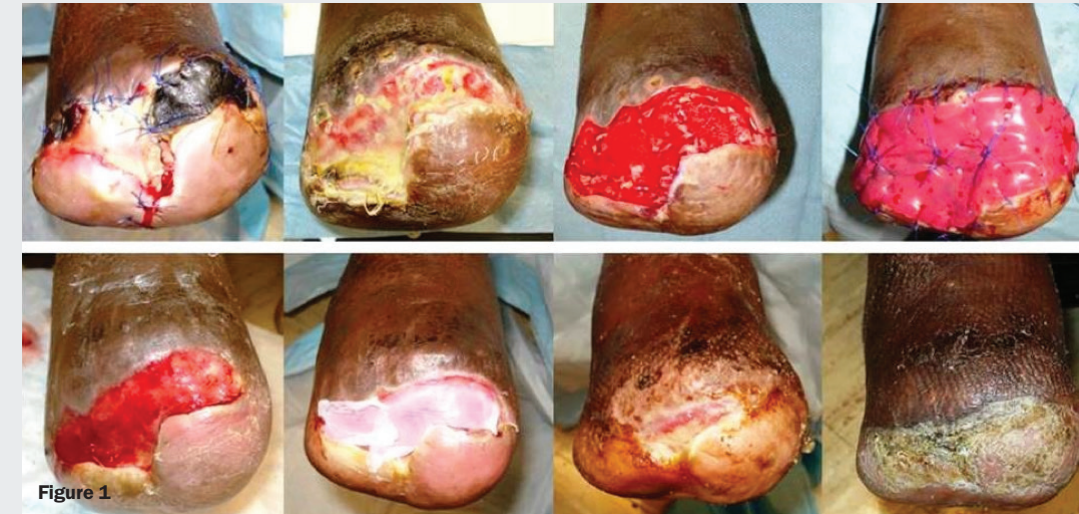


Figure 1

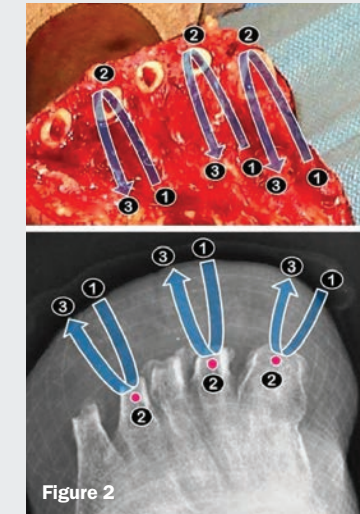


Figure 2



Figure 3



Figure 4

esis which improve oxygen delivery to cells and tissues [14].

Following TMA, total healing rates range from 44-92%, and ambulating rates exceed 77%. One retrospective review of 91 TMA demonstrated a total of 69% of limbs were healed at follow-up. Primary healing occurred in 46% of residual limbs and significantly increased the likelihood of ambulation ($p < 0.0001$) and overall limb salvage ($p < 0.0001$) [15]. Leg amputation was more common when the TMA was not closed (58%) in comparison to when it was sutured or stapled primarily (12%) [16]. Patients with infection, but otherwise without a diagnosis of ischemia, were significantly more likely to heal than those patients with ischemia [17]. Landry

examined predictors of healing in patients with TMA, and found that independent ambulation is significantly more likely in patients with healed TMA (73%) than in patients with non-healed TMA (14%) ($P < 0.001$); in addition, non-ambulation was a predictor of mortality following TMA (62% vs 36%; $P = .04$) [18]. The authors concluded that TMA is a reasonable choice for patients with a greater likelihood of continued ambulation following the amputation.

Compared to other procedures, the TMA provides better patient outcomes in several categories. Various studies demonstrate ambulation rates of less than 50% in trans-tibial amputations. Additionally, the time required to rehabilitate after a transtibial amputation is much lon-

Fig 1 TMA complications often require additional surgical procedures and significant delays in unassisted locomotion. The wound healing complication experienced by the patient above delayed functional ambulation for eight months. **Fig 2** Two depictions of the course of the suture utilized to secure the raised fasciocutaneous flap. The horizontal mattress suture begins externally (1), passes through the drill hole in the metatarsal's dorsal cortex (2), and exits parallel to the entrance point of the suture (3) **Fig 3** Final operative appearance of the secured fasciocutaneous flap **Fig 4** The modified Jones compression bandage with a total contact cast allows for immediate weight bearing in a patient undergoing a TMA on the left lower extremity and a previous Syme ankle disarticulation on the right side. The cast can be bivalved to allow inspection of the incision and subsequently reapplied and secured with self-adherent bandage.

ger than what is required following TMA. Friedmann stated that limb preservation at the transmetatarsal level not only improves gait by "maintaining a foot lever arm," but it also "preserves all but part of heel-off and toe-off and lowers energy expenditure by smoothing the path of the center of gravity during walking," compared to a more proximal amputation that requires prosthesis [19]. Pinzur et al advocate perform-

ing the amputation as distally as possible to preserve limb function and therefore the ability to walk post-operatively. Sixty four patients undergoing midfoot amputation had a total healing rate of 81%. When serum albumin, total lymphocyte count, and Doppler ischemic index were optimized the healing rate improved to 92%. The authors conclude that energy expenditure

| continued on p.19

POSTOPERATIVE COURSE

Postoperative Day	Postoperative Course
1	Modified Jones compression bandage/total contact cast applied, protected weight bearing commences
14+	Cast bivalved and removed to allow for inspection of the incision Bivalved cast reapplied and secured with self-adherent or elastic bandage
21+	Sutures removed
6 weeks+	Transition into KAFO or diabetic shoe with toe filler Continue diabetic foot care visits

Depression in Heart Failure: A Teachable Moment

By **Raktim Kumar Ghosh MD** and **Keyvan Ravakhah MD MBA**

CLINICAL VIGNETTE

A 51-year-old woman with a history of nonischemic dilated cardiomyopathy and New York Heart Association class III heart failure (HF) presented to the emergency room with chest tightness, shortness of breath, increasing pedal edema, and weight gain for two weeks. Her most recent echocardiogram demonstrated a left ventricular ejection fraction of 25-30%, thought to be secondary to cocaine abuse for the preceding two years. Her current admission was her fourth in the past year. During each hospital admission she was treated aggressively as a case of exacerbation of heart failure. Of note, she resides alone in her home and had been deemed “non-compliant” with medical therapy, wearable cardiac defibrillator, and continuous positive airway pressure (CPAP). Her past medical history was significant for hypertension, morbid obesity, hyperlipidemia and obstructive sleep apnea, which were treated with appropriate medications. Her physical examination disclosed a jugular venous pressure of 12 cm of water, grade III/VI holosystolic systolic murmur at the cardiac apex with radiation to her left axilla, bibasilar pulmonary rales, and significant pedal edema up to both knees. Apart from elevated B-type natriuretic peptide and elevated troponin, her remaining laboratory investigations (including complete blood count, thyroid and liver function tests, urine toxicology,

electrocardiogram and chest radiograph) were normal. She was started on intravenous furosemide 40 mg twice daily and her other home medications were resumed. During her hospital stay, she mentioned feeling worthless, fatigued from recurrent admission, a severely restricted social life, and her inability to perform work for the past year. These had not previously been recounted

to her medical providers, and prompted a screening test. Patient Health Questionnaire-9 (PHQ-9) was administered to screen for depression. Her score was 14 out of 27 points, consistent with moderate depression. Psychiatry service was consulted and she was scheduled for cognitive behavioral therapy. Her follow-up visit after 3 months showed improvement of her PHQ-9 score by 8 points with no hospital readmission during this interval.

TEACHABLE MOMENT

Heart failure (HF) is a burgeoning chronic health condition affecting more than 20 million people worldwide. Patients with HF have

a significant (17.1%) 30-day readmission rate, which invites substantial penalty in payment to hospitals from Centers for Medicare and Medicaid Services, as per the newly introduced Hospital Readmissions Reduction Program. Depression is an independent poor prognostic factor in HF patients in terms of mortality and rehospitalization which leads to increased cost of healthcare and poor quality of life. [1] It has a significant prevalence in patients with HF and contributes to the overall poor quality of life in them. Several behavioral (smoking, obesity, lack of exercise and medication non-compliance) and pathophysiological factors (hypercortisolism, elevated in-

Table 1: EFFECT OF INTERVENTIONS ON DEPRESSION IN HF

Antidepressants in HF

- Treating depression with antidepressants may not always improve HF outcomes.
- Safest antidepressant in HF- SSRI.
- S/E of antidepressants that can worsen HF outcomes - hypotension, hypertension, loss of diurnal BP variation, QTc prolongation and fatal arrhythmias (TdP).
- Several notable drug interactions between antidepressants and HF medications.
- MOOD-HF trial failed to show significant improvement of depression with Escitalopram.

Cognitive Behavioral Therapy (CBT)

- Improvement observed in physical function, HRQOL and cardiac event-free survival.
- Promising results with internet-based CBT (ICBT) protocol.
- A special form of CBT (CBT-h) needs to be designed.

Exercise Therapy

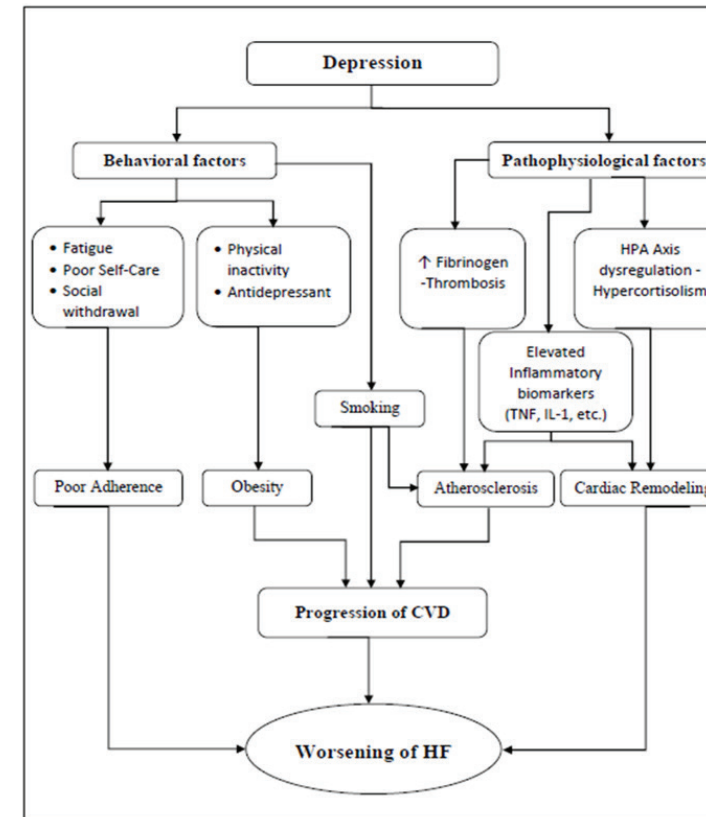
- Aerobic mode found beneficial for depression in HF with reduced EF (HFREF).
- Significant improvement in QOL and reduction in HADS score.
- Drop in epinephrine level noted – possible beneficial effect in HF;
- Increased serotonin release – improvement in depression.
- Favorable effects on hypercortisolism, inflammation, endothelial dysfunction, and hypercoagulability.

Electroconvulsive therapy (ECT) in HF

- Limited data – further study needed.
- Potential adverse CV effects e.g. arrhythmias, hypotension, etc.
- Recent retrospective data observed no major CV complications with ECT in patients with HFREF.

[HF – Heart failure, CV – Cardiovascular, QTc – Corrected QT interval, TdP – Torsade’s de Pointes, CYP – Cytochrome P 450 enzymes, SSRI – Selective Serotonin Reuptake Inhibitors, HRQOL – Health Related Quality of Life, QOL – Quality of Life, HADS – Hospital Anxiety and Depression Scale]

Figure 1: INTRICATE PATHOPHYSIOLOGICAL RELATIONSHIP BETWEEN DEPRESSION AND HF



[TNF – Tumor Necrosis Factor, CVD – Cardiovascular Disease, HF – Heart failure]

flammatory biomarkers, fibrinogen, and atherosclerosis) have been found responsible for the adverse outcome in patients with HF and concomitant depression (Figure 1). [1]

Despite the emerging recognition of the impact of depression on adverse cardiovascular outcomes which is proportionate with the severity of heart failure, depression still remains under-recognized in chronic HF patients. [2] Screening for depression in HF patients continues to be challenging due to a considerable overlap in symptoms. The 2009 American Heart Association (AHA) guidelines on chronic HF management recommend routine

screening of all HF patients for depression with modern screening questionnaires commencing with PHQ-2 and employment of PHQ-9 to investigate depressive symptoms in details in case of a positive PHQ-2 screen. [3]

These imperatives are balanced against the lack of randomized clinical trials to support level I evidence for depression treatment in HF and potential risk of over-diagnosis. The merits of a timely diagnosis of depression in HF patients and subsequent strategies for management (e.g., pharmacologic, cognitive-behavioral) warrant urgent investigation. Published trials on the use of antidepressants and cognitive

behavioral therapy (CBT) have shown variable outcomes. Newer modalities like internet-based CBT have been tried in small studies, with promising results. A recent meta-analysis observed the beneficial role of aerobic exercise training in patients with HFREF (Table 1).

The first step in the evaluation of depressive disorder in HF is recognition of its symptoms, which may largely overlap with HF. Somatic symptoms of major depressive disorder (e.g., fatigue, weight changes, poor sleep) may mimic the symptoms of HF. A thorough review of patient complaints by putting equal emphasis on these symptoms—lack of concentration, diminished energy, insomnia, decreased appetite and anhedonia—along with somatic symptoms—fatigue, weight loss, sleep disturbance—may improve early detection and treatment of depression in HF. [4] Proper triage of heart failure patients to psychiatric consultation with mild to moderate uncomplicated depression and MDD, with or without suicidal ideation, screened with PHQ-9 for comprehensive evaluation is warranted. In effect, a multidisciplinary strategy pertaining to heart failure management starting in the clinic setting with the internist or cardiovascular provider and involving psychiatry may improve cardiovascular longevity and hospital readmission. [5]

Our aforementioned patient was suffering from moderate depression for the past year, which was under-diagnosed due to overlapping HF symptoms and lack of formal questioning and recognition while she was treated aggressively for exacerbation of heart failure in each hospital re-admission. In this case, we hope that timely diagnosis of her depression

References:

1. Angermann CE, Gelbrich G, Störk S, et al. Effect of Escitalopram on All-Cause Mortality and Hospitalization in Patients With Heart Failure and Depression: The MOOD-HF Randomized Clinical Trial. *JAMA*. 2016;315(24):2683-2693. doi:10.1001/jama.2016.7635.
2. Cully JA, Jimenez DE, Ledoux TA, Deswal A. Recognition and Treatment of Depression and Anxiety Symptoms in Heart Failure. *Prim Care Companion J Clin Psychiatry*. 2009;11(3):103-109.
3. Lichtman JH, Bigger JT, Blumenthal JA, et al. Depression and coronary heart disease: recommendations for screening, referral, and treatment: a science advisory from the American Heart Association Prevention Committee of the Council on Cardiovascular Nursing, Council on Clinical Cardiology, Council on Epidemiology and Prevention, and Interdisciplinary Council on Quality of Care and Outcomes Research: endorsed by the American Psychiatric Association. *Circulation*. 2008;118(17):1768-1775. doi:10.1161/CIRCULATIONAHA.108.190769.
4. Hammash MH, Hall LA, Lennie TA, et al. Psychometrics of the PHQ-9 as a measure of depressive symptoms in patients with heart failure. *Eur J Cardiovasc Nurs J Work Group Cardiovasc Nurs Eur Soc Cardiol*. 2013;12(5):446-453. doi:10.1177/1474515112468068.
5. McAlister FA, Stewart S, Ferrua S, McMurray JJV. Multidisciplinary strategies for the management of heart failure patients at high risk for admission: a systematic review of randomized trials. *J Am Coll Cardiol*. 2004;44(4):810-819. doi:10.1016/j.jacc.2004.05.055.



Hospice Care: Its Place in the Evolving Models of HealthCare

By **Nana Yaa Koram MD MPH; and Dervilla McCann MD MPH**

hospice / häspəs / *noun* — a home providing care for the sick, especially the terminally ill.

Archaic: a lodging for travelers, especially one run by a religious order.

HISTORY OF THE HOSPICE MOVEMENT

Hospice, like many other American customs, is an import. The term, in medieval times, referred to a resting place for weary travelers. Dame Cicely Saunders is credited with the creation of the first modern Hospice, St. Christopher's, in London (1948). Further impetus was supplied by the book "On Death and Dying" by Dr. Elisabeth Kubler-Ross, who argued before the senate about the need for more assistance for families and patients who wanted final care at home, in the form of spiritual, emotional, and financial help. Congress passed a Medicare hospice benefit in the Tax Equity and Fiscal Responsibility Act of 1982, and this benefit was made permanent in 1986 by Congress.

In 1989, only 35% of eligible hospice facilities were Medicare-certified and low reimbursement was cited as one of the reasons for slow growth of the program. A

20% increase in reimbursement was therefore granted, and future increases in funding were tied to the hospital market through the Omnibus Budget Reconciliation Act (1989). Gradually, other organized patient groups issued reports on hospice care, and in 1993, the Clinton health reform proposal included hospice as a nationally guaranteed benefit, symbolizing its national acceptance.

By 2004, more than 1 million Americans were served by hospice. Non-cancer diagnoses were brought to center stage when the American Heart Association and the American College of Cardiology released new practice guidelines for treating heart failure that included recommendations regarding the early use of hospice. In 1990, 16% of Medicare hospice recipients had non-cancer diagnoses, but by 2012, more than two thirds of patients had alternative diagnoses, such as dementia, congestive heart failure and chronic

obstructive pulmonary disease (COPD).

HOSPICE TRENDS FROM INCEPTION TO 2014

Since 1982, when the Medicare hospice benefit was authorized, hospice has become increasingly integrated within Medicare, and has been shown to reduce expenditures, reduce hospitalizations, and improve patient and family satisfaction with their care. However, despite its acceptance, and the widespread hope that use of Hospice services would reduce end of life costs, more than 25% of Medicare dollars continue to be allocated to patients in their last year of life (1)(Halpern et al). Additionally, there remain troubling, expensive interventions in the last days of life, such as surgery, as well as evidence that pain control is inadequate in the last year of life.(2)Singer, et al). The mean length of stay in a hospice program has also increased significantly, (from 54 days in 2000 to 86 days in 2010), although the median, 17 to 18 days, has not. A cynical interpretation of these statistics would suggest patients fall into two groups, those admitted too early to hospice, and those that are admitted too late.

Hospice care is now also a major business entity. In the private sector, corporate hospice organizations have purchased smaller organizations in a consolidation movement resulting in the five largest for-profit chains owning 283 agencies. Many of the biggest chains are themselves subsidiaries of larger corporations.

For-profit hospices also have a higher profit margin, relative to non-profit hospices, which may be attributable to having a higher proportion of patients with non-cancer diagnoses, who tend to have longer LOS and require less skilled care (Rezae, et al., 2013).

Recognizing that America is undergoing the greatest demographic shift in its history in which 20% of Americans will be over 65 by 2030, the Institute of Medicine (2014) was prompted to examine problems with integration of systems to support the provision of quality care consistent with the values, goals and informed preference of people with advanced serious illnesses. Specific recommendations were made for reform in ambulatory hospice delivery, required reporting of quality measures, and enhanced professional education and skills development along with public education and engagement to ensure high quality of care delivery at the end of life.

ELIGIBILITY FOR HOSPICE CARE

Medicare hospice care is provided under Medicare Part A, covering hospital admission care (Rezae, et al., 2013). To be eligible for Medicare hospice services, the patient's attending physician and the hospice medical director must certify that the individual is terminally ill, with the certification of terminal illness supporting a life expectancy of 6 months or less (CMS, 2014). Since 1983, the basic requirement of hospice care is that a patient unselects curative

treatments in order to receive hospice care (Taylor, 2012). Hospice care is available for two periods of 90 days and an unlimited number of subsequent 60-day periods (Rezae, et al., 2013), after which recertification is needed for the beneficiary to switch, or revoke hospice care (CMS, 2015).

HOSPICE PAYMENT MODEL

Since the inception of the Medicare Hospice Benefit, hospices have been paid on a daily per diem rate, with this global payment covering all care related to the terminal diagnosis (MedPAC, 2010). This capitated per diem rate is fixed regardless of the care needs of the patients or the services provided (Wachterman, Marcantonio, Davis, & McCarthy, 2011). The categories of care provided are routine home care, continuous home care, inpatient respite care and general inpatient care, with the per diem rate changing based on the category of care provided (MedPAC, 2010). Routine home care provides services at home for a range of ordinary days, and comprises the vast majority of hospice days covered by Medicare (94.1%), with continuous home care covering periods of patient crises that can be accommodated at home(Nicosia, Reardon, Lorenz, Lynn, & Beeuwkes, 2009).

Inpatient respite care covers short periods to give the primary care provider a break, and inpatient care is for symptoms that cannot be managed in other settings (Nicosia, Reardon, Lorenz, Lynn, & Beeuwkes, 2009). Currently, Medicare beneficiaries comprise 84% of patients in hospice, and about 40% of Medicare decedents use hospice annually (Wachterman, Marcantonio, Davis, & McCarthy, 2011). Medicare total spending on hospice in 2013

was approximately \$15 billion (MedPAC, 2014), accounting for just 2% of Medicare payments (NHPCO, 2015), and up from \$2.9 billion in 2000 (MedPAC, 2012).

Unlike other Medicare payment systems, hospice payments are not adjusted for case mix, urban/rural location, costly outliers or other factors that could affect costs (Nicosia, Reardon, Lorenz, Lynn, & Beeuwkes, 2009). The payments are only adjusted for wage differences in the different regions (Nicosia, Reardon, Lorenz, Lynn, & Beeuwkes, 2009). This has resulted in increasing concern among policy makers and researchers that this may create incentives for providers to select patients with particular diagnoses or longer expected length of stay(Huskamp, Buntin, Wang, & al, 2001; MedPAC, 2002; Moon & Boccuti, 2002; Tibi-levy, Le Valiant, & de Pouvourvieve, 2006).

Patients with non-cancer diagnoses in 2010 accounted for 64.4% of hospice admissions, and extended the average LOS, perhaps due to increased difficulty prognosticating a 6-month survival (17) (NHPCO, 2012). The percentage of all Medicare hospice patients with a terminal diagnosis of cancer dropped from 52.8% in 1998 to 31.1% in 2008 (CMS, Medicare Hospice Data Trends 1998-2008). These non-cancer hospice patients differ from other patients in the intensity of services used, length of stay, location of care (e.g. home versus nursing home), and may be older, with possibly a higher number of co-morbidities and lower probability of a living partner to act as a caregiver(Nicosia, Reardon, Lorenz, Lynn, & Beeuwkes, 2009).

The average LOS for such diagnoses as chronic kidney disease and cancers remained stable between

1998-2008, whilst the average LOS increased significantly for other diagnoses, such as Alzheimer's disease, non-Alzheimer's dementia, and others (Rezae, et al., 2013). These factors may affect service utilization and cost of care among these patients, with evidence suggesting increased use of more expensive elements as drugs, nursing, social services and durable medical equipment (Office, 2004).

Another concern with the current payment model is that it no longer accurately reflects costs because of changes in provider, patient and service characteristics (Huskamp, Buntin, Wang, & al, 2001). Despite the recognition of these issues, the Medicare claims and facility cost reports account for the number of days billed, the per diem payments and expenditure by category, but don't measure the resource utilization such as number and length of visits, etc., and allocation of costs to individual patients (Nicosia, Reardon, Lorenz, Lynn, & Beeuwkes, 2009). As a result, the differences in service utilization and costs across diagnoses and variations in intensity of care among patients cannot be examined directly (Nicosia, Reardon, Lorenz, Lynn, & Beeuwkes, 2009).

Medicaid is responsible for health service payment for eligible low income people. Medicaid SNF residents cannot simultaneously access Medicare hospice, unless the SNF care is unrelated to the terminal condition (Gozalo, Miller, Intrator, Barber, & Mor, 2007). Thus, when dual-eligible SNF residents elect hospice care, it becomes the responsibility of Medicaid, not Medicare (Gozalo, Miller, Intrator, Barber, & Mor, 2007). However, due to the lower Medicaid per diem payments, relative to Medicare per diem rates,

there is a financial disincentive to promote hospice enrolment among short-stay nursing home residents. (Gozalo, Miller, Intrator, Barber, & Mor, 2007).

Most private insurers pay for hospice care. Therefore, patients with private insurance can opt for hospice care, with the costs being covered by their insurance minus co-pays and coinsurance.

COST OF CARE AT THE END OF LIFE

The stubborn persistence of high cost in the last year of life has prompted a re-examination of the forces impacting current end of life practices. These include the entry of for-profit corporations in the world of end of life care, the structure of the hospice payment systems, and the lack of integration between hospice and other health services such as palliative care. With the increased use of hospice both in nursing homes and private homes, the costs of the program, funded predominantly by Medicare, have grown substantially, quadrupling in the decade from 2002 to 2012 (Stevenson, NEJM 2012). Palliative care programs have also had significant growth. These programs are not limited to the last 6 months of life, and are designed to relieve suffering from chronic pain or symptomatic disease. Hospice and palliative care are often confused. Palliative care, as defined by the World Health Organization, is an approach that improves the quality of life of patients and their families impacted by life threatening illness through the identification and treatment of pain and other physical, psychosocial and spiritual problems. Palliative care is not paid through the same system as Hospice care.

| continued on p.10

Although it is paid for through Medicare part B, neither Medicare or Medicaid currently use the language “Palliative care” in the description of covered services. As a result, insurance coverage for palliative care is inconsistent, and incomplete. Frequently, patients must absorb costs for palliative care through copays and coinsurances to Medicare part B. Private insurance is also inconsistent in coverage for palliative care, despite recent evidence that palliative care is cost effective. (May, P J. Palliat. Care 2014).

AFFORDABLE CARE ACT AND ITS EFFECT ON HOSPICE

In 2009, CMS implemented a seven-year phase cut of the Budget Neutrality Adjustment Factor (BNAF), a key element in the calculation of the Medicare hospice wage index, resulting in a permanent reduction in hospice reimbursement rates of approximately 4.2% (NHPCO, 2015). The introduction of the Affordable Care Act (ACA) further altered the Medicare hospice rate formula through the introduction of a “productivity adjustment factor,” which will reduce annual hospice payments by an additional 7.4% over the next 10 years (NHPCO, 2015). Additionally, hospice payment authority has been transferred from Congress to the Secretary of Health and Human Services, who is mandated to collect and analyze data in order to implement a new hospice payment model (NHPCO, 2015).

SUGGESTED PAYMENT REFORMS

Suggested payment reforms include a case-mix or outlier adjustment to the hospice payment model, as pertains in other areas of Medicare payments (Rezae, et al., 2013). In addition, it has been

noticed that hospice costs follow a U-shaped payment system, with higher utilization and costs at the beginning, followed by relatively lower use as LOS increases, and higher resource use just prior to death (GAO, 2004; Huskamp, Stevenson, Grabowski, Brennan, & Keating, 2008). Several researchers have therefore recommended an intensity-adjusted payment model accurately reflecting resource use patterns (Rezae, et al., 2013). Hospice care for nursing home residents has been found to cost much less than for non-resident hospice patients, suggesting possible financial benefits for hospices to serve nursing home patients (Huskamp, Stevenson, Grabowski, Brennan, & Keating, 2008). Therefore, payment refinements specific to nursing home hospice care has been proposed, with a downward adjustment to hospice per diem rates for nursing home residents, and a separate end of life Medicare benefit for these nursing homes that will pay them directly for hospice services, and hold them accountable for high quality end-of-life (Rezae, et al., 2013).

CONCLUSION

Hospice care is a vital and indispensable service to people with terminal illnesses, but the landscape of hospice providers is changing. Additionally, there is a disconnect between how the public wish to be treated at the end of life, and how care is actually delivered. Under the current payment model, Medicare remains the biggest payer. The current global per diem payment model allows system abuse and payment fraud and provides no incentive for quality. The Affordable Care Act has proposed changes to the current payment formula, with the introduction of a

production adjustment factor, potentially reducing payments by up to 7.4%. The IOM report, “Dying in America” suggest the need for a comprehensive review of the hospice system, its payment, delivery, and monitoring model, along with redesign of physician education, public engagement, and policy reform to encourage an integrated approach to care. Perhaps in no other phase of life is the public so vulnerable, and the need so great to provide care with true value; the highest quality care for the terminally ill, at the fairest price.

References

1. www.cdc.gov/Aging/advancecare-planning/index.htm
2. *Best Care at Lower Cost: The path to Continuously Learning Health Care in America*, Wash DC, National Academies 2013
3. CAPC. Growth of Palliative Care in the US. Hospital Snapshot
4. Casaret, D. (2011). Rethinking Hospice Eligibility. *JAMA*, 305(10), 1031-1032.
5. Cassarett, D., Crowley, R., Stevenson, C., Xie, S., & Teno, J. (2005). Making difficult decisions about hospice enrollment: What do patients and families want to know? *Journal of American Geriatrics Society*, 53, 249-254.
6. Cassell, C., & Vladeck, B. (1996). ICD-9 code for palliative or terminal care. *N Engl J Med*, 135, 1232-1234.
7. CMS. (2013, December). *www.cms.gov*. Retrieved May 08, 2015, from [www.cms.gov: http://www.cms.gov/outreach-and-education/Medicare-Learning-Network-MLN/MLNProducts/downloads/hospice_pay_sys_fs.pdf](http://www.cms.gov/outreach-and-education/Medicare-Learning-Network-MLN/MLNProducts/downloads/hospice_pay_sys_fs.pdf)
8. CMS. (2014). *Medicare Program; FY 2015 Hospice Wage Index and Payment Rate Update; Hospice Quality*
9. *Reporting Requirements and Process and Appeals for Part D Payment for Drugs for Beneficiaries Enrolled in Hospice*. Washington DC: Department of Health and Human Services.
10. CMS. (2015). *Medicare Benefit Policy Manual: Coverage of Hospice Services under Hospital Insurance*. Baltimore: Center for Medicaid and Medicare Services.
11. CMS. (n.d.). *Medicare Hospice Data Trends 1998-2008*. Retrieved May 08, 2015, from [www.cms.gov: http://www.cms.gov/Medicare/Medicare-fee-for-service-payment/hospice/index.html](http://www.cms.gov/Medicare/Medicare-fee-for-service-payment/hospice/index.html)
12. CMS. (n.d.). Retrieved 05 07, 2015, from [www.cms.gov: http://www.cms.gov/Center/Provider-Type/Hospice-Center.html](http://www.cms.gov/Center/Provider-Type/Hospice-Center.html)
13. Committee on Approaching Death, IOM: Dying in America; Improving Quality and Honoring Individual Preferences Near the end of Life Wash D.C. National Academies Sept 2014
14. Field, M., & Cassell, C. e. (1997). *Approaching Death. Improving Care at the End of Life*. Washington DC: National Academy Press.
15. GAO. (2004). Medicare hospice care: Modifications to payment methodology may be warranted. Washington, DC: Government Accountability Office.
16. Gibson, M., Kimbrel, J., Protus, B., Perdue, W., & Arradaza, N. (2012). Medication costs across hospice stay: an evaluation of medications costs in response to the MedPAC proposed reimbursement model. *American Journal of Hospice and Palliative Medicine*, 30(7), 670-675.
17. Gleckman, Howard, Hospice is becoming a Chain Business. <http://www.forbes.com/sites/howardgleckman>
18. Gozalo, P., Miller, S., Intrator, O., Barber, J., & Mor, V. (2007). Hospice effect on government expenditures among nursing home residents. *Health Research and Educational Trust*, 134-153.
19. Gozalo, Pedro et al, Changes in Medicare Costs with the Growth of Hospice Care in Nursing Homes, *NEJM* 372:19 1823-31
20. Halpern, Scott D MD PhD and Ezekiel Emmanuel: Can the U.S. Buy Better Advance Care Planning *Ann Intern Med*. 2015; 162(3):224-225. doi:10.7326/M14-2476
21. Hamel, MaryBeth, Investing in Better Care for Patients Dying in Nursing Homes, *NEJM* 372:19, May 2015
22. Huskamp, H., Buntin, M., Wang, V., & al. e. (2001). Providing care at the end of life: Do Medicare rules impede good care? *Health Affairs*, 20(3), 204-211.
23. Huskamp, H., Stevenson, D., Grabowski, D., Brennan, E., & Keating, N. (2008). Variations in patients' hospice costs. *Inquiry*, 45, 232-244.
24. Johnson BH, Abraham: Partnering with Patients, Residents and Families. Bethesda Md, Institute for Patient and Family Centered Care
25. Lupu D; American Academy of Hospice and Palliative Care Medicine Workforce Task Force; Estimate of current hospice and palliative medicine physician workforce shortage; Pain Symptom Management 2010
26. May P, Norman C, Morrison RS: Economic Impact of Hospital Inpatient Palliative Care Consultation. A review of Current Evidence and Directions for Future Research *J Palliat Med*. 2014 Sep; 17(9):1054-63. doi: 10.1089/jpm.2013.0594. Epub 2014 Jul 1
27. MedPAC. (2002). *Report to Congress: Medicare Beneficiaries' Access to Hospice*. Medicare Payment Advisory Commission.
28. MedPAC. (2010). *Report to Congress: Medicare Payment Policy*. Medicare

29. MedPAC. (2011). *Report to the Congress: Medicare Payment Policy, March 2011 Report*. Washington DC: Medicare Payment Advisory Commission.
30. MedPAC. (2012, March). *Report to Congress: Medicare Payment Policy Chapter 11, Hospices Services*. Retrieved May 08, 2015, from [www.medpac.gov: http://www.medpac.gov/documents/reports/march-2012-report-to-the-congress-medicare-payment-policy.pdf?sfvrsn=0](http://www.medpac.gov/documents/reports/march-2012-report-to-the-congress-medicare-payment-policy.pdf?sfvrsn=0)
31. MedPAC. (2013, March). *Hospice services, Chapter 12*. Retrieved May 08, 2015, from [www.medpac.gov: http://www.medpac.gov/documents/reports/mar13_ch12.pdf?sfvrsn=0](http://www.medpac.gov/documents/reports/mar13_ch12.pdf?sfvrsn=0)
32. MedPAC. (2014, December 16). Public Meeting. Medicare Payment Advisory Commission.
33. Meier, DE, Morrison RS. American Care of Serious Illness: a State by State Report Card on Access to Palliative Care in our Nation's Hospitals, 2013 <http://www.CAPC>
34. Moon, M., & Boccuti, C. (2002). Medicare and End-of-Life Care.
35. NHPCO. (2012). *NHPCO Facts and Figures: Hospice care in America*. Washington DC: National Hospice and Palliative Care Organization.
36. NHPCO. (2015, January). *The Medicare Hospice Benefit*. Retrieved May 8, 2015, from [www.nhpc.org: http://www.nhpc.org/sites/default/files/public/communications/Outreach/The_Medicare_Hospice_Benefit.pdf](http://www.nhpc.org/sites/default/files/public/communications/Outreach/The_Medicare_Hospice_Benefit.pdf)
37. Nicosia, N., Reardon, E., Lorenz, K., Lynn, J., & Beeuwkes, B. (2009). The Medicare Hospice Payment System: A Consideration of Potential Refinements. *Health Care Financing Review*, 30(4), 47-59.
38. Office, U. G. (2004). *Medicare Hospice Care: Modification to Payment Methodology May be Warranted*. Washington DC: U.S. Government Accountability Office.
39. Pizzo, Philip A. MD: The Doctors for Life and the End of Life. 'Ideas and Opinions. *Annals Int Med*, 3 Feb 2015, Vol 162:3 pp 228-29
40. Pizzo, Phillip and Walker David, Should we Practice What we Profess? Care near the End of Life, *NEJM* Feb 12 2015 372:7.pp 595-597
41. Rezae, M., Luallen, J., Pozniak, A., Gerteis, J., Edwards, A., Bradshaw, B., et al. (2013). *Medicare Hospice Payment Reform: A Review of the Literature*. Providence: Brown University Center for Gerontology and Healthcare Research.
42. Singer, Adam E, M Phil, Meeker, Daniela PhD: Symptom Trends in the Last Year of Life from 1998 - 2010, a Cohort Study *Ann Intern Med*. 2015; 162:175-183. doi:10.7326/M13-1609
43. Stevenson, David, Growing Pains for the Medicare Hospice Benefit, *NEJM*, 2012;367:1683-1685
44. Taylor, D. (2012). Medicare as Insur-

- ance Innovator: The Case of Hospice. *American Journal of Hospice and Palliative Medicine*, 30(6), 556-557.
45. Tibi-levy, Y., Le Vaillant, M., & de Pourvoirvivo, G. (2006, march). Determinants of resource utilization in four palliative care units. *Palliative Medicine*, 20(2), 95-106.
46. Wachterman, M., Marcantonio, E., Davis, R., & McCarthy, E. (2011, February 2). Association of hospice agency profit status with patient diagnosis, location of care, and length of stay. *JAMA*, 305(5), 472-479.
47. Weinberger S.E, Johnson BH, & Ness DC: Patient and Family Centered Medical Education: The next Revolution in Medical Education? *Ann Int Med*. 2014; 161: 73-5
48. www.iom.edu/Reports/2014/Dying-In-America-Improving-Quality-and-Honoring-Individual-Preferences-Near-the-End-of-Life.aspx
49. www.nhpc.org/history-hospice-care
50. (<http://www.iom.edu/Reports/2014/Dying-In-America-Improving-Quality-and-Honoring-Individual-Preferences-Near-the-End-of-Life.aspx>)

Poem to a Cadaver

The humanity disappears quickly,
Pieces of you, on the table, my hands.
Your kingdom awaits,
and you wait patiently.

One last lesson
A gift to those you will never know.
Altruism in truth and pun,
A remarkable double entendre, bestowed.

You laugh with us, as we cut into you.
Your steel grin.
Our shortcomings, naked.
Our insecurities, deftly dissected.

Is your repose familiar, homespun?

You come home with me, your scent ubiquitous.
As I put my children to bed,
As I drink my wine,
As my eyes fasten.

Never contemporaneous, you and I.
How strange, our secret.

The humanity will return,
Yours and then mine.
I wonder, but you must already know.

—Mike Fellenbaum (M1)



Leriche's syndrome: A rare complication following anterior approach lumbar spinal surgery

By **Ramyashree Tummala MD; Ronak Bhimani MD; Anjan Gupta MD; and Keyvan Ravakhah MD**

ABSTRACT

Leriche's syndrome is an aortic occlusive disease, which is due to obliteration of distal aorta above the site of bifurcation of common iliac arteries. Post-surgical acute Leriche's syndrome is rare and needs a strong index of suspicion to diagnose. We report a case of thrombotic occlusion of infrarenal aorta, with acute presentation of sensory and motor impairment 3 weeks following anterior lumbar interbody fusion surgery (ALIF). The diagnosis was made from symptoms and physical examination which was later confirmed by computed tomography angiography. The patient received emergent aortoiliac endarterectomy and aortobifemoral bypass. This report attempts to remind internists about this rare but potentially fatal complication of spinal surgeries and also the importance of vascular examination in patients with the presentation of neuropathy. This case summary also emphasizes on mechanism of formation of thrombus in patients with anterior approach spinal surgeries and its prevention.

BACKGROUND

Leriche's syndrome is an aortic occlusive disease, which is due to obliteration of distal aorta above the site of bifurcation of common iliac arteries [1]. The classic triad of symptoms include claudication, impotence, and absent or decreased femoral pulses [2]. It may be acute or chronic in onset. Most

of the cases are chronic in nature due to baseline pathophysiology involving atherosclerotic changes in the aorta. Risk factors like hyperlipidemia, hypertension, diabetes would aggravate the underlying chronic condition [1]. Acute cases are rare and are usually related to acute thrombus occlusion.

Injuries of the thoracic and abdominal aorta after spine surgery are rare but may result in severe life threatening complications. Acute and chronic vascular injuries such as perforations leading to major bleeding or hematoma formation, erosions or pseudoaneurysm formation are some of the vascular complications of lower spinal surgeries [2, 3,4]. However, most injuries are delayed due to chronic irritation of the aortic wall.

The majority of spinal surgery complications highlight neurological sequelae, while vascular issues are less frequent [5]. Post spinal surgery Leriche's syndrome often misdiagnosed because of overlapping symptoms of pseudo-claudication from spinal canal stenosis. We highlight a case of acute Leriche's syndrome after Anterior Lumbar Interbody Fusion (ALIF) surgery, and its presentation.

CASE PRESENTATION

A 58-year-old male patient presented to the hospital 3 weeks after ALIF surgery at L2-S1, performed due to lumbar spinal stenosis. He reported sudden numbness, tingling and weakness of both lower extremities from the waist down.

He had none of these lower extremity symptoms before surgery. Prior to his visit to our emergency department (ED), he was discharged from two EDs in last 48 hrs with the diagnosis of diskitis. Review of system included new onset leg claudication but no rest pain. The patient had blood pressure of 140/95 mm Hg, a heart rate of 80 beats/min and a respiratory rate of 16 breaths/min, whereas laboratory tests were inconspicuous. His past medical history was significant for osteoarthritis, chronic back pain, and hypertension.

There was no prior history of peripheral vascular disease, coronary artery disease, hypercoagulable state or prior thrombosis formation. Only past surgical history included an operative history of ALIF of L2-S1, 3 weeks prior to presentation for lumbar spinal stenosis. He was a chronic smoker with 30-year history. There was no associated fever, abdominal pain, nausea, vomiting, bladder or bowel incontinence. Initially, all his symptoms were attributed to post-surgical changes leading to pseudo-claudication and other symptoms. At this point, our differentials for sudden sensory and motor deficit in lower extremities (LE) were spinal cord compression, spinal cord abscess, retroperitoneal hematoma and myelopathy.

On physical examination, he was alert and oriented. There was no point tenderness noted on palpation of the back. Abdomen was soft on palpation and normal

bowel sounds heard without any tenderness. In neurological examination, there was loss of sensation to fine and crude touch in both lower extremities up to the mid thighs (L2-S1) and 4/5 power with +2 reflexes (patellar and ankle). The motor and sensory system of L1 distribution was normal. Babinski's sign was present bilaterally. Rectal sphincter tone was normal. Patient had no sensory or motor deficits in the upper extremities. I-XII Cranial nerves intact. Vitals were stable.

Review of operative note revealed, that anterior aspect of lumbosacral spines was reached by the surgeon through retroperitoneal approach, following left paramedian incision. Exposure of the disks was accomplished after mobilization of left iliac vessels to the right side and retraction by a malleable retractor. During disk removal and positioning the cages, the major vessels were mobilized to right side and protected by the retractor. No direct injury to any vessels or excessive bleeding leading to hematoma was noted intraoperatively. The operative time was approximately 4 hours.

WORK-UP

Routine blood works including complete blood count with differentiation, complete metabolic profile, erythrocyte sedimentation rate, C-reactive protein, creatinine kinase were normal.

Due to strong suspicion of complications from recent spinal

surgery Computed Tomography (CT) of the thoracolumbar spine was ordered which showed anterior interbody fusion changes at L2-S1 with intact hardware. Mild to moderate multilevel central canal narrowing was noted in CT scan; which was secondary to scar tissue in the anterior epidural recesses, consistent with recent surgical history. Imaging study ruled out any critical central canal stenosis, acute lumbar osseous injury or paraspinous abscess. There was not enough evidence of myelopathy and radiculopathy from the CT and blood works, explaining the symptoms. His condition did not improve despite steroid treatment as well. Then we started looking for vascular causes. CT angiography of abdomen and pelvis was performed, which ruled out intramural hematoma or aortic dissection. However, there was extensive aortoiliac atherosclerotic disease with long segment occlusive thrombosis of infrarenal abdominal aorta by a crescentic mural thrombus (Figure 1 and 2). As part of acute thrombosis work up, hypercoagulable studies were normal. No abnormal cardiac rhythm including atrial fibrillation was detected in the telemetry. Transesophageal echocardiography ruled out any left atrial thrombus. There were no compressive lymph nodes or any other structure compressing on the aorta. Diagnosis of acute Leriche's syndrome was established which was attributed to acute vascular injury following ALIF. The patient underwent emergent aortoiliac endarterectomy (TEA) and aortobifemoral bypass (AFB). During the surgery, acute thrombus was found in the more proximal infrarenal aorta which was retrieved and then dacron graft was placed. His postopera-

tive period was uneventful with complete resolution of symptoms within next 48 hours. Postoperative, the patient was started on anti-thrombotic therapy. The symptoms completely resolved post vascular surgery interventions and he was followed up as an outpatient after a week. He resumed his regular lifestyle without any residual symptoms. Although the patient had risk factors for Leriche's syndrome, the acuity of the presentation was attributed to his recent surgical intervention where abdominal aorta was likely traumatized. The injury to aortic endothelium resulted in acute thrombus formation.

DISCUSSION

Leriche's syndrome is an occlusive disease of aorta which is characterized by triad of symptoms like erectile dysfunction, claudication of thighs and legs and diminished or absent femoral pulses [6].

There are many causes of acute Leriche's syndrome like surgical manipulation, trauma, thromboembolic disease, hypercoagulability, atrial fibrillation, neoplasm, intraplaque hemorrhage in an aneurysm. Post-surgical Leriche's syndrome is rare and needs a strong index of suspicion to diagnose. Surgical treatment of adult lumbar spinal disorders are associated with substantial risk of intra, peri, and postoperative complications [7]. A systematic review conducted by Wood et al [16] showed that vascular injury in elective anterior lumbosacral surgery is less than 5% and complications being thrombosis, pulmonary embolism, and prolonged hospitalization. It is shown that vascular complications after anterior fusion (ALIF) range from 1.9 to 5.6% in the general population [5, 8, 9]. The vascular complications can be in the form of



Figure 1

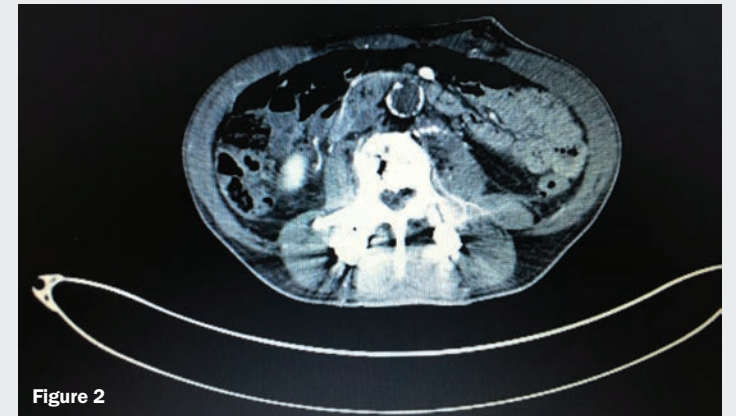


Figure 2

acute thrombosis, retroperitoneal hemorrhage and injury to the major blood vessels.

We highlight the rare case of acute Leriche syndrome following ALIF surgery which was initially misdiagnosed. Firstly, the patient's presentation of sensory and motor impairment misled physicians to have impression of neuropathy. Secondly, ischemic neuropathy is rarely caused by Leriche's syndrome [10, 11]. Another reason for misdiagnosis is his recent spinal surgery. Though the patient was at risk for thrombus formation due to risk factors and atherosclerosis, the interesting part was the acute presentation of

Figure 1: Enhanced computed tomography of thorax and abdomen imaging (sagittal reformation) shows a complete thrombosis of the distal aorta below the left renal artery, extending to the common iliac bifurcations.

Figure 2: Enhanced computed tomography imaging (axial) demonstrates an acute thrombus in the abdominal aorta (arrow) causing complete occlusion

symptoms. There was a case study in 2003 which reported 8 cases arterial complication following ALIF in which possible risk factors were analyzed. The authors encountered six cases of common iliac artery occlusion and two cases of acute vaso-

| continued on p.19

Boerhaave's Syndrome: The Importance of Early Recognition

By **Mary A. Esho MD MPH; Kusuma Kurmagayari MD; and Anil Pai MD**

Boerhaave's syndrome is a transmural[1] effort rupture of the esophagus with increased intraesophageal pressure from straining, vomiting or coughing combined with negative intrathoracic pressure [2, 3]. Approximately 15% are spontaneous[4] while 85-90% are iatrogenic. The incidence is about 3.1 in 1,000,000 cases per year[5].

Mortality rate is 14% for treatment onset within 24 hours of incident versus 27% after 24 hours and is heralded by mediastinitis and sepsis[6]. Hence, the aim of this report is to underscore the impact of an early versus delayed diagnosis on treatment outcome.

CASE REPORT

A 51-year-old Caucasian man presented with sudden onset of sharp retrosternal chest pain of 1 hour. This started immediately after the inability to swallow the first bite of his breakfast. Pain was rated 8/10, non-radiating, worse with deep breathing and followed by vomiting of bright red blood. He denied cough, SOB, fever and chills.

He had a history of type 2 DM, arthritis (with long-term use of ibuprofen) and alcohol abuse. He was a smoker for 12 years and consumed 6 cans of beer daily. Ten years prior he had dysphagia, was diagnosed with peptic stricture and underwent repeated mechanical dilations at another facility.

On examination, BP was 172/97, pulse 71, temperature 37, RR 20, pulse oximetry 96% on room air. He was awake, alert but in moderate painful distress. There was epigastric tenderness,

no rigidity, guarding or rebound tenderness. Other systems were unremarkable.

Chest x-ray showed a streaky opacity in the right lung base with soft tissue air at the lower neck. CT chest showed a right pneumothorax and pneumomediastinum tracking around the subcutaneous soft tissues of the neck and all the way down the lesser curvature of the stomach. There was also a right pleural effusion.

He was intubated, admitted to the ICU and commenced on antibiotics. He subsequently underwent a Gastrografin fluoroscopy, which showed no contrast extravasation. The EGD showed an esophageal tear with fibrosis and a false lumen. Due to the extensive esophageal damage, he underwent a video assisted thoracoscopic surgery (VATS) esophagectomy, esophagostomy, gastrostomy and jejunostomy tube placements. He was eventually discharged home.

DISCUSSION

Risk factors for Boerhaave's syndrome include medication-induced esophagitis (NSAIDs, bisphosphonates), alcohol abuse, eosinophilic esophagitis and Barrett's esophagus. However, the condition may also occur in normal underlying esophagus[2, 3].

Severe straining, coughing or weightlifting may lead to increased intraesophageal pressure and negative intrathoracic pressure [2, 4]. This results in a longitudinal esophageal tear [2, 3], most commonly in the left

posterolateral aspect of the distal intrathoracic esophagus. Other possible rupture sites include cervical and intraabdominal esophagus [8].

Intrathoracic rupture results in leakage of gastric contents into the mediastinal cavity, leading to chemical mediastinitis, bacterial infection, mediastinal necrosis, sepsis and if untreated, organ failure [6, 8].

Conversely, the cervical esophageal rupture favors a more innocuous course. This is due to the attachment of the esophagus to the paravertebral fascia slowing down the spread of mediastinal contents and esophageal flora[10].

Clinical presentation includes severe neck pain or dysphagia for cervical esophageal rupture [7]. There could be retrosternal chest and epigastric pain radiating to the shoulder (for intrathoracic and intraabdominal ruptures respectively). The course of the disease may be rapid as patients may develop odynophagia, dyspnea and sepsis within hours after perforation[10]. Subcutaneous emphysema may result in crepitus on palpation of the chest wall or neck.

Chest radiograph may show free peritoneal air, mediastinal air/widening, hydrothorax, and hydropneumothorax [2]. Neck radiograph may show subcutaneous emphysema in the paravertebral tissues. However, these findings are not sensitive for an esophageal perforation [19].

Hence, diagnosis is established with contrast esophagram or chest CT. Contrast esophagram

with Gastrografin or barium reveals the perforation site by contrast extravasation [13]. Gastrografin is preferred because of its water-soluble property. Barium has a strong propensity for inducing mediastinal and pleural inflammation, albeit better at delineating smaller perforations than Gastrografin [17].

Chest CT reveals esophageal edema, mediastinal widening, pneumothorax and pneumomediastinum [14-16].

Upper endoscopy is indicated wherein imaging fails to identify the location of the perforation. However, a controversy lies in the risk of further extension of the perforation and introduction of air into the mediastinum by the endoscope and air insufflation [11].

Medical management is reasonable when [9] :

- The leak is confined to the neck or mediastinum

- There is retrograde flow of contrast into the esophagus from perforation cavity

- There is absence of sepsis

- There is easy availability of an experienced thoracic surgeon in the event of clinical deterioration

The opposite holds true regarding indications for surgical intervention [9,18]. Medical management comprises keeping the patient NPO, parenteral nutritional support, broad-spectrum antibiotics, IV fluids, proton pump inhibitors and chest tube placement for air or fluid removal.

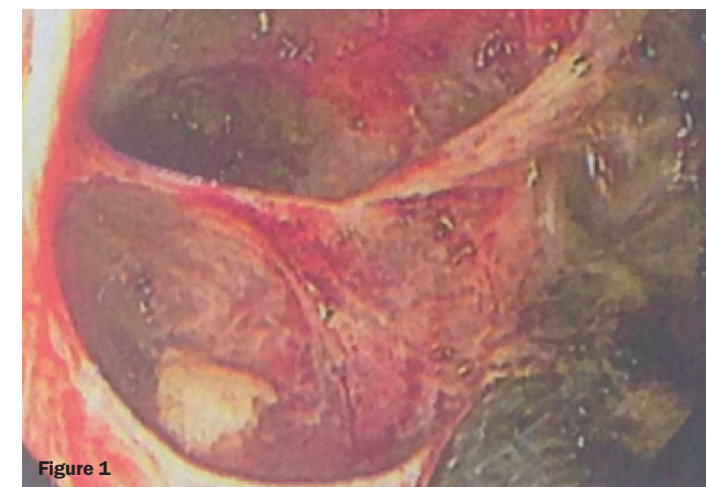


Figure 1



Figure 2

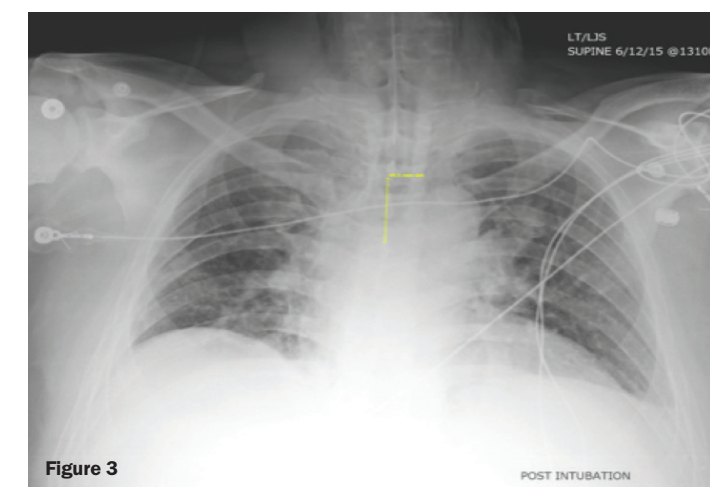


Figure 3

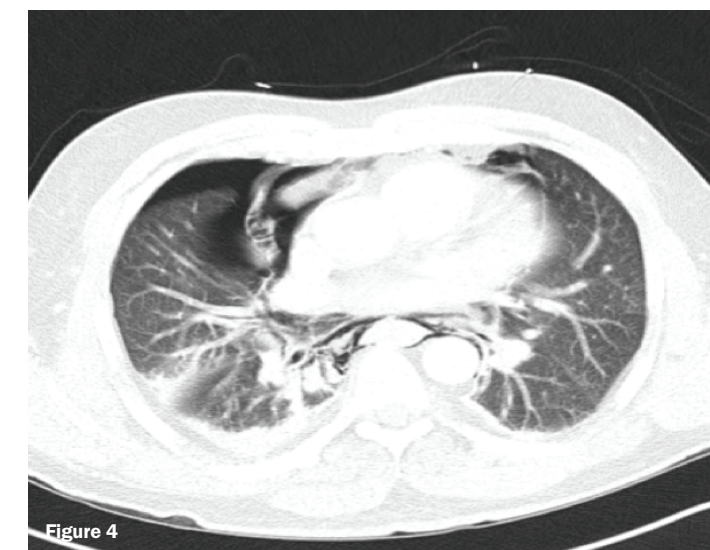


Figure 4

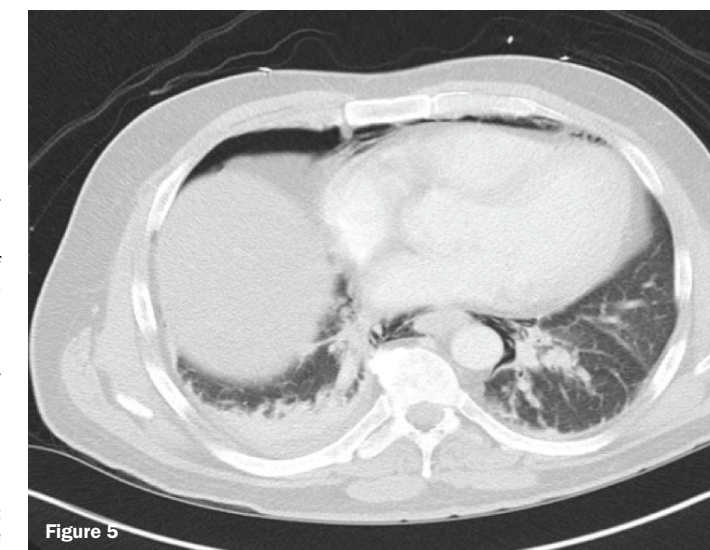


Figure 5

Figures 1 & 2: EGD showing the perforated esophagus with true and false lumens
Figure 3: Chest x-ray showing streaky opacity in the right lung base with soft tissue air at the lower neck.
Figures 4 & 5: CT thorax with contrast showing b/l pleural effusions, pneumomediastinum and right-sided pneumothorax

Surgery may include primary repair of the defect, drainage of fluid collections, diversion or esophagectomy. An alternative treatment for poor surgical candidates is placement of metal or plastic stents via EGD. There's a high rate of migration and stricture for the plastic and metal stents respectively [12].

In this patient, within the first 24 hours, aggressive management was instituted in the ICU with IV fluids and broad-spectrum antibiotics. This was an important life-saving measure, based on the mortality rate comparison between early versus late disease recognition and treatment.

The fibrosed esophagus from chronic dysphagia, mechanical

dilatation and NSAID use precluded salvaging the esophagus. Hence surgical intervention was the reasonable ultimate approach to treatment.

References

1. Bruno MS, Grier WRN, Ober WB. Spontaneous laceration and rupture of oesophagus and stomach. *Arch Intern Med* 1963; 112: 574 - 83.
2. Pate JW, Walker WA, Cole FH Jr, et al. Spontaneous rupture of the esophagus: a 30-year experience. *Ann Thorac Surg* 1989; 47:689.
3. Herbella FA, Matone J, Del Grande JC. Eponyms in esophageal surgery, part 2. *Dis Esophagus* 2005; 18:4.
4. Brinster CJ, Singhal S, Lee L, et al. Evolving options in the management of esophageal perforation. *Ann Thorac Surg* 2004; 77:1475.
5. Vidarsdottir H, Blondal S, Alfredsson H, et al. Oesophageal perforations in Iceland: a whole population study on incidence, aetiology and surgical outcome. *Thorax Cardiovasc Surg* 2010;

| continued on p.23



Knowledge of Advance Directives in the Primary Care Clinic at St. Vincent Charity Medical Center

By **Kulsoom Fatima MD; Ajay Kumar MD; Sohilkumar Manvar MD; Syed Naqvi MD; Neelima Rao MD; Nana Yaa Koram MD MPH; Lloyd Cook MD**

LITERATURE AND BACKGROUND REVIEW

Advanced directives (AD) are written documents in which people outline the treatments that they do or do not agree to, if at some point in the future, they are no longer competent to communicate their wishes [1]. In most countries, the term living will is used in place of or towards the same end as ADs [2]. The concept of respect for autonomy originated from the Utilitarian John Stuart Mill, who argued that the sole justification for interfering in another person's action was whether that person was going to harm someone else [3]. This principle, also known as Mill's "harm principle" is the basis of the right of a competent person to refuse medical treatment, even if it is life-saving, and for a doctor not to interfere with that decision [3]. The concept of AD originated in the United States, and was given legal status with the passage of the "Natural Death Act" in California in 1976, which gave the legal framework for what was described then as a living will [4,5]. In Australia, the United Kingdom, Germany, the United States and most developed countries, competent patients have a legal and moral right to refuse medical treatment, even life-saving

treatment [6].

The actual use of AD documents varies widely between countries due to factors such as legal status of ADs, the importance given to patient autonomy and cultural patterns in communication [7]. One study showed that there was high agreement from physicians of all nationalities on the use of, and compliance with, ADs, which is attributed to a universal "medical culture" of patient autonomy as a central tenet [8]. A law passed in Germany in 2009 made the carrying out of treatment detailed as unwanted in a patient's AD a physical assault on the patient [9]. This essentially converted non-compliance with a patient's AD into a criminal offence [7]. This increasing legal recognition of AD in Europe has promoted patient autonomy as the main guiding principle in the ethics of patient care. [7][10].

A doctor's legal role in end-of-life care includes assessing the patient's capacity to make treatment decisions, knowing who the authorized substitute decision maker is, and knowing whether a person's AD is valid under the law and must be followed in the prevailing circumstances [11]. The

BASELINE CHARACTERISTICS OF STUDY PARTICIPANTS

Characteristic	Frequency	Percentage
Male	84	52.5
Female	74	46.3
Age		
18-35	5	2.7
36-50	28	14.9
51-75	127	63.5
>75	28	15
Educational level		
High school	78	41.5
GED	17	9
Undergraduate	35	18.6
Graduate	58	30.9
Insurance		
Medicare	88	47.1
Medicaid	28	15
Private	49	26.2
None	20	10.7
>1 insurance type	2	1

Patient Self Determination Act requires that hospitals and other health care agencies provide education to staff and community on issues concerning patients' rights to formulate advance directives [12]. It has been shown that most decision making for ADs occur in the inpatient hospital setting [13]. The outpatient unit does not appear to be utilized in initiating the conversation about advance directives between physicians and patients. This is despite the fact that patients with formal, written care planning have been shown to have significantly more frequent and detailed discussions with their physicians and proxies than patients with less formalized arrangements [14]. It is widely acknowledged that physicians have a generally positive attitude towards patients' ADs [3]. However,

although 82% of physicians in a study felt they were responsible for initiating the discussion on AD decision-making process, only 13.1% of DNR orders were based on patient preferences [13,15]. Another study also showed that nearly half of the physicians surveyed did not routinely ask patients or their families if there was a living will, and more than half did not routinely read over the wishes stated in a living will [16].

It is therefore only logical that physicians encourage the discussion and formation of advance directives and written documents for medical outpatients during times of relative wellness [12]. Research has also shown that primary care physicians and family members are often inaccurate when making substituted judgments for patients without advance directives [17].

With the current advent of hospital medicine, most primary care physicians are ceding the inpatient care of their patients to hospitalists, who may not have a close relationship with the patient, and so may have never had the opportunity to discuss their advance directives with them. The importance of initiating the conversation about advance directives in the outpatient's department cannot be overstated.

The primary purpose of this study is to determine the knowledge, attitudes and practices of patients in the primary care clinic of St Vincent Medical Center towards Advance Directives and Living wills. The secondary purpose of this study will be to facilitate the discussion of ADs and living wills between patients in the outpatient departments and their primary care doctors by encouraging the patients to bring up the topic with their doctors.

METHODOLOGY

Subjects were randomly recruited from the Internal Medicine Primary Care Clinic over a period of 1 month. The subjects were asked to complete a questionnaire. The questionnaire collected basic demographic information, and also asked questions about knowledge of advanced directives, and current advanced directives possession and planning. The data was collated using Excel, and analyzed using SPSS.

RESULTS

Two hundred questionnaires were distributed to patients in the outpatient clinic during a 1-month period. Of the respondents, 74 (37%) were female, and 84 (42%) were male. Twenty-one percent of the respondents (42) did not state their gender. Majority of the respondents (64%) were in the age range of 51-75 years,

with 14% of respondents being 18-35 years, and more than 75 years. Eighty-four respondents (43%) were single, with 37% (73) being married or in a relationship, 9% [17] were divorced and 11% (22) were widowed. Most of the respondents were in a low socioeconomic bracket, with 76% (109) of those who stated their income earning less than \$50,000 annually. Thirty-one patients (22%) earned \$50-100,000 annually, with a very small percentage (2.8%) earning more than \$100,000. Majority of the respondents (42.5%) lived alone, with 37.7% living with a partner, and only 3% living with their children or in a nursing home.

Regarding insurance status, Medicare was the most prevalent form of insurance (44%), with private insurance being the second commonest insurance form (24.5%). Medicaid was the insurance coverage for 15% of patients, whilst 10% had no insurance coverage at all. The highest educational status for most of the patient was high school (41.5%), with 30.9% completing some form of graduate education, and 18.6% completing an undergraduate degree. Concerning their healthcare status, 51.5% had one chronic health condition, whilst 48.5% had two or more chronic conditions. Mental health conditions were also common, affecting 26% of the respondents. Depression was the most common mental health disorder (50%), with bipolar disorder (7.7%), anxiety (11.5%) and schizophrenia (1.9%) also being reported. Of those who had been hospitalized in the past year, a vast majority (85%) had been admitted once, with only 5.7% being admitted more than 3 times in the past year.

Of the respondents, a large majority (62.1%) were not aware of

an advanced directive, with only 62.1% being aware of what an advanced directive was. Only 20% of respondents had an advanced directive, with 80% having no form of advanced directive. Of those who had an advanced directive, the commonest form of advanced directive was the living will (62.5%), with 18.8% having either a healthcare proxy or both living will and health care proxy. Of those who did not have an advanced directive, 14.2% said it was because they were too young to need it, 10.6% thought they were too healthy and 14% thought it was too time consuming to complete one. Majority of respondents (46.1%) did not give any reason whatsoever for not having an advanced directive. Interestingly, on a Likert scale of 1-5, 53% of the respondents thought advanced directives were very important to have, whilst only 9.6% of respondents thought advanced directives were not important at all. Most of the respondents (72.9%) were not interested in discussing advanced directives during the index visit, whilst only 27.1% were willing to discuss advanced directives with their primary care physicians during the index visit. These patients were subsequently counseled about advanced directives, and given the option of writing up an advanced directive at their convenience.

DISCUSSION

Advance directives allow patients to document preferences regarding health care in the event of impaired decision making in the future [12]. The various forms of advance directives include living will and healthcare proxy. Despite the benefits of advance care planning for patients, primary care clinicians face barriers to effective counseling on the issue,

including their limited time and a lack of clinic-based support [18]. From our data, an overwhelming majority of the respondents had no advance directives. The most common reasons for not having an advance directive included being too young and healthy, and not really needing an advance directive. This was an interesting finding, as most of the respondents were middle aged, falling in the age bracket of 51-75 years. There was also a high prevalence of at least one chronic disease, with some having at least 2 chronic diseases. Majority of the patients (88%) had also been hospitalized at least once in the past year due to an acute or chronic medical condition. We can therefore infer that the patients may not have a very clear understanding of their chronic ailments, and therein the need for advance directives, so that their future healthcare wishes would be clearly spelled out. The fact that an overwhelming majority of the patients (75.3%) did not want to discuss advance directives at the time of filling out the questionnaire may indicate a general level of discomfort with advance directives. Of those who wanted to discuss advance directives during that index visit, they were counseled and given the option of filling out an advance directive then or at a subsequent visit.

This study shows that there is a dearth of information among our patient population concerning advance directives. Barriers to advance directive planning by patients include lack of knowledge about advance directives, and attaching a low level of importance to the need for an advance directive. The primary care setting presents an ideal opportunity to educate patients about advance directives and counsel and guide them into developing and signing advance directives of their own.

| continued on p.18

CONCLUSION

With the current costs of health-care spiraling out of control, the role of advance directives in preventing unwanted and unnecessary medical treatment cannot be overemphasized. The Dying in America Report emphasized the need to integrate advance care planning into clinical care [20] and the Centers for Medicare and Medicaid Services has recently approved reimbursement for counseling on advance care planning [21]. Our study shows that there is a significant lack of knowledge about advance directives, and indicates the need for more counseling in the primary care setting about advance directives.

References

1. Robertson, G. (1993). Making an advance directive. *British Medical Journal*, 310(236).
2. Wilkinson, A., Wenger, N., & Shurgaman, L. (2007). Literature review on advanced directives. *On behalf of the US Department of health and human services. Assistant Secretary for Planning and Evaluation. Office of Disability, Aging and Long term care policy.* Rand Corporation.
3. Coleman, A. (2012). Physician attitudes toward advanced directives: A literature review of variables impacting on physicians attitude towards advance directives. *American Journal of Hospice*, 30(7), 696-706.
4. Brown, B. (2003). The history of advanced directives. A literature review. *J Gerontol Nurs.*, 29(9), 4-14.
5. Sabatino, C. (2010). The evolution of healthcare advance planning law and policy. *Milbank Q.* 88(2), 211-239.
6. Cartwright, M., White, B., Willmott, L., Williams, G., & Parker, M. (2015). Palliative care and other physicians' knowledge, attitudes and practice relating to the law on withholding/withdrawing life-sustaining treatment: Survey results. *Palliative Medicine*, 1-9.
7. Evans, N., Bausewein, N., Arantza, M., Andrew, E., Higginson, I., Harding, R., et al. (2012). A critical review of advanced directives in Germany: Attitudes, use and healthcare professionals' compliance. *Patient Education and Counseling*, 87, 277-288.
8. Voltz, R., Akabayashi, A., Reese, C., Ohi, G., & Sass, H. (1999). Attitudes of healthcare professionals towards clinical

9. Wiesing, U., Jox, R., Hebler, H., & Borasio, G. (2010). A new law on advance directives in Germany. *Journal of Medical Ethics*, 36(779).
10. Walter, T. (2003). Historical and cultural variants on the good death. *British Medical Journal*, 327(218).
11. White, B., Willmott, L., Trowse, P., & al. (2011). The legal role of medical professionals in decisions to withhold or withdraw life-sustaining treatment: part 1 (New South Wales). *J Law Med*, 18(3), 498-522.
12. Landry, F., Kroenke, K., Lucas, C., & Reeder, J. (1997). Increasing the use of advance directives in medical outpatients. *J Gen Intern Med*, 12, 412-415.
13. Markson, L., Clark, J., Glantz, L., Lambertson, V., Kern, D., & Stollerman, G. (1997). The doctor's role in discussing advance preferences for end-of-life care: perceptions of physicians practising in the VA. *J Am Ger Soc*, 45, 399-406.
14. Emmanuel, E., Weinberg, D., Gonin, R., Hummel, L., & Emmanuel, L. (1993). How well is the patient self-determination act working? An early assessment. *Am J Med*(95), 619-28.
15. Wilson, D. (1997). A report of an investigation of end-of-life care practices in health care facilities and the influences of those practices. *J Pall Care*, 13, 34-40.
16. Westphal, D., & McKee, S. (2009). End-of-life decision making in the intensive care unit: Physician and nurse perspectives. *American Journal of Medical Quality*, 24(3), 222-228.
17. Coppola, K., Ditto, P., Danks, J., & Smucker, W. (2001). Accuracy of primary care and hospital-based physician's predictors of elderly outpatients' treatment preferences with and without advance directives. *Arch Intern Med*, 161(13), 431-440.
18. Lum, H., Jones, J., Matlock, D., & al. e. (2016). Advance Care Planning Meets Group Medical Visits: The Feasibility of Promoting Conversations. *Annals of Family Medicine*, 14(2), 125-132.
19. Johnson, J., Pinholt, E., Jenkins, T., & Carpenter, J. (1988). Content of ambulatory internal medicine practice in an academic Army medical center and an Army community hospital. *Mil Med*, 153, 21-25.
20. Medicine, C. o. (2014). *Dying in America: Improving Quality and Honoring Individual Preferences Near the End of Life.* Washington DC: The National Academies Press.
21. CMS. (2015). *CMS Finalizes 2016 Medicare Payment Rules for Physicians, Hospitals and other Providers. Centers for Medicare and Medicaid Services.*

and need for physical therapy is decreased while the ability to ambulate increases after performing a more distal amputation [20].

Similarly, Pinzur studied 25 amputees from the midfoot to transfemoral levels; and found that increasing the level of amputation slowed normal walking-speed and cadence while oxygen-consumption per-meter-walked increased with higher levels of amputation [21]. Additionally, higher levels of amputation led to decreased functional independence and increased cardiovascular expenditure [22]. Waters et al examined energy cost during walking of amputees at the Syme, transtibial, and transfemoral levels in both traumatic and vascular amputees. Patients with transfemoral amputation had a higher metabolic cost during walking than below knee amputation or Syme amputation patients, as demonstrated by the increased oxygen consumed per meter traveled, net oxygen cost, maximum aerobic capacity and relative energy cost [23].

A majority (85%) of amputees are fitted with prostheses after a major lower-extremity amputation. Of those patients, only 5% use their prosthetic for more than half of their waking hours. The rate of wheelchair use in major lower-extremity amputation is 13% one year after amputation, and rises to 39% after five years [24]. Comparatively, transmetatarsal patients can ambulate unshod, with a less cumbersome brace, or AFO, shortly after surgery with less cardiac output and fewer physiologic effects than a more proximal-amputation.

The suture technique described combined with appropriate tendon balancing, strict glucose control, adequate peripheral perfusion, and eradication of infection can effec-

tively prevent common complications encountered with the standard TMA. This modification of the standard TMA allows for immediate protected weight bearing which is important for tendon rebalancing, providing a means for angiogenesis through capillary ingrowth, and preventing mortality as described above. Although TMA is associated with several complications, the benefits of a healed TMA over a more proximal-amputation are well catalogued. This technique is strongly recommended to promote immediate postoperative weight bearing which can in turn improve angiogenesis and allow physiologic tendon rebalancing which in turn may lead to less postoperative complications. Obviously further study is required, but the described technique could potentially improve outcomes in diabetic patients undergoing transmetatarsal amputations.

References

1. Attinger C, Brown B., Amputation and ambulation in diabetic patients: Function is the goal. *Diabetes Metab Res Rev* 2012; 28(Suppl 1): 93-96.
2. Armstrong DG, Wrobel J, Robbins JM Guest Editorial: are diabetes-related wounds and amputations worse than cancer? *Int Wound J* 2007;4(4):286-287
3. Brown ML, Tang W, Patel A, Baumhauer JF. Partial Foot Amputation in Patients with Diabetic Foot Ulcers. *Foot Ankle Int.* 33(9):707-716, 2012.
4. Anthony T, Roberts J, Modrall JG, Huerta S, Asolati M, Neufeld J, Parker B, Yang W, Sarosi G. Transmetatarsal Amputation: assessment of current selection criteria. *The American Journal of Surgery.* 193:e8-e11, 2006.
5. Dunkel N, Belaieff W, Assal M, Corni V, Karaca S, Lacraz A, Uckay I. Wound Dehiscence and Stump Infection after Lower Limb Amputation: Risk factors and association with antibiotic use. *J Orthop Sci.* 17:588-594, 2012.
6. Hosch J, Quiroga C, Bosma J, Peters EJC, Armstrong DG, Lavery LA. Outcomes of Transmetatarsal Amputations in Patients with Diabetes Mellitus. *J Foot Ankle Surg.* 36(6): 430-434, 1997.
7. O'Brien PJ, Cox MW, Shortell CK, Scarborough JE. Risk Factors for Early Failure of Surgical Amputations: An analysis of 8,878 isolated lower extremity amputation procedures. *216(4)836-842, 2013.*

8. Nguyen TH, Gordon IL, Whalen D, Wilson SE. Transmetatarsal Amputation: Predictors of healing. *Am Surgeon.* 72(10):973-977,2006
9. Younger ASE, Awad MA, Kalla TP, deVries G. Risk Factors for Failure of Transmetatarsal Amputation in Diabetic Patients: A cohort study. *Foot Ankle Int.* 30(12):1177-1182, 2009.
10. Funk C, Young G. Subtotal Pedal Amputations. *J Am Pod Med Assoc.* 91(1):6-12, 2001.
11. Salonga C, Blume P. A Guide To Transmetatarsal Amputations In Patients With Diabetes. *Podiatry Today.* 19(7): 82-90, 2006.
12. Terashi H, Kitano I, Tsuji Y, Hashikawa K, Tahara S. A Modified Transmetatarsal Amputation. *J Foot Ankle Surg.* 50:441-444, 2011.
13. Bibbo C. Modification of the Syme Amputation to Prevent Postoperative Heel

14. Haas TL, Lloyd PG, Yang HT, Terjung RL. Exercise training and peripheral arterial disease. *Compr Physiol.* 2(4):2933-3017, 2012.
15. Blume P, Salonga C, Garbalosa J, Pierre-Paul D, Key J, Cahtan V, Sumio BE. Predictors for the Healing of Transmetatarsal Amputations: Retrospective study of 91 amputations. *Int Soc Vasc Surg.* 15(3):126-133, 2007.
16. Toursarkissian B, Hagino RT, Khan K, Schoolfield J, Shireman PK, Harkless L. Healing of transmetatarsal amputation in the diabetic patient: is angiography predictive? *Ann Vasc Surg.* 19(6): 769-73, 2005.
17. Hosch J, Quiroga C, Bosma J, Peters EJC, Armstrong DG, Lavery LA. Outcomes of Transmetatarsal Amputations in Patients with Diabetes Mellitus. *J*

18. Landry GJ, Silverman DA, Liem TK, Mitchell EL, Moneta GL. Predictors of Healing and Functional Outcome Following Transmetatarsal Amputations. *Arch Surg.* 146(9):1005-1009, 2011.
19. Friedmann LW, Padula PA, Weiss JM, Root B, Polchaninoff M, Shapiro D. Studies on the survival of transmetatarsal amputation stumps. *Vascular Surgery Proceedings of 34th Annual Meeting of the American College of Angiology, Paradise Island, Bahamas, 1987.*
20. Pinzur MS. Wolf B. Havey RM. Walking Pattern of Midfoot and Ankle Disarticulation Amputees. *Foot Ankle Int* 18(10): 635-638, 1997.
21. Pinzur MS, Gold J, Schwartz D, Gross N. Energy demands for walking in dysvascular amputees as related to the level of amputation. *Orthopedics.* 15(9): 1033-7, 1992.

22. Sage RA, Pinzur M, Stuck R, Napolitano C. Amputation and Rehabilitation of the Diabetic Foot. *The Diabetic Foot, Second Edition*
23. Waters RL, Perry J, Antonelli D, Hislop H. Energy cost of walking of amputees: the influence of level of amputation. *JBJS.* 58(1): 42-46, 1976.
24. Standard of Care: Lower extremity amputation. Brigham and Women's Hospital Department of Physical Therapy Services. 2011. http://www.brigham-womens.org/patients_visitors/pcs/rehabilitation-services/physical%20therapy%20standards%20of%20care%20and%20protocols/general%20-%20le%20amputation.pdf. Wagner FW. Amputations of the Foot and Ankle: Current status. *Clin Ortho.* 122: 62-69, 1977. Pinzur MS. Amputation Level Selection in the Diabetic Foot. *Clin Ortho Related Res.* 296:68-70, 1993.

Leriche syndrome

(cont. from page 13)

spasm as a complication of ALIF [5]. Another article in 2010 documented the incidence of vascular complications during ALIF in 212 consecutive patients, out of which 13 (6.1%) vascular injuries occurred of which five were major (38.5%). One major arterial injury (0.5%) occurred and required arterial thrombectomy and stent placement [9]. A case report of an acute Leriche-like syndrome after posterior instrumentation of the spine highlighting iatrogenic trauma to aorta during spinal surgeries was described by in a 47-year-old female who developed an acute occlusion of the infrarenal aorta after posterior transpedicular instrumentation of an L1 burst-fracture [12].

In the literature review, it was found that ALIF surgery at L2-L5 levels is most likely prone to cause vascular injury [3, 4, 5], just as the procedure in our case. The explained reason is that left common iliac vessels normally transverse the prevertebral space the L4-5 interspace, and thus prevents direct access to the spine. These vessels must be mobilized with

the help of retractors from left to right to expose the bony midline [8]. And there might be progression of the injury from iliac artery upwards to aorta. We believe the retraction of vessels can promote thrombus formation, through a mechanical injury to the intima of artery. The mechanism of thrombus formation is detailed below. The retraction of artery is considered as non-penetrating arterial injury which has been shown that stretching of artery can cause a rupture of the intimal layer [13]. The second reasoning is vascular retraction causes turbulent flow near the retraction site. The disturbance in normal flow cause platelets to adhere to the injured endothelium and lead to the process of primary hemostasis [14]. The turbulent flow also prevents dilution by fresh flowing blood with activated clotting factors, which promote secondary hemostasis and eventual thrombus formation [14]. The aortic occlusion of Leriche syndrome is usually caused by diffuse atherosclerotic changes, exacerbated by smoking, diabetes, hypertension, and hypercholesterolemia [1]. However, iatrogenic trauma to the blood ves-

sels as a cause for thrombosis has been documented [15].

The retraction of iliac vessels in our case during ALIF could have promoted endothelial injury leading to thrombus formation. In addition, smoking itself can promote hypercoagulability via unknown mechanisms [14].

References

1. Leriche's syndrome. *Int J Emerg Med.* 2008 Sep; 1(3): 223. Published online 2008 Aug22.
2. Kakkos SK, Shepard AD. Delayed presentation of aortic injury by pedicle screws: report of two cases and review of the literature. *J Vasc Surgery* 2008;47:1074-82.
3. Baker JK, Reardon PR, Reardon MJ, et al. Vascular injury in anterior lumbar surgery. *Spine* 1993;18:2227-30.
4. Brau SA, Delamarter RB, Schiffman ML, et al. Vascular injury during anterior lumbar surgery. *Spine* 2004;4:409-12
5. Kulkarni SS, Lowery GL, Ross RE, Sankar KR, Lykometros V. Arterial complications following anterior lumbar interbody fusion: report of eight cases. *Eur Spine J* 2013; 12: 48-54
6. Jawor WJ, Plice SG. "Thrombotic obliteration of the abdominal aorta; report of a case." *Journal of the American Medical Association* 1952; 149: 142-3
7. Tom Faciszewski, Robert B. Winter, John E. Lonstein, Francis Denis, Linda Johnson. The surgical and medical perioperative complications of Anterior Spinal Fusion Surgery in the Thoracic and Lumbar Spine in Adults. A review of 1223 procedures *Spine* 1995; 20: 1592-1599
8. Heary RF, Benzel EC, Vaicys C. Anterior lumbar interbody fusion. In: Benzel EC (ed) *Spine surgery techniques, complication avoidance, and management*, 2nd Edition. (2005) Churchill Livingstone, Philadelphia, pp 474-485.
9. Joy Garg, Karen Woo, Jodi Hirsch, James D. Bruffey, and Ralph B. Dilley, La Jolla, Calif. Vascular complications of exposure for anterior lumbar interbody fusion. *J Vasc Surg* 2010; 51:946-50.
10. Brau SA, Delamarter RB, Schiffman ML, Williams LA, Watkins RC. Vascular injury during anterior lumbar surgery. *Spine J* 2004;4:409-12
11. Do Hyun Yoon, Hyungpil Cho, Seung Jun Seol, Taikon Kim. Right Calf claudication revealing Leriche syndrome presenting as Right sciatic neuropathy. *Ann Rehabil Med* 2014;38:132-137
12. Martina Blocher, Michael Mayer, Herbert Resch, and Reinhold Ortmaier. Leriche-Like Syndrome as a Delayed Complication Following Posterior Instrumentation of a Traumatic L1 Fracture A Case Report and Literature Review. *Spine* 2015;40:E1195-E1197
13. Sonmez B, Yorukoglu Y, Williams BT. Traction injury in the internal mammary artery. Report of a case and review the literature. *J Cardiovasc Surg* 1990; 31:592-594.
14. Mitchell RN, Cotran RS (1999) Hemodynamic disorders, thrombosis, and shock. In: Cotran RS, Kumar V, Collins T (eds) *Robbins pathological basis of disease*, 6th edition. Saunders, Philadelphia, pp 124-129.
15. Jen-Hsuan Huang, Cheng-Hung Lee, Tzung-chieh Tsai, Shih-Yen Peng. Perioperative thrombotic occlusion of left external iliac artery during anterior lumbar interbody fusion. *Arch Orthop Trauma Surg* 2008; 128:1107-1110
16. Wood KB, Devine J, Fischer D, Detori JR, Janssen M. Vascular injury in elective anterior lumbosacral surgery. *Spine (Phila Pa 1976).* 2010;35::S66-75.



Carbon Fiber Fixation: A Novel Fixation Technology in Foot and Ankle Surgery

Primary Author: **Michael B. Canales DPM FACFAS, Chief of the Division of Podiatry, Director of the Podiatric Residency Program, St. Vincent Charity Medical Center, Podiatric Surgical Residency St. Vincent Charity Medical Center, Podiatric Surgical Residency**

Corresponding: **Ashley M. Mandela DPM, Resident, Post-Graduate Year 3, St. Vincent Charity Medical Center, Podiatric Surgical Residency;**
Joshua Fisher DPM, Resident, Post-Graduate Year 2, St. Vincent Charity Medical Center, Podiatric Surgical Residency;
Bradley Benson DPM, Resident, Post-Graduate Year 2, St. Vincent Charity Medical Center, Podiatric Surgical Residency;
Gurneet Khangura DPM, Resident, Post-Graduate Year 1, St. Vincent Charity Medical Center, Podiatric Surgical Residency

ABSTRACT

There are a variety of metallic internal fixation devices available to the foot and ankle surgeon. Fixation plates, Steinmann pins, Kirschner wires, staples, screws, and intramedullary nails are employed to achieve stable fixation of arthrodesis surfaces, fractures, and osteotomies. Metallic internal fixation devices can create impediments to accurate postoperative imaging. Specifically, radiopacity on plain film radiographs and scatter artifact on Computer Tomography (CT) and Magnetic Resonance Imaging (MRI) can make assessment of bone healing a challenge. This article discusses the properties of carbon fiber fixation, practical applications in the foot and ankle, and shares brief experiences of utilizing carbon fiber fixation in foot and ankle surgery. The radiolucent properties of carbon fiber and the modulus of elasticity are potential advantages to this form of fixation that could have widespread applications in bone and joint surgery.

INTRODUCTION

Carbon fiber is a versatile material that has unique biomechanical properties that make it an ideal material for internal fixation of osteotomies, arthrodesis sites,

and fractures. Reported complications of internal fixation for arthrodesis and fracture fixation include nonunion, failure of fixation, and infection [1]. The CarboFix “Piccolo” ankle arthrodesis nail, distal fibular plate, and one-third tubular plate possess many properties that may reduce the risk of complications.

Carbon fiber is radiolucent on plain film radiographs, allowing for unobscured views of cortical and cancellous bone on intraoperative and postoperative radiographs. This quality allows for enhanced visualization of arthrodesis surfaces and fracture sites and could aid in achievement of optimal positioning and alignment. It is proposed that enhanced visualization leads to less use of intraoperative fluoroscopy and a decrease in operative time [3]. Additionally, the unobscured view can potentially afford an accurate assessment of the progression of fusion or fracture healing during the postoperative course. Nonunions and delayed unions can potentially be identified earlier and appropriate intervention can be initiated sooner. Unlike metallic IM nails, that create artifact on MRI and CT, Carbon Fiber nails do not exhibit signal pile up or signal loss [4]. When viewing

an MRI image of a patient with a metallic implant, significant signal loss and signal pile is encountered if the implant is not parallel to the magnetic field. This impediment to visualization is avoided even when a carbon fiber implant is not parallel to magnetic field [4].

Carbon fiber possesses physical properties that make it comparable, if not superior, to implant alternatives composed of titanium and cobalt chrome molybden. The CarboFix® “Piccolo” ankle arthrodesis nail has a similar modulus of elasticity to bone and has the ability to withstand prolonged fatigue strain [5]. The similar modulus of elasticity lessens stress shielding and allows for enhanced callous formation and stronger union [5]. It was demonstrated that carbon fiber has significantly less wear debris compared to titanium when wear debris was studied by Steinberg et al. Decreased debris theoretically decreases the risk of local tissue reaction and inflammation. Literature reveals the prevalence of metal allergy ranging from 2.7 to 9.4%. Currently, the majority of metallic joint implants contain nickel, chromium, cobalt-chromium and titanium-aluminum alloys. Allergic reactions to these components can manifest as der-

matitis, impaired wound healing, joint effusions, pain, implant loosening and implant failure [6]. Carbon fiber has shown to be inert and there are no current reports of allergic reaction [7].

This small, preliminary case series of carbon fiber fixation with short term-follow up aims to stimulate further research on the use of this technology in the foot and ankle as well as other areas of the body.

CARBON FIBER TECHNOLOGY IN 1ST METATARSO-PHALANGEAL JOINT ARTHRODESIS

An unobscured view of trabeculation across the fusion site was evaluated in the postoperative period. However, the thickness of the plate is a disadvantage in fore-foot procedures and did result in removal of the carbon fiber plate in one of the patients.

CARBON FIBER TECHNOLOGY IN TTC ARTHRODESIS

In a case series of TTC arthrodesis, the carbon fiber intramedullary nail was utilized for fixation with the modulus of elasticity being similar to bone, stable fixation was achieved without additional stress risers. The radiolucent property of the IM rod requires a precise

| continued on p.22

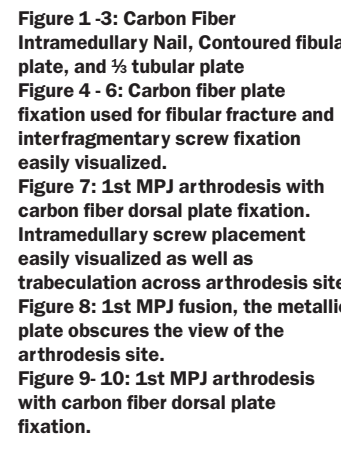
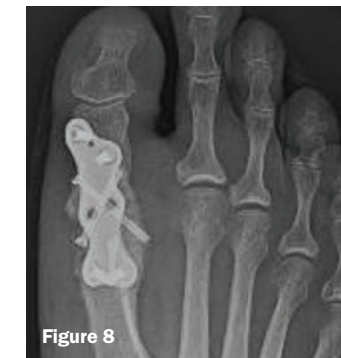
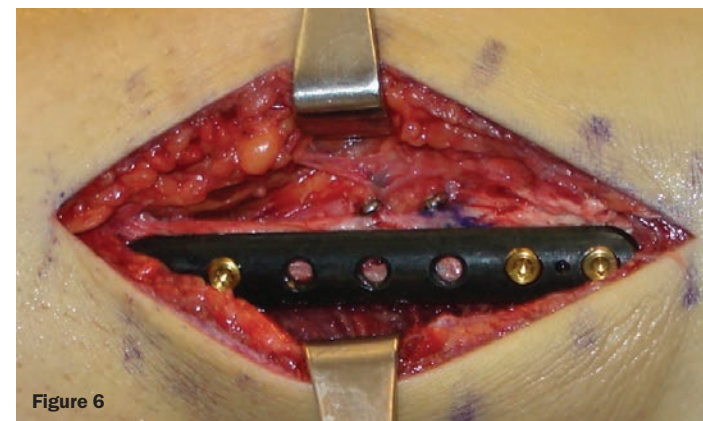


Figure 1-3: Carbon Fiber Intramedullary Nail, Contoured fibular plate, and 1/3 tubular plate
Figure 4-6: Carbon fiber plate fixation used for fibular fracture and interfragmentary screw fixation easily visualized.
Figure 7: 1st MPJ arthrodesis with carbon fiber dorsal plate fixation. Intramedullary screw placement easily visualized as well as trabeculation across arthrodesis site.
Figure 8: 1st MPJ fusion, the metallic plate obscures the view of the arthrodesis site.
Figure 9-10: 1st MPJ arthrodesis with carbon fiber dorsal plate fixation.



Figure 11



Figure 12



Figure 13



Figure 14

Figure 11-14: A nonunion of ankle and STJ fusion status post revisional TCC fusion with carbon fiber IM rod.
Figure 15-16: Equinovarus deformity status post TCC fusion with carbon fiber IM rod. CT displaying the arthrodesis site without obscuring artifact.
Figure 17-18: Artifact displayed on CT with metallic screws, plates & IM Rod.
Figure 19: A disadvantage of carbon fiber fixation is over-tightening of the screws resulting in stress risers and cracking of the plate, as displayed with this fibular construct.
Figure 20-21: Intraoperative fluoroscopy of carbon fiber fibular plate and metallic plate displaying the difficulty in visualizing the holes within the plate, potentiating the collision of the screws within the plate with the interfragmentary screws.



Figure 15



Figure 16

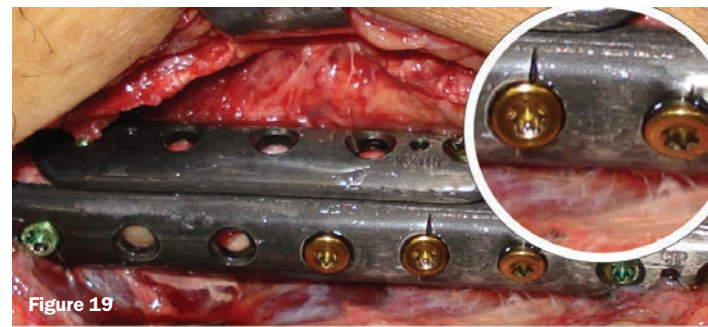


Figure 19

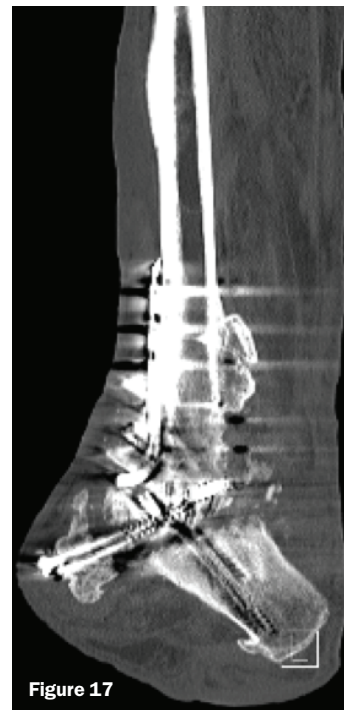


Figure 17



Figure 18

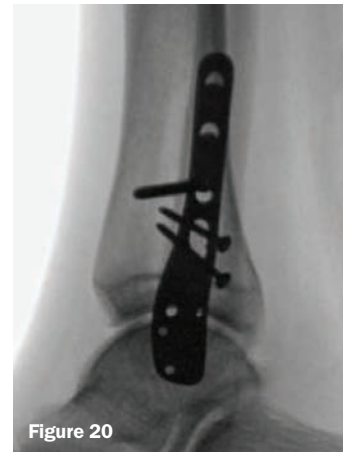


Figure 20



Figure 21

three dimensional visualization to achieve proper placement of the proximal and distal screws with the assistance of small radiopaque markers contained within the nail. The advantage of the radiolucent property was the ability to evaluate the fusion site with radiographs or CT. In a comparison of CT a traditional IM nail and a carbon fiber IM nail, there was no artifact obscuring the fusion site and it was clearly projected with the carbon fiber IM nail.

DISCUSSION

Carbon fiber technology has been used by orthopedic oncologists in the treatment of osseous tumors for years. CarboFix technology provides the surgeon with an unobscured view of the underlying pathology or trauma. The carbon fiber reinforced polyetheretherketone (CFT - PEEK) allows for the use of MRI and CT with little to no artifact [1]. Carbon fiber technology provides strength and durability with ease of placement as compared to stainless steel and titanium [2]. The modulus of elasticity of the CarboFix technology is closer to that of cortical bone than stainless steel or titanium implants [2], allowing the surrounding bone to function without undue stress from the internal fixation. The implants are composed of longitudinal and diagonally oriented fibers of carbon allowing for strength in multiple planes [2]. Carbon fiber technology has been utilized in the treatment of infected non-unions. The radiolucency of the construct allows unparalleled visualization of an osteotomy or arthrodesis site aiding in the ability to assess bone healing [3]. The addition of antibiotic cement coating to the fixation may be a useful option in cases involving infection. Carbon technology also provides an inert biochemical profile allowing the

technology to be used in those patients with documented metallic allergies [5]. Carbon technology plating and nails have been designed for both the tibia and fibula. The carbon fiber ankle arthrodesis IM nail has been shown to have a lower rate of revision at five years in comparison to other IM nails [4].

The ability to visualize an arthrodesis site or fracture progression potentially can facilitate more precise management of patients postoperatively. In addition, advanced imaging (CT and MRI) may be obtained with little to no artifact is beneficial. Carbon fiber technology can be applied to the treatment of a myriad of pathologies in the foot and ankle, however, it is not without complications or difficulties. Some of the initial challenges are due to the characteristic radiolucency on intraoperative fluoroscopy. This can be a challenge for blind screw placement especially with the placement of cortical screws in close proximity to interfragmentary screws can be problematic. The difficulty is due to an inability to visualize the holes within the plate relative to the interfragmentary fixation while looking on intraoperative fluoroscopy, this leads to potential collision of cortical screws with interfragmentary screws. In the case of intramedullary fixation, even when a jig is utilized, if the drill bit is torqued in the slightest it can lead to collision of the drill bit with the implant. Placement of the the intramedullary nail end cap, which has no embedded metallic identifiers to clue the surgeon in on the exact position relative to the intramedullary nail, has proven to be difficult. The carbon fiber plates cannot be bent and are brittle, the primary author has experienced shattering of a plate which had

already been implanted. Another drawback is the plates inability to be contoured to the bone, leaving the surgeon unable to modify the plate if necessary. These are some of the initial challenges facing this carbon fiber technology which make it an imperfect alternative to traditional internal fixation materials. That being said, the carbon fiber technology has shown to be a useful tool in the primary author's repertoire, however, further research is required to elucidate all the potential applications in foot and ankle surgery as well as other areas of the body.

References

1. Siebachmeyer, M., Boddu, K., Bilal, A., Hester, T. W., Hardwick, T., Fox, T. P., ... & Kavarthapu, V. (2015). Outcome of one-stage correction of deformities of the ankle and hindfoot and fusion in Charcot neuroarthropathy using a retrograde intramedullary hindfoot arthrodesis nail. *Bone Joint J*, 97(1), 76-82.
2. Anderson, R. T., Pacaccio, D. J., Yakacki, C. M., & Carpenter, R. D. (2016). Finite element analysis of a pseudoelastic compression-generating intramedullary ankle arthrodesis nail. *Journal of the mechanical behavior of biomedical materials*, 62, 83-92.
3. Maniscalco, P., Caforio, Marco, Groppi, Giulia, Vallisa, Daniele, Cavanaugh, Luigi. (2015) The Carbon Fiber Intramedullary Nail in Pathological Humeral Shaft Fractures: Two Case Reports. *Jacobs Journal of Orthopedics and Rheumatology*, 1(2):008
4. Zimel, M. N., Hwang, S., Riedel, E. R., & Healey, J. H. (2015). Carbon fiber intramedullary nails reduce artifact in postoperative advanced imaging. *Skeletal radiology*, 44(9), 1317-1325.
5. Hillock, R., & Howard, S. (2014). Utility of carbon fiber implants in orthopedic surgery: literature review. *Reconstructive Review*, 4(1).
6. Krecisz, B., Kieć-Swierczyńska, M., & Chomiczewska-Skóra, D. (2012). Allergy to orthopedic metal implants—a prospective study. *International journal of occupational medicine and environmental health*, 25(4), 463-469.
7. Steinberg, E. L., Rath, E., Schlaifer, A., Chechik, O., Maman, E., & Salai, M. (2013). Carbon fiber reinforced PEEK Optima—a composite material biomechanical properties and wear/debris characteristics of CF-PEEK composites for orthopedic trauma implants. *Journal of the mechanical behavior of biomedical materials*, 17, 221-228.
8. Michel L, Grillo HC, Malt RA. Operative and nonoperative management of esophageal perforations. *Ann Surg* 1981; 194:57.
9. Brauer RB, Liebermann-Meffert D, Stein HJ, et al. Boerhaave's syndrome: analysis of the literature and report of 18 new cases. *Dis Esophagus* 1997; 10:64.
10. Saha A, Jarvis M, Thorpe JA, O'Regan DJ. Atypical presentation of Boerhaave's syndrome as Enterococcal bacterial pericardial effusion. *Interact Cardiovasc Thorac Surg* 2007; 6:130. Michel
11. Ivey TD, Simonowitz DA, Dillard DH, Miller DW Jr. Boerhaave syndrome. Successful conservative management in three patients with late presentation. *Am J Surg* 1981; 141:531.
12. McGovern M, Egerton MJ. Spontaneous perforation of the cervical esophagus. *Med J Aust* 1991; 154:277.
13. Gubbins GP, Nensey YM, Schubert TT, Batra SK. Barogenic perforation of the esophagus distal to a stricture after endoscopy. *J Clin Gastroenterol* 1990; 12:310.
14. Schweigert M, Beattie R, Solymosi N, et al. Endoscopic stent insertion versus primary operative management for spontaneous rupture of the esophagus (Boerhaave syndrome): an international study comparing the outcome. *Am Surg* 2013; 79:634.
15. Bladergroen MR, Lowe JE, Postlethwait RW. Diagnosis and recommended management of esophageal perforation and rupture. *Ann Thorac Surg* 1986; 42:235.
16. Backer CL, LoCicero J 3rd, Hartz RS, et al. Computed tomography in patients with esophageal perforation. *Chest* 1990; 98:1078.
17. de Lutio di Castelguidone E, Merola S, Pinto A, et al. Esophageal injuries: spectrum of multidetector row CT findings. *Eur J Radiol* 2006; 59:344.
18. Tonolini M, Bianco R. Spontaneous esophageal perforation (Boerhaave syndrome): Diagnosis with CT-esophagography. *J Emerg Trauma Shock* 2013; 6:58.
19. Dodds WJ, Stewart ET, Vlymen WJ. Appropriate contrast media for evaluation of esophageal disruption. *Radiology* 1982; 144:439.
20. Carrott PW Jr, Low DE. Advances in the management of esophageal perforation. *Thorac Surg Clin* 2011; 21:541.
21. Han SY, McElvein RB, Aldrete JS, Tishler JM. Perforation of the esophagus: correlation of site and cause with plain film findings. *AJR Am J Roentgenol* 1985; 145:537.

58:476.



ST. VINCENT CHARITY
MEDICAL CENTER

JOURNAL