

Volume 90 No. 4 April 2007

# Medicine & Health RHODE ISLAND

PUBLICATION OF THE RHODE ISLAND MEDICAL SOCIETY



—◆—  
Orthopedics

# What's in a Name???

GOOD - authentic, honest, just, kind, pleasant, skillful, valid

NEIGHBOR - friend, near

ALLIANCE - affiliation, association, marriage, relationship

CORPORATION - company, business establishment

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# Medicine Health RHODE ISLAND

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## Commentaries

### The Journal of Goldberg Research [April Fool]

**For those readers who have never scrolled** through the incredible list of journals available on-line at Brown, there are wonders to behold. There are over 10,000 journals, I think, probably a lot more. You can find annals, archives, journals, and transactions of almost every topic under the sun.

Every once in a while I stumble on a new journal that makes me take an instant detour from the search path I had intended. My favorite journal, which I truly invite the reader with access to the Brown library system to look up, is *The Journal of Near-Death Studies*, a publication of the *International Association of Near-Death Experiences*. Unfortunately, in 2003, this journal passed beyond near-death and is either hibernating or fully dead. The topics covered in the journal are, in fact fascinating, such as multi-dimensionality of the near death experience, but readers who may have experienced near-death experiences will probably not find this amusing.

The very next journal in the Brown list, which is alphabetically arranged, is the *Journal of Negative Results in Biomedicine*. This journal is based on a terrific idea. Imagine the possibilities of publishing all those results that no other journal wants because they're negative. Of course, there are often good reasons to publish negative studies. They often contradict current treatment paradigms, based more on "common sense" or "standard practice" than on evidence; however, a whole journal of negative studies must be playing to the grinch in us. Who wants to read only about things that fail? When your promotions committee reviews your CV won't you worry that they will think this is a joke, like being published in the *Journal of Irreproducible Results*, another journal, really dead before its time?

I thought the idea of a *Journal of Negative Results* to be a great idea that should have universal application. Why just a journal of negative results in biomedicine? What is so special about medicine? Why

not bioengineering, biophysics, metaphysics, "real" physics, organic chemistry, whatever? The *Journal of Airplanes that Don't Fly*? If there are positive studies to be published, there must be negative studies that need to see the light of day as well. I have formed a committee to study the possibility of a franchise for *Journals of Negative Results*. If successful we can publish a journal devoted to the "best" or most exciting negative results which might be published annually in *The Best Negative Results*, or *The Journal of the Best Studies of Things that Don't Work*.

But what about results that are sort of in the middle? *The Journal of Nearly-Effective Therapies* would be perfect for that. Imagine if you had a treatment that worked a little better than placebo, say, something like the cholinesterase inhibitors in Alzheimer's disease, or riluzole for amyotrophic lateral sclerosis. Instead of getting trumpeted in the *New England Bugle*, where statistical significance trumps clinical significance, they could be published in the journal where they belong, where all results are nearly-effective. My critics have charged that this journal really should be called *The Journal of Nearly Effective Therapies that Cost a Lot of Money*, and I can hardly disagree. Why not spend a lot for something that is significant? And the placebo effect of spending a lot cannot be overemphasized.

Of course, one can also make an argument for a journal to cover insignificant results. This ambiguous title, *Journal of Insignificant Results*, could include results that were statistically insignificant, with a "trend" towards significance, or it can include statistically significant, clinically insignificant results, thus including results that are either clinically or statistically insignificant. I had tried to establish, *Power, The Journal of Small Clinical Trials*, but no one was interested 10 years ago. Now its time may be drawing near as "Designer Journals" become more popular.



For those who become more emotionally involved, manuscripts can be published in the *Journal of Disappointing Results*. But the worst journal of all is the *Journal of Boring Results*, which has had difficulties getting peer reviewers.

Probably the most interesting journal is the *Journal of Goldberg Research* because the results are always so unpredictable. I learned about Goldberg research when I was a resident. I rotated with a neuro-ophthalmologist who began discussing the problems of having a bad fellow or resident. These take up a lot of time without any reward for the attending physician, so they are sent off to do "Goldberg research." Of course the fellow and I, hoping not to be invited to join the Goldberg research working group, did not know what this was, and asked. The attending explained, "You tell the fellow to go to the chart room and review the charts of everyone ever admitted to the hospital named Goldberg and write down why they are admitted." In a New York City hospital there are a lot of Goldberg charts to be perused.

Personally I am a bit gladdened that the *Journal of Near-Death Studies* has fulfilled its destiny. There are way too many journals in the world and they cost far too much. *Neurology*, the journal of the American Academy of Neurology, has gone from monthly to biweekly to weekly in the last decade. It is too much. At first as the journals multiply they are thin, but they soon thicken, and the amount of material to be ignored increases too quickly. Journals summarizing the other journals now exist and soon there will be journals summarizing the journals summarizing the actual journals, the "source" documents. As we get to know more and more about less and less, I wonder about how many of these articles should have been published in the *Journal of Goldberg Research*.

— JOSEPH H. FRIEDMAN, MD



# Jefferson Consults a British Physician

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**A review of the standard American medical school curriculum** reveals little that might prepare future physicians for political leadership; and certainly nothing to educate them in the rudiments of political philosophy. The mission of the four years of medical schooling in this nation is simply to prepare candidates for a competent and compassionate practice of medicine with little attention invested in the technical intricacies of public office or public policy.

Accordingly, American physicians have rarely entered the domain of politics [the recently retired senator from Tennessee, William H. Frist, MD, is a notable exception.] History texts, however, do recall those rare physicians who had forsaken their caring ministry to take on new roles of political leadership. Sun Yat-Sen, for example, relinquished his medical practice in Hong Kong to assume the first presidency of China in the early 20th Century. Georges Clemenceau went from the general practice of medicine to polemic journalism and then, finally, to the premiership of France, leading his embattled nation during the hazardous years of the first World War. And of course a physician from Buenos Aires, Ernesto "Che" Guevaro, played an important role in the Cuban revolution of the 1950s. But these are rare exceptions.

The major players in the political leadership of this nation have largely been lawyers and career military personnel with an assortment of diverse professions but no physicians. Of our 43 presidents, 24 had been lawyers, six had primary careers in the military, three were farmers or ranchers [T. Roosevelt, L. B. Johnson and J. Carter], four were in business [A. Johnson, H. Truman, G. H. W. Bush and G. W. Bush], two were in teaching [W. Harding and W. Wilson], two were writers or editors [W. Harding and J. Kennedy], one was an engineer [H. Hoover] and one was an actor [R. Reagan]. Not a single physician in this group of presidents although one, William Henry Harrison, had briefly attended medical school.

Yet some practitioners of medicine, in a quiet way, exerted a marginal influence in molding the political agenda of this nation during its formative days. Fifty-six men signed the Declaration of Independence. And in doing so pledged their lives, their fortunes and their sacred honor in behalf of a statement asserting their freedom from British rule. Of these 56 Americans, five were physicians: Josiah Bartlett of New Hampshire, Lyman Hall of Georgia, Benjamin Rush of Pennsylvania, Matthew Thornton of New Hampshire and Oliver Wolcott of Connecticut.

These five physician-patriots signed this precious document and then some served as military physicians and later as judges and legislators. Their signatures on the Declaration attested to their agreement with its declared premises, but the inspired words of this immortal document were assembled solely by a lawyer and scholar from Virginia, Thomas Jefferson.

From what source, either within himself or from the writings of others, did Jefferson distill such emboldened thoughts as his assertion that certain truths are self-evident? And that men, having been created equal, are accordingly endowed with

certain unalienable rights such as life, liberty and the pursuit of happiness? Jefferson's home in Monticello contained an extensive library; and prominent in this collection of scholarly texts were the writings of an English philosopher and physician named John Locke. Jefferson as well as some of his colleagues, readily acknowledged the enormous influence exerted by Locke upon the principles motivating the separation of the colonies from their mother country.

Who was Locke? England's most eminent philosopher and political theorist was born in 1632 in Somersetshire. His father was a modest landowner, a village attorney, a devout Puritan and a fervent adherent of the anti-royalist Parliamentary party. Young Locke was educated at home by his father until age 14. Those were years of great social turmoil and Locke's father left home periodically to join the forces of Cromwell in fighting the troops of King Charles. In 1652 young Locke entered Christ Church College, Oxford. The college in those civil war days was firmly on the side of those who advocated religious tolerance.

Locke prospered at Oxford, finding it an academic community that challenged his inquisitive mind. After receiving his baccalaureate degree, he stayed on to study both medicine and philosophy, enamored with the writings of Descartes and Hobbes. He was moved, too, by the new spirit of experimentalism and even joined the Royal Society, England's renowned association of physical and biological scientists. For the next few years Locke practiced medicine but was attracted by the political and intellectual circle surrounding the Earl of Shaftsbury. Locke transferred to London to enter the household of Shaftsbury as physician and confidential secretary.

During the restoration years immediately after 1660, Locke's status in England became perilous, and he fled to France, living there for a number of years. Then back to England and then fleeing again, this time to the tolerant environment of Holland, where the influence of Erasmus, Grotius, Descartes and Spinoza prevailed.

During these years of political turmoil and flight Locke composed his enduring essays on the nature of civil government and the merit of political, civil and religious tolerance. And it was in Locke's Second Treatise on Government that he set down the many memorable phrases that stirred Jefferson's ideological soul. These were thrilling concepts such as the view that the state exists solely to preserve the rights of its citizens, Or further, that certain rights were not gifts to be granted arbitrarily by those in temporal authority but, rather, unalienable rights which included the rights of life, liberty, property and the pursuit of a tranquil existence [a phrase that Jefferson had amended to a pursuit of happiness.]

Somewhere, mingling congenially with our founding fathers, was the amiable ghost of a sometime physician named John Locke.

— STANLEY M. ARONSON, MD

# Introduction: Orthopedics

Michael G. Ehrlich, MD

**This issue focuses on some of the many** musculoskeletal issues that the primary care physician confronts on a regular basis. Some estimates have suggested that as many as half of the cases seen in a generalist's office are related to the musculoskeletal system. Patients often ask their primary care physicians, for advice, especially since many of these problems occur in children. These questions may relate to timing of surgery, the need for it or the newer techniques now available.

For example, Julia Katarincic, in her essay on congenital problems in children, points out that surgery on syndactyly should generally be deferred until two years of age. Otherwise, the web between the fingers tends to recur. On the other hand, if there is a big discrepancy between lengths of adjacent fingers, then the longer one will bend, so they should be done earlier. These pearls should remain on your shelf as a great reference.

Similarly, an obstetrician should be able to tell parents of a child with brachial birth palsy that most will recover. The pediatrician or primary care physician should know that if biceps function fails to develop by six months, microsurgical repair is indicated. These and other points in the article should

be in the knowledge base of the primary care provider.

Rob Shalvoy addresses the very important issue of over-abuse injuries in adolescents engaged in sports. He explains how little league pitchers crush the lateral joint surfaces of the elbow, and tear the ligaments on the medial. He goes on to explain how the injuries can be avoided by certain limitations on the numbers and types of pitches. Similar problems affect swimmers and other athletes, sometimes who are being egged on by their parents. The lessons in his article should be shared by physicians with the local trainers and coaches.

Craig Eberson is primarily interested in scoliosis and other deformities of the spine. Knowing when to refer these patients is of vital importance, since minor curves are ubiquitous in the population, and thousands of children are being identified by school screening programs. Most of these children don't need to go to a musculoskeletal specialist, and it saves society money, parents time, and children, needless x-rays if the primary care physician is properly involved. He also has interesting perspectives on the new treatments for scoliosis, including the use of thoroscopic

surgery, nighttime bracing, and the use of pedicle screws.

Finally Patricia Solga has contributed a very interesting article on the current management of femur fractures in children. Of all the developments in pediatric orthopaedics, this area has undergone the most radical changes in the last decade. She discusses the new role of treating infant femur fractures with Pavlik harnesses, the orthosis used primarily for hip dislocations, and the new reliance on internal fixation as opposed to traction and spica casts. This has great implications for the parents now taking care of these children, and provides much relief compared to the old ways.

Therefore, we hope that you find this issue challenging, interesting and useful.

*Michael G. Ehrlich, MD, is Vincent Zecchino Professor and Chairman, Department of Orthopaedics, Warren Alpert Medical School of Brown University, and Surgeon-in-Chief, Orthopaedics, Rhode Island and Miriam Hospitals.*

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## Pediatric Upper Extremity Conditions: Traumatic and Congenital

Julia A. Katarincic, MD

**Children may present with a variety of** upper extremity conditions. The cause can be traumatic, congenital or developmental.<sup>1,2</sup> The first physician involved in the diagnosis of congenital or developmental processes is the pediatrician or family practitioner. Parents with injured children often seek emergency treatment, with follow-up by the child's primary physician.

### EMBRYOLOGY

The upper extremity limb bud first appears on the dorsal ventral embryo at about 4 weeks' gestation; development is complete by 8 weeks. The development

of the arm is about 2 weeks ahead of leg development. The limb bud first appears as a paddle on the dorsal side of the embryo. This is important to remember because of the proximity early in gestation to the chest wall. Certain early insults such as brachysyndactyly (short/ absent fingers and metacarpals) may be associated with Poland's syndrome (absent pectoralis muscle). The proximal to distal growth of the limb bud is controlled by the sonic hedgehog gene. Any insult to this gene can lead to a congenital amputation. Radial to ulnar limb growth is controlled by the wnt gene. Problems related to this gene include radial or ul-

nar dysplasia.<sup>3,4</sup> The hand paddle is complete at 6 weeks. Apoptosis, or preprogrammed cell death, will cause the tissue of the finger clefts to regress leading to a five fingered hand.<sup>5</sup> A disruption in the process can lead to syndactyly (webbed fingers).

### SYNDACTYLY

Apoptosis occurs in the hand paddle at about 6 weeks, leading to a five-fingered hand. Any disruption in this preprogrammed cell death will lead to syndactyly or webbed fingers. Syndactyly is classified as complete or incomplete and complex or simple. Complete syndactyly

is when the fingers are joined together all the way to the tip. Incomplete syndactyly means the webbing stops before the end of the fingers. In a simple syndactyly, bone structure is normal. In a patient with complex syndactyly, there are often more bones than normal with anomalous attachments of muscles. Treatment for these children is separation to improve hand span and help function. Typically 18-24 months of age is the appropriate age for the division. Doing the surgery at a younger age increases the chance of web creep, a recurrence of the syndactyly at the base of the fingers, the most common complication of the surgery. The exception to this timing is a child with a border digit syndactyly with a length discrepancy. If one finger is tethered by its neighbor, earlier division (6 to 12 months of age) is recommended to limit grown deformities. Full thickness skin grafts, usually from the groin are always required to cover the divided fingers.

## **POLYDACTYLY**

Polydactyly is any condition with more than five fingers on a hand. In white and Asian children a duplicate thumb is common, while in black children the little finger is often duplicated. If the opposite is found with no family history, an associated syndrome should be ruled out. If there is no known or suspected bleeding disorder, these can be tied off in the nursery. The downside is that the adult will have a nubbin on the hand at the point of ligation. There are also reports of neuromas developing at the point of ligation. If the polydactylous digit is large, it should be removed in the operating room after 6 months of age. Joint reconstruction may be required. It is also important to tell the parents, especially when the thumb is involved, that the digits aren't "duplicate" because one tends to be smaller, and this may affect reconstruction and function.

## **AMPUTATIONS**

A vascular insult in the apical ectodermal ridge will lead to a congenital upper limb amputation. The most common is a congenital below elbow amputation. Traditional teaching is to fit these children with a passive prosthesis at about 6 months of age. Most children with a nor-

mal contra-lateral extremity will not wear a prosthesis because of the lack of sensation. Some of these patients will use a prosthesis for a specific function or a cosmetic prosthesis as teenagers and adults in social situations.

A recent study has shown that children with congenital upper limb amputations do not wear their prostheses and have higher self esteem than teenagers without an upper extremity anomaly.

Also in this group is intercalary failure of formation. Some type of insult occurs, typically to the metacarpal area, leaving a short hand with small digits. These digits or nubbins will have a nail, which differentiates this diagnosis from constriction bands. There is no evidence of Streeter's dysplasia or amniotic band noted at delivery to differentiate the diagnosis. Unfortunately, there are limited reconstruction options in this group.

## **BENT FINGERS**

### **Trigger Thumb and Finger**

There are three common reasons for a flexed thumb in a young child: spasticity, a hypoplastic EPL (**extensor pollicus longus**) and a trigger thumb.

If a toddler cannot fully extend the thumb, it is most likely a trigger thumb. Also included in the differential should be a hypoplastic thumb extensor tendon or spasticity. Typically, a caregiver notices the child cannot give a "thumb's up". The family may associate it with trauma but the timing is coincidental. A large nodule, a Noda's nodule, may be palpable at the base of the thumb along the **FPL (flexor pollicus longus tendon)**. The nodule causes the FPL to get stuck on the proximal side of the A1 pulley. As the child or parent tries to extend the thumb, the friction causes an increase in the size of the nodule and the cycle continues. Surgical release of the A1 pulley is required. Release is recommended by age 4 to avoid any permanent flexion deformity of the thumb. One released, the trigger should not recur.

Trigger fingers in children are a different process. In a toddler, surgery may involve release of the A1 and A3 pulleys and possibly a resection of a portion of the flexor digitorum superficialis tendon. If a pre-adolescent or adolescent presents with a trigger finger, the clinician should rule out rheumatoid arthritis.

## **CAMPTODACTYLY**

Camptodactyly means bent finger. It is inherited as autosomal dominant. The little finger **PIP (proximal interphalangeal joint)** joint is most commonly involved, followed by the ring finger. The parents should be examined because often they don't realize they have the condition. Surgery is rarely indicated because a functional deficit is uncommon. Extension splinting or casting for the involved joint is appropriate if the child is symptomatic or if the deformity is progressive.

## **CRUSH INJURIES**

Fingertip crush injuries are one of the most common reasons for visits to the emergency room. Typically, the finger is caught in a door jam or car door. The nail bed may be injured with an underlying tuft fracture or the tip may be avulsed. If there is a subungual hematoma of 50% or more, it may be reasonable to remove the nail and repair the nail bed. If this is not done at the time of the injury, a late repair is probably not indicated unless there is some sign of infection.

In children with open growth plates, one has to be suspicious of a Seymour fracture.<sup>6</sup> There is displacement of a growth plate fracture of the distal phalynx and the germinal matrix (base of the nail bed) becomes interposed into the fracture site. In this case, the fracture will be irreducible because of the interposed soft tissue. These need to be treated emergently like an open fracture to avoid the development of osteomyelitis.

Children may also avulse the entire tip of their finger, commonly from getting caught in a recliner or an exercise bike. If the injury is distal to the nail, microsurgical replantation is not possible. It may be possible in children younger than age 8 to replace the tip as a composite graft and obtain reasonable cosmesis and good function. If the tip is not available to be put back on, these will typically heal well by secondary intention.

## **TENDON LACERATIONS**

Children not uncommonly will sustain a laceration to the underside of their fingers with a scissors or knife. Or a child may reach into the garbage and be cut with a piece of glass or the lid of a can. Another type of tendon injury is a jersey

finger where the FDP (**Flexor digitorum profundus**) tendon is avulsed from the insertion at the base of the distal phalynx. The tendon may retract to the palm of along the finger. These need to be repaired in the first 10 days.

These children are typically hard to examine. An Xray will rule out an injury down to bone or an avulsion fracture in the case of an FDP avulsion. The individual FDS (**Flexor digitorum superficialis**) and FDP tendons should be examined. If this is not possible, the resting position of the hand should be evaluated or tenodesis evaluated. Hold the hand and move the wrist up and down. When the wrist is flexed, the fingers should all extend and when the wrist is extended, the fingers are all flexed. If there is any asymmetry, a tendon laceration should be suspected. Nerve injuries are even more difficult to assess. A child older than 8 may be able to tell you that a finger is numb. With a nerve laceration the fingers will lose their normal sweat pattern and feel cool to exam. If there is a tendon laceration, repair should be undertaken by 2 or 3 weeks. Delays may make repair impossible or necessitate the use of a nerve graft. Post-operative care for children with a tendon injury is 4 weeks in a cast followed by therapy if the patient will cooperate.

## BRACHIAL PLEXUS LESION

Brachial plexus injuries from work occur in about .5% of live births. Often these newborns have a pale, immobile "marble like" arm. Differential includes a clavicle fracture (a good prognostic sign since the plexus is decompressed as the baby is delivered), proximal humerus fracture or septic joint. The most common injury, occurring 76% of the time,

is an Erb's Palsy, involving the upper trunk, or C5, C6 and possibly the C7 nerve root. A total Brachial Plexus palsy occurs 23 % of the time. A Klumpke's palsy, or isolated lower trunk lesion, is very rare.<sup>7</sup>

The majority (56%) of these injuries are related to a shoulder dystocia. Babies delivered by cesarian section may sustain a lower plexus injury because their arms are abducted over their heads at the end of delivery. Other risk fractures include maternal diabetes, breech presentation, maternal obesity and or an instrumented delivery. There is also a 10% risk of having a child with a brachial plexus lesion in a subsequent pregnancy.<sup>8</sup>

About 90% of these children will have a full functional recovery. Children who do not recover biceps function by 5 months typically require microsurgical nerve reconstruction to improve the chance of a functional recovery. Lack of wrist extension in children with no biceps function is a poor prognostic sign.

Infants who do not show signs of recovery by 3 months (total plexus lesion) or 5 months (upper trunk lesion) will require operative treatment. This includes first exploration of the plexus. If there is a neuroma in continuity or a rupture of the plexus, the lesion may be graftable using a cable of sural nerve graft from the leg. The deficit from harvesting the sural nerve is a tiny numb patch on the lateral border of the foot.

If the nerve root was avulsed from the spinal cord, the lesion is irreparable. A nerve will have to be borrowed from other muscles, without causing another deficit, to power the extremity. Sources of this "extraplexal neurotization" in children include a branch of the spinal ac-

cessory nerve to the trapezius or a single fascicle of the ulnar nerve to the FCU (**Flexor carpi ulnaris**). In adults the phrenic nerve or intracostal nerves are possible sources but this should be avoided in children.

In these cases, recovery is noticed at 4 to 6 months post operatively. Recovery will continue for approximately 3 years. Parents should be told that the affected limb will be 8-10% shorter and smaller.

Even children who recover reasonable hand and elbow function may have a shoulder internal rotation contracture. These children should work to maintain shoulder external rotation, through therapy or overhead activities such as volleyball or swimming. In children who develop a shoulder contracture, a tendon transfer or a humeral osteotomy may be required to improve function.

## SUMMARY

There are a variety of upper extremity conditions both traumatic and congenital that the physician will encounter. Some require emergent treatment; some should be observed. It is important to make the correct diagnosis and refer in a timely fashion.

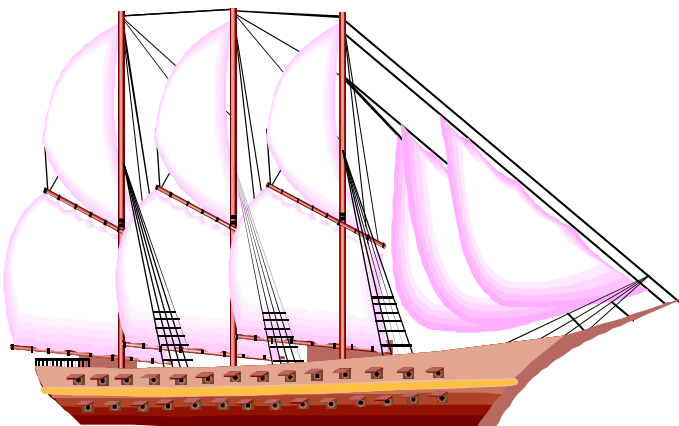
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# Adolescents and Upper Extremity Sports Injuries: The Throwing Arm

*Robert M. Shalvoy, MD*

**Adolescents, who comprise the largest** group of competitive athletes in the United States, are also the most active, usually participating daily while in season. As a result, adolescents as a group are responsible for the most athletic injuries. Not all of adolescents' sports injuries are the result of frequent exposure to sports. The many pronounced and rapidly occurring changes that occur in the adolescent body can create vulnerabilities that result in injury. This article will highlight some common athletic injuries.

The large ongoing injury surveillance studies of the **National Athletic Trainers Association (NATA)** and the **Athletic Health Care System (AHCS)** revealed that 70 to 80% of reportable injuries in all sports are relatively minor, causing the athlete to miss fewer than 7 days of participation. Four to eight percent of injuries cause a time loss of greater than 3 weeks. More than 60% of all high school athletic injuries occur during practice, reflecting the greater amount of time spent at practice compared to games.<sup>1</sup>

In the adolescent, injuries to the upper extremity are potentially serious because of the tremendous growth potential and intricate articulations of the shoulder and elbow. They are common in all sports but of particular concern in baseball, swimming, gymnastics and tennis. Of these, baseball is by far the greatest contributor to injury in the upper extremity both in frequency and severity. Despite numerous studies and growing recommendations on baseball pitching, an alarming upward trend in musculoskeletal injuries has been reported in younger and less mature patients.

## **UPPER EXTREMITY INJURIES**

There are two categories of injuries to consider in the upper extremity. The first is direct injury secondary to falls on an outstretch hand or direct contact. These injuries are more common in younger athletes and those who have yet to develop the basic skills of their sport. The second category is overuse injuries

from repetitive motions (as in tennis, swimming and baseball pitching/throwing).

### **Direct Injuries**

Direct injuries to the upper extremity are secondary to a fall or direct contact or collision. These injuries are not unique to the adolescent: there's a higher rate in younger children. The rate of injury from routine recreation or "play" equals that of organized sport. These injuries can be minimized by taking a "safety first" approach to sports and instituting guidelines of fair play and safe playing conditions.

### **Overuse Injuries**

The adolescent athlete is particularly vulnerable to overuse injuries in the upper extremity. During adolescence, rapid increases in muscle mass and strength result in increased forces and stresses with athletic activity. Bone growth occurs at the physis. Rapid growth means a widening and relative softening or weakening of the physis which translates to an increased vulnerability to injury.

Swimming entails long hours of practice and large volume of work. Injuries occur from a resultant poorly balanced muscle development in the shoulder girdle from a highly repetitive activity with little variation. This can lead to contracture or limited mobility in the shoulder joint and detrimental joint mechanics. The result is tendonitis in the rotator cuff and occult shoulder instabilities.

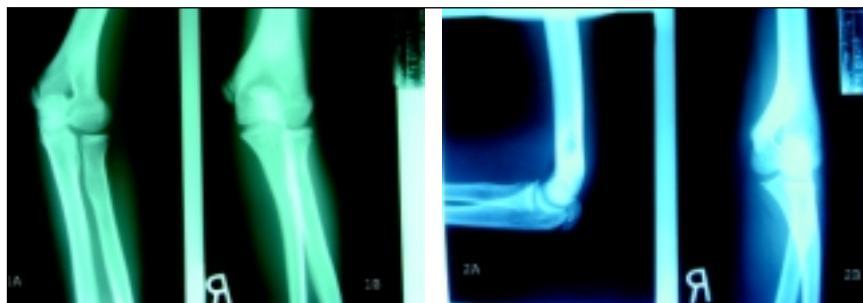
The swimmer who complains of shoulder pain usually has visible muscle imbalances characterized by a protracted or "shoulders forward" posture. Treatment rarely includes surgical intervention, but frequently the swimmer must stop swimming and undertake a course of physical therapy to correct muscle imbalances across the shoulder, regain control of the scapula, and stabilize the shoulder. When the athlete returns to the pool, s/he must continue a maintenance exercise program to prevent recurrence.

A therapist well versed in shoulder mechanics and the demands of swimming is crucial. Similarly, tennis is known for repetitive stress in the racquet arm. Overhand strokes and serves provide particular stress on the shoulder joint and rotator cuff complex while ground strokes tend to concentrate stress on the elbow and forearm. Again, overuse tennis injuries rarely result in surgical treatment in the adolescent athlete, but repetitive play in the developing extremity frequently results in tendonitis in the elbow, shoulder or both. Rotator cuff tendonitis with contracture is common as is medial and lateral epicondylitis—"tennis elbow"—in the flexor and extensor musculature of the forearm where it inserts at the elbow. Less common, but consistent with the vulnerability of the adolescent athlete, is apophysitis in the physis of the proximal humerus or the epicondyles of the immature elbow, both a form of stress fracture.

The athlete is more likely to present with diminished range of motion in the shoulder than in the elbow and x-ray with physical examination is usually sufficient to make a diagnosis. Like swimming, a reduced volume of play and a formal physical therapy program with a specialty-trained therapist can correct most overuse injuries. Maintenance exercise is necessary to prevent recurrence and should include a core strengthening program that includes the hips and abdominal muscles.

### **Throwing Injuries**

Baseball pitching can lead to injury in the throwing arm. The repetitive stress of pitching can cause permanent change in the growth plate, articular cartilage, ligament and tendons of the shoulder and elbow. Any discussions on throwing injuries requires a working understanding of the physis and ossification centers of the shoulder and elbow as well as a basic understanding of the biomechanics of pitching. Fast pitch softball or "windmill" pitching has more recently been studied



Figs 1 and 2. Normal elbow 15 yo pitcher.

although upper extremity injury is much less frequently reported in either male or female athletes.

### Anatomy

The primary growth plate in the shoulder is in the proximal humerus. Eighty percent of the overall growth of the humerus occurs in this proximal physis. Substantial growth can still remain in boys until skeletal age 16.

The elbow is a complex joint composed of three individual joints within a common articular area. The elbow contains no less than six secondary ossification centers forming and developing over varying periods during development. This creates a highly vulnerable area during adolescence because the onset of ossification can be as late as thirteen years of age in certain areas of the elbow and the time for actual fusion of the physis can be as late as sixteen or seventeen years of age. In particular, the medial epicondyle begins to form at about five or six years of age as a small concavity on the medial aspect of the ossification border. During the fusion process, just before completion of growth, the capitulum, lateral epicondyle, and trochlea fused to form one epiphyseal center. Metaphyseal bone separates the medial epicondyle from this center. The medial epicondyle is the last to fuse to the metaphysis and may not be fused until the late teens. (Figures 1 or 2).<sup>2</sup>

### Pitching Biomechanics

Baseball pitching is one of the most demanding motions on the human body in sports. A pitcher generates high levels of energy in the arm and body to accelerate the baseball. Upon release, energy is needed to decelerate the pitching arm. Forces and torques generated in the shoulder and elbow joints to accelerate and decelerate the arm are dangerously

near the physiological limits of the joints and ligaments. Cumulative affects of frequent pitching can lead to system overload and overuse injury.

A pitch can be divided into six phases. (Table 3). This continuous fluid motion takes place in about 0.14 seconds between the front foot's placement on the ground and the ultimate release of the ball.

During the cocking phase, high shoulder forces and torques are generated. To balance the rapidly rotating torso of the pitcher, a peak compressive force between 550 and 570 N is generated at the shoulder. High forces and torques are also generated at the elbow during the cocking phase, specifically a varus torque is generated to withstand valgus stress equaling about 50 to 75Nm. During the acceleration phase, the elbow extends reaching an angular velocity of 2100 to 2400 degrees per second. During deceleration, large eccentric loads are needed at both the elbow and shoulder in order to decelerate the arm. Large forces and torques are again generated. A maximum compressive force that approximates the pitcher's body weight are needed at both the elbow (800 to 1000 N) and shoulder (1000 to 1200 N) to prevent distraction of the joint. These are the greatest forces generated during the pitching motion.<sup>3</sup>

The forces generated by pitching vary according to the types of pitches. A fastball and a change-up generate the lowest amount of stress to the throwing arm, whereas a curve ball generates a greater amount of medial force on the elbow as well as varus torque. Split finger fast balls or "splitters" as well as screwballs generate the largest stress on the throwing arm, frequently exceeding physiologic limits.

Comparing the biomechanics of adult pitchers with adolescent pitchers show that when forces were expressed as percentages of body weight,

**Table 1. Swimmer's shoulder**

Limit swimming
Stretch pectoralis
Stabilize scapula
Strengthen rotator cuff

joint forces and torques were slightly greater for the adult pitcher, but the adolescent pitcher produced greater elbow varus torque than the skeletally matured adult.<sup>3,4</sup>

### Elbow Injuries Pathomechanics

The valgus torque applied by the forearm to the elbow can lead to medial elbow injuries. This includes tendonitis or medial epicondylitis, avulsions fractures involving the growth plate and medial collateral ligament injuries. While throwing a fastball, adult pitchers average 64Nm of torque with the elbow flexed. With the elbow flexed and a valgus load applied to the elbow, the **ulnar collateral ligament (UCL)** generates greater than 50% of the torque required to resist this force. Similarly, the UCL starts to fail at about 32Nm which is half of the torque produced when throwing a fastball. Clearly the load on the UCL during pitching appears to be near the maximum capacity of this ligament. It is generally accepted that in the skeletally immature elbow, the strength of the physis is less than the strength of the ligamentous structures. In the growing elbow, the load of stress affects not only the UCL but the medial epicondyle of the humerus. The growth center at the medial epicondyle is one of the last to fuse and is one of the most vulnerable structures in the pitcher's elbow. Apophysitis, widening of the physis and displaced fractures of the epicondyle are commonly seen. (Figure 3)

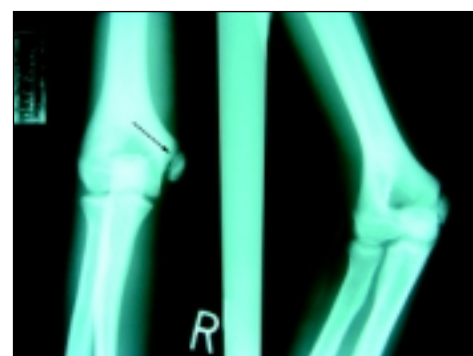


Fig 3. pathologic widening of medial apophysis

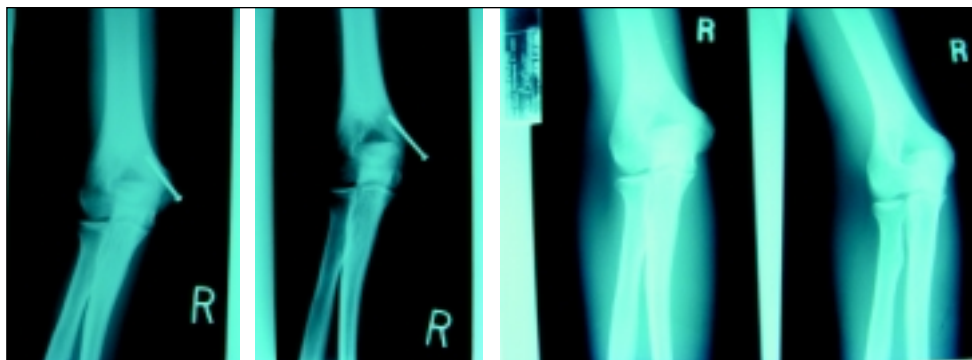


Fig. 4. Surgical fixation 3 month. Fig. 5. Surgical fixation 6 month. Fig 6. Healed hardware removed.

Valgus torque on the elbow can also lead to compression injuries on the lateral side of the elbow. This creates compression between the radial head and the capitulum of the humerus. This results in avascular necrosis, osteochondritis dissecans and intra articular osteochondral fractures.<sup>3,5</sup>

### Presentation

Throwing injuries to the elbow will present as pain medially, laterally, or within the joint. Symptoms may have a sudden onset or, more likely, an insidious onset. Symptoms usually begin while throwing and resolve when play is over. Over time symptoms will become more consistent and will persist after play.

On examination the contralateral elbow should be used for comparison. The injured elbow may lack extension. Tenderness can usually be isolated to the involved area either over the epicondyle, across the joint in the area of the ligament, or distally in the musculature of the medial elbow. Pain may be identified

laterally or posteriorly in injuries involving these areas. Pain with pronation and supination usually indicates injury in the radiocapitellar joint. Stability examination is more likely to elicit complaints of pain and very subtle evidence of instability than gross instability.

### Imaging

The radiographic exam of the elbow should include a true AP, lateral, and radial head view of the elbow. Comparison views of the contralateral elbow are useful in determining whether nuances in the skeletal anatomy represent pathology or a particular stage of skeletal maturity. MRI evaluation of the elbow can demonstrate injury to the medial epicondyle, UCL and radiocapitellar joint. Avascular necrosis and osteochondritis dissecans of the capitellum are best demonstrated in this manner.

### Treatment

Any pain in the elbow while throwing is abnormal. An adolescent pitcher should not throw through the pain, but should rest, with anti-inflammatory modalities including regular icing and non-steroidal anti-inflammatory medication. Physical therapy should be recommended for the adolescent thrower who lacks extension. A six to twelve week period of rest is typically required to resolve most symptoms. Physical damage with widening of the physis seen on x-ray or frank avulsion fractures may take longer and should show radiographic evidence of resolve prior to considering a return to throwing. Failure to heal is an indication for surgical repair. (Figures 4,5,6).

A physical therapist should supervise a return to throwing,

with a formal return-to-throw program. Pitching coaches, personal trainers, and baseball clinics typically lack the expertise to advance the pitcher safely. Pitching coaches and baseball specialists, however, can assess the pitchers' mechanics and identify errors that can contribute to the development of injuries.

## SHOULDER INJURIES

There is a large distraction force across the shoulder joint when throwing a baseball. Any force that shifts the humeral head during distraction will place the glenoid labrum at risk for injury. The labrum becomes stuck between the humeral head and glenoid rim resulting in fraying and tearing. Because of the large magnitudes and rapid changes in force, the stability of the joint is threatened. Capsular laxity and muscle fatigue add to the problem.

The rotator cuff functions to resist distraction across the shoulder joint. To this end, it serves to decelerate the throwing arm, not accelerate the arm during delivery as commonly thought. An eccentric load is placed on the rotator cuff tendons as the shoulder joint is being distracted. This is one of the hardest loads to resist. Eccentric loads are known for causing pain and reflex tightness in muscles and tendons. As a result, the pitcher's rotator cuff becomes excessively tight causing decreased internal rotation of the shoulder joint. This repetitive tensile stress in a tight shoulder leads to rotator cuff tears. In the adolescent thrower, the proximal humeral epiphysis shares the stress. This results in the physis becoming widened or fractured. Eventually the epiphysis externally rotates,

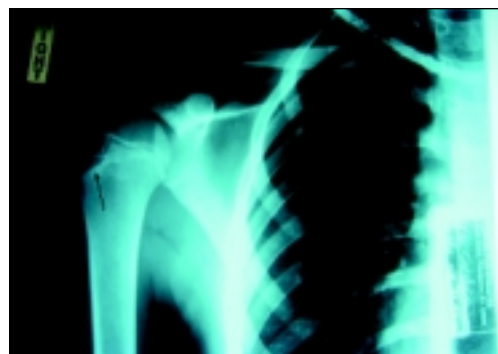


Fig 7. Pathologic widening prox humeral apophysis

### Table 2. Tennis Program

- Reduce volume of play
- Stretch rotator cuff
- Forearm musculature
- Stabilize scapula
- Strengthen rotator cuff
- Forearm
- Core strengthening

### Table 3. Phases of Pitching

- Windup
- Stride
- Arm cocking
- Arm acceleration
- Arm deceleration
- Follow through

causing a permanent change in version or alignment of the shoulder. To complicate matters, any changes in the shoulder are passed down the kinetic chain to the elbow, further increasing the risk of injury in the adolescent thrower.

## Presentation

The adolescent pitcher with a shoulder injury complains of pain, typically in the lateral shoulder but not uncommonly in the elbow only. The evaluation of elbow pain always requires a thorough examination of the shoulder. Again, an examination of the contralateral shoulder is required to get an adequate base line for the throwing shoulder. Evaluation of the scapula may show some asymmetry or some compensatory muscle dysfunction. Palpation of the shoulder may reveal tenderness in the subacromial area around the underlying rotator cuff or may be slightly more laterally and distally in the region of the proximal humeral physis. Range of motion examination in both the sitting and supine positions may show a discrepancy in motion. Contracture of the rotator cuff will show limitations in internal rotation which may or may not be painful. Excessive external rotation may be seen if the proximal epiphysis has been shifted or rotated. Stability examination may reveal apprehension or frank instability.

## Imaging

An AP and axillary radiograph of the shoulder is the minimum requirement for evaluation of the shoulder. Additional views

including an AP radiograph in internal and external rotation or a subacromial outlet view can be helpful. Images of the contralateral shoulder can prove helpful in comparing and evaluating nuances in the symptomatic shoulder. The widening of the proximal humerus epiphysis is best identified radiographically and confirmed with comparison radiographs of the other shoulder. (Figure 7) An MRI study of the shoulder will reveal injuries to the rotator cuff and glenoid labrum.

## Treatment

Some shoulder tightness or discomfort can be expected in a pitcher. Pain that lasts beyond the period of play or becomes constant is not normal. A period of rest is required to resolve these symptoms. Anti-inflammatory modalities including ice and non-steroidal anti-inflammatory medications are indicated. A qualified physical therapist is required to restore flexibility and strength to the rotator cuff complex. Once corrected, a maintenance exercise program is required to address future stress to the shoulder. Partial and full thickness tears to the rotator cuff require surgical treatment. A six to twelve week period of rest is prescribed for injuries to the proximal humeral physis or rotator cuff. Labral injuries and instability are treated with a stabilization exercise program supervised by a physical therapist. Surgery is reserved for a failure to improve or persistent pain complaints.

## Recommendations for Pitching

Given the high stress of the pitching motion and the vulnerability of the adolescent elbow, limitations on the numbers of pitches, the frequency of pitching, and the types of pitches thrown should be observed. Traditionally, limits have been set only as to the number of innings a pitcher can throw in a given week. Given the variability of pitches thrown in an inning, this is not adequate. Presently, we are moving towards recommendations of pitch counts for adolescent pitchers as outlined in table 4. Types of pitches should be closely monitored. (Table 5) <sup>4</sup>

Adolescent pitchers should be limited to fast balls and change ups to age 14. At that time, curve balls and breaking pitches can be introduced. Sliders and split finger fast balls should be prohibited until age 16 when the medial epicondyle is fused.

In addition, adolescent pitchers should not pitch for multiple teams during the same season or play for more than nine months in the calendar year.<sup>6</sup>

## Fast pitch softball

Fast pitch softball or windmill pitching has a much lower incidence of injury despite pitchers throwing more frequently with little or not rest between outings. Injury studies suggest that throwing injuries are not even the most commonly occurring injury among softball players. Biomechanical studies, however, show similarities in joint distraction forces seen at the shoulder joint in windmill pitchers as well as similarities between elite adult pitchers and adolescent pitchers. Nevertheless, this has not been reflected in the number or severity of injuries reported in fast pitch softball. Few recommendations limit the type or number of pitches thrown or the frequency of play. Adolescents should be aware that while experiencing new levels of size and strength they are still growing and particularly vulnerable to the stresses of sports activity.

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**Table 4. Pitch Count Limits**

Age	Pitches per game	Pitches per week	Season
9-10	50	75	1000
11-12	75	100	1000
13-14	75	125	1000

**Table 5. Pitch type vs. age permitted**

fastball	8 years
change-up	10 years
curve ball	14 years
knuckle ball	15 years
slider	16 years
forkball	16 years
split finger	18 years



# Idiopathic Scoliosis In Children: An Update

Craig P. Eberson, MD

**The diagnosis of scoliosis in a growing child** is often a cause for great concern for the patient's family and primary physician. Treatment in the past often involved lengthy hospital stays, prolonged bed rest, and postoperative casting. Even patients treated non-operatively suffered the stigma of the Milwaukee brace, a metal framed structure extending from the hips to the chin, worn 23 hours daily. Modern insight into the potential causes of scoliosis, the evaluation of a child with spinal deformity, and advanced operative and non-operative treatments allow successful treatment of patients of all ages with scoliosis.

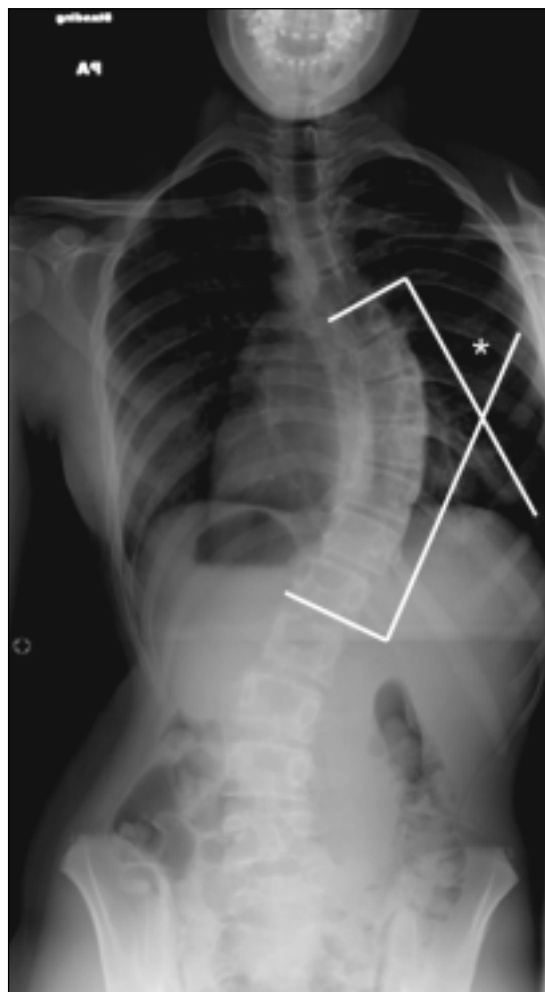


Figure 1. Cobb Angle. Lines are drawn parallel to the endplates of the most tilted vertebrae above and below the apex of each curve. The angle formed by the intersection of the lines drawn perpendicular to the endplate lines is the Cobb angle (\*). Modern digital radiographs allow rapid, easy calculation of these lines

## BACKGROUND

Scoliosis is defined as a lateral curvature of the spine exceeding 10 degrees as measured on a radiograph using the Cobb method. (Figure 1) While some patients may present with pain, the majority of patients with scoliosis are asymptomatic.<sup>1</sup> Patients and their families may notice an asymmetry of the waist, a rib hump, or a difference in breast size due to spinal rotation associated with the curve. Most patients are diagnosed through a screening program, either by their primary care provider or through a school program.

The cause of scoliosis remains the subject of intense investigation. While the cause of idiopathic scoliosis is unknown, recent investigations have pointed to a genetic link, as well as other etiologic factors.<sup>2,3,4,5</sup> Although a single "scoliosis gene" has not been found, studies of families with a high incidence of scoliosis have revealed several potential candidates.<sup>4</sup> As in all disorders, the diagnosis of "idiopathic" scoliosis presumes the exclusion of known causes. A thorough investigation into possible etiologies

must be undertaken prior to treatment. (Table 1)

## HISTORY AND PHYSICAL EXAM

Evaluation of the patient with scoliosis includes a thorough history and physical examination. A history of pain, numbness, bladder dysfunction, headache, weakness or dysesthesia should be sought. A family history of scoliosis, connective tissue disorder, or neurologic disorder is also relevant.

Physical exam includes a neurologic examination, including reflexes. The abdominal reflex is performed by stroking each quadrant of skin above and below the umbilicus. The umbilicus should move toward the stimulus symmetrically. Asymmetric reflex may indicate the presence of a neurological problem either in the spinal cord or the brain. Testing for ligamentous laxity (i.e. Marfan Syndrome), a skin exam to look for lesions associated with systemic disease (i.e. Neurofibromatosis—see Figure 2) as well as an assessment of the spine is performed. The location of the curve, degree of rotational prominence, and spinal balance (head centered over the pelvis) are noted. The Adams forward bending test is the most commonly used screening examination for scoliosis. In this test, the rotational component of the curvature is visualized by having the patient bend forward and view-

**Table 1. Potential Etiology of nonidiopathic scoliosis**

Neurologic	
	Tethered spinal cord
	Syringomyelia
	Cerebral palsy
	Muscular dystrophy
	Freidrich's Ataxia
	Other neuromuscular disorder
Connective tissue disorder	
	Marfan's syndrome
	Ehlers Danlos syndrome
Syndromic	
	Beal's syndrome
	Rett syndrome
Other	
	Post-sternotomy
	Thoracogenic (post thoracic surgery)



Figure 2. A. Axillary freckling associated with neurofibromatosis. B. Café-au-lait spots seen in Neurofibromatosis.



Figure 3. The Risser sign. Prior to the appearance of a “cap” on the iliac wing, the patient is referred to as Risser Zero. Upon closure of the apophysis, the patient is Risser V. As the apophysis ossifies, it moves from lateral to medial, with progression into each quadrant signifying the next Risser stage. The arrow on the ilium points to the apophysis, roughly Risser II in this patient. Risser IV signifies the end of spinal growth in girls, with boys often growing through Risser V.

ing the spine at eye level. In idiopathic scoliosis, there is a rotational deformity as the spine twists in the direction of the convexity of the curve. For a right thoracic curve, this means that the patient will have a prominence of the ribcage on the right side. For a left lumbar curve, the paraspinous muscles on the left will be prominent. The rotation can be quantified using a scoliometer; if the maximal rotational deformity measures less than 7 degrees, the patient is unlikely to have a curve with a Cobb angle greater than 20 degrees, and thus may not need to be referred to a specialist. Dropping an imaginary line from the base of the neck to the floor will identify an out of balance spine should the line not pass through the center of the sacrum. The patient should be checked for a limb-length discrepancy, as this may cause an apparent rotational deformity. This is most easily done by comparing the heights of the iliac crests in a standing patient.

## RADIOGRAPHIC EVALUATION

Standing posteroanterior and lateral views of the entire spine are the initial radiographs ordered. The iliac crests are

included in the film, in order to assess the Risser sign, a marker of skeletal maturity. (Figure 3) Films are scrutinized for evidence of congenital spinal malformation, abnormalities in the frontal or sagittal planes, spondylolysis, or spinal lesion. Non idiopathic curves often will not have a significant rotational component (i.e. osteoid osteoma-see Figure 4). The magnitude and direction of each curve is noted.

Indications for **magnetic resonance imaging (MRI)** in scoliosis are based on the presence or absence of certain “red flags.” These include: young age (younger than 10), left-sided thoracic curves, rapid progression of a curve, large curve at presentation without prior history of scoliosis, abnormal neurologic examination, unilateral acquired foot deformity such as a cavus foot, atypical pain, and others. The MRI is of the entire spine and brainstem, in order to identify spinal dysraphism, a tethered spinal cord or lipoma of the cord, syrinx, or Chiari malformation.

## CLASSIFICATION

Scoliosis can be classified by etiology, age of onset, and curve location. By definition, idiopathic scoliosis has no known etiology. Idiopathic scoliosis is further subdivided, somewhat arbitrarily, by age; infantile (0-3 years), juvenile (3-10 years) and adolescent (older than 10 years). Finally, the location of the curve is based upon the apical vertebrae: curves are described as cervical, cervicothoracic, thoracic, thoracolumbar, and lumbar. Curves can be further classified using accepted systems, such as the King or Lenke systems.<sup>6,7,8</sup>

## NATURAL HISTORY

Scoliosis of large magnitude (greater than 100 degrees) has been shown to

cause restrictive lung disease.<sup>9</sup> Curves greater than 60 degrees can cause changes detectable on pulmonary function testing. Treatment is aimed at preventing curves from reaching this magnitude. The two factors that determine curve progression are the amount of growth remaining and the size of the curve. At maturity, curves less than 30 degrees are unlikely to progress, while curves greater than 50 degrees tend to progress roughly 1 degree per year after the end of skeletal growth.<sup>10</sup> Prior to maturity, curve progression is related to the amount of growth remaining. Remaining growth can be determined by using the Risser sign, Greulich and Pyle atlas, menstrual status, and chronologic age. The classic study of curve progression, which used the Risser sign as a marker of maturity, showed that immature patients (Risser 0 to 1) with curves between 20 and 29 degrees had a 68% chance of progression, where as more mature patients (Risser 2 to 4) had only a 23% probability. For smaller curves (5 to 19 degrees), immature patients had a 22% probability of progression, while mature patients showed only a 1.9% likelihood of progression.<sup>11</sup> These factors can

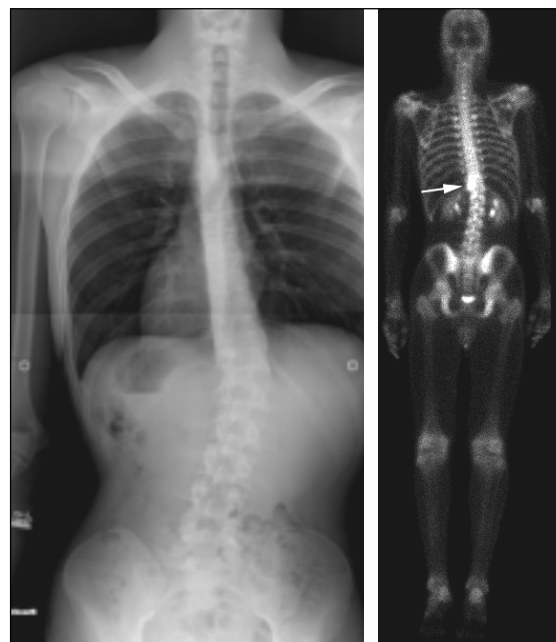


Figure 4. Osteoid osteoma. This patient presented with an acute onset of scoliosis and pain at night which responded to non-steroidal anti-inflammatories, a classic history for this benign tumor. A. Plain Radiographs show non-rotational curve centered at T12. B. Bone scan showing focal uptake on the left side of T12. CT-guided biopsy confirmed the lesion as an osteoma, which was treated with radiofrequency ablation.



Figure 5. Young girl in a scoliosis cast. After molding the cast to control the deformity, the cast is overwrapped in fiberglass to strengthen it. A hole is cut in the abdominal portion to allow breathing and eating. In this case, an arm was included to prevent the child from removing the cast, although this is not typical.

be used to design a treatment regimen, which is based on remaining growth and curve magnitude.

### NON-OPERATIVE TREATMENT OF SCOLIOSIS

The initial management of scoliosis is nonoperative. Despite significant interest, no well controlled studies demonstrate successful treatment of scoliosis using electrical stimulation, chiropractic manipulation, physical therapy, or any of the multiple regimens that have been suggested. These treatments are best reserved as an adjunct to other more traditional treatment and should not delay orthopaedic referral. Brace treatment is usually initiated in curves greater than 25-30 degrees in children with substantial growth remaining. Bracing is not designed to correct the curvature, merely to prevent progression. The success rates for avoiding surgery using bracing vary with the age of the patient and the magnitude of the curve at the initiation of bracing. While traditional methods require the child to wear the brace 20 or more hours per day, evidence exists that suggests nighttime bracing is equally effective for certain types of curves.<sup>12</sup> The Providence brace is an example of one such orthosis, first used at Hasbro Children's Hospital. The brace allows the effective treatment of moderate curves, particularly in the thoracolumbar region. By requiring only nighttime use, the stigma of brace wear at school is avoided

and compliance is improved.

Another form of non-operative treatment is casting. (Figure 5) Although it had fallen somewhat out of favor, there has been a resurgence of interest in casting, particularly in infantile scoliosis, where surgery is often delayed for years to allow lung and spinal growth. The patient is placed on a specialized casting table and a corrective cast applied. The cast is changed at regular intervals. If the curve is completely corrected, the patient is followed closely. Other patients are transitioned into a brace to help maintain correction.<sup>13</sup>

### SURGICAL TREATMENT

Treatment of curves greater than 50 degrees in mature patients and greater than 45 degrees in immature patients usually consists of surgery. For the purpose of this discussion, surgical treatments will be divided into early onset scoliosis

(less than 10 years old) and **adolescent idiopathic scoliosis (AIS)**. The growing spine presents challenges not seen in AIS, and these will be addressed separately.

### ADOLESCENT IDIOPATHIC SCOLIOSIS

In the past, surgical treatment was performed with a Harrington rod, a technology no longer used. Patients routinely had to wear a body cast following surgery, and the inability to control the sagittal plane resulted in "flatback syndrome" and pain. Modern techniques address the spine in three dimensions (frontal, sagittal, and axial rotation), thus providing a balanced spine in all planes. In addition, modern hardware obtains excellent bone purchase, allowing patients early mobility without casting or bracing.<sup>14</sup> (Figure 6) Lumbar and thoracolumbar curves are usually addressed through an anterior approach, while thoracic and double curves are usually addressed posteriorly. For large, rigid curves, occasionally the spine is "released" anteriorly (a procedure to cut the ligaments and remove the discs from the front of the spine) and then fused posteriorly as well. The anterior procedure in the past was done through a



Figure 6. A. preoperative film of a young girl with a double major curvature. B. Postop film demonstrating balanced fixation of both curves. This represents standard "hybrid" instrumentation of scoliosis with pedicle screws below the apex of the thoracic curve and hooks above.

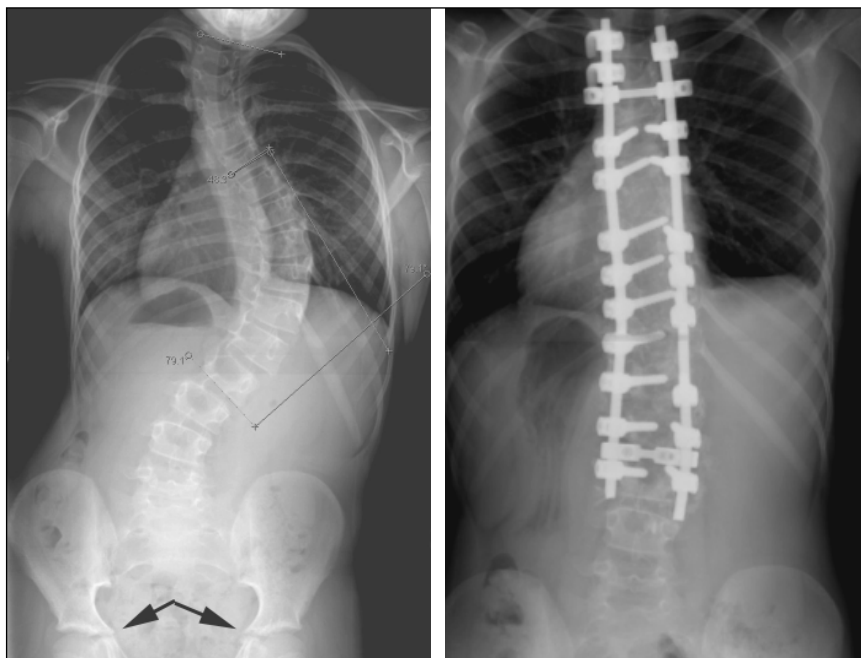


Figure 7. This 10 year-old girl presented with a rapidly progressive scoliosis. Preoperative evaluation revealed a tethered spinal cord. Following release of the tethered cord, she underwent surgery. A. Preoperative film showing a 79 degree main thoracic scoliosis and a 48 degree upper thoracic curve. Note the open triradiate cartilage (arrows), indicating significant concern of “crankshafting”. B. Postoperative film. The patient underwent thoracoscopic anterior fusion in the prone position, followed immediately by posterior spinal fusion.

thoracotomy, a procedure with significant postoperative morbidity. Newer minimally invasive approaches allow the procedure to be done thoracoscopically, through 3 or 4 half-inch incisions, thus avoiding the post-operative pain and respiratory effects of a thoracotomy. (Figure 7)<sup>15</sup> In all of these procedures, the spine is corrected, and bone graft (autologous or allograft) is used to fuse the instrumented segment.

The most recent addition to the armamentarium of the scoliosis surgeon is the thoracic pedicle screw.<sup>16,17</sup> Research into the morphology of the thoracic pedicles in scoliosis has led to techniques to safely instrument the spine in this manner. Pedicle screws extend through the pedicle into the vertebral body, thus obtaining purchase in all three columns of the spine. This allows control of spinal rotation, a feat not achievable using standard hook techniques. In addition, by combining this technique with posterior osteotomy, an anterior procedure can be avoided in many patients with large curves, due to the significant correction obtained.<sup>18,19,20</sup> While the expense of this technique may limit its use, in the hands of an experienced spine surgeon thoracic pedicle screws offer an excellent option for treating the most challenging cases. (Figure 8)

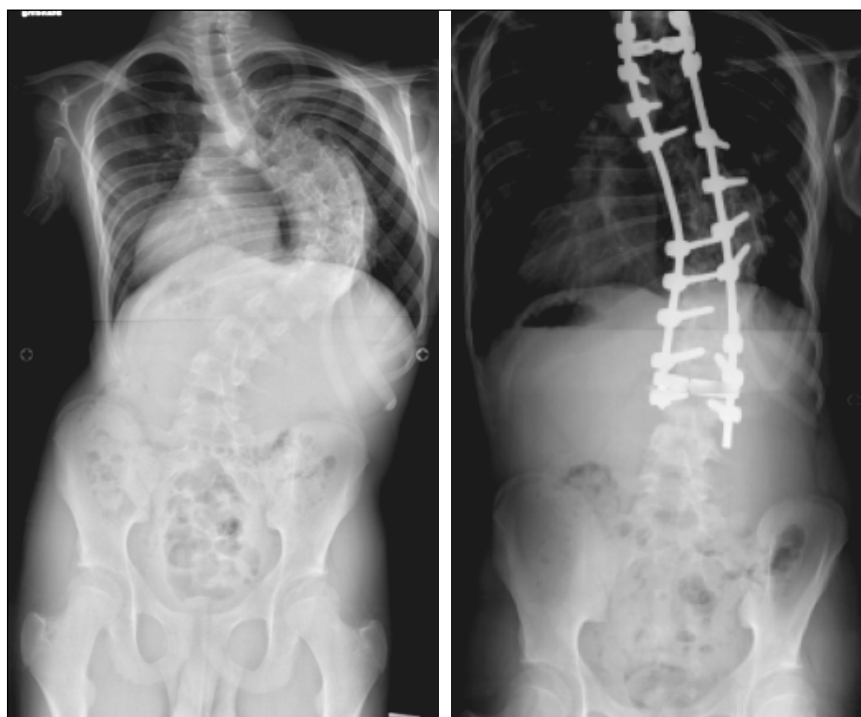


Figure 8. A. preop radiograph of a 16 year old patient born with a congenital longitudinal deficiency of both upper extremities and severe, rigid scoliosis measuring greater than 110 degrees. B. After thoracoscopic release and fusion of seven apical discs, the patient underwent posterior spinal fusion with pedicle screws. Postoperative Cobb angle is roughly 30 degrees. Note in increase in trunk height, increase in volume of the right lung, and centering of the thorax over the pelvis, compared to the preoperative radiographs. The direction of the screws, pointed laterally on the right at the apex, highlights the severe rotation seen in some cases.

## EARLY ONSET SCLIOSIS

The young child with scoliosis who fails non-operative treatment cannot undergo standard treatments due to factors related to lung development and spinal growth. The alveolar tree of the growing child continues to divide until 8 years of age. Spinal fusion before this age will impair chest growth and prevent normal pulmonary development.<sup>13</sup> Specific techniques, such as “growing rods” allow control of the curvature until lung maturity allows more definitive treatment. (Figure 9) Specially designed hardware is implanted and the spine is distracted to improve the curve, but no fusion is performed except at the hook sites. The rods are then lengthened every six months as an outpatient procedure, until a fusion can be safely performed. This technique was popularized years ago, but was largely abandoned due to complications of the technique. Newer implants and research dedicated to finding the optimal fixation and lengthening regimens have led to a resurgence in the use of this technique.<sup>21,22,23</sup>

In patients older than age 8, with substantial growth remaining, a standard pos-



terior fusion will fail to control the curve; and continued spinal growth from anterior growth centers will cause the deformity to progress despite a solid fusion posteriorly. This is true for patients previously treated with growth rods, as well as for many juvenile patients. This phenomenon, known as “crankshaft” because of the way the anterior spine grows and rotates around the posterior fusion, is avoided by performing an anterior fusion on any patient with open triradiate cartilage who is undergoing a posterior spinal fusion. While this approach was often avoided in the past due to the morbidity of a thoracotomy, newer thoracoscopic techniques allow the minimization of pulmonary side effects and postoperative pain while achieving the same goals. (Figure 7)

Several areas of research involve modulation of growth in the young patient while avoiding fusion. Betz and colleagues have shown early success with stapling of vertebral growth centers thoracoscopically to control curve progression by using the growth of the concave spine to maintain or improve spinal alignment.<sup>24</sup> Other authors have attempted similar technique using a flexible tether.<sup>25</sup> Biologic epiphyseodesis of the spine is also under investigation.<sup>26</sup> All these techniques seek to modulate the growth of the spine in order to avoid spinal fusion and promote greater spinal flexibility.<sup>27,28,30</sup>

## CONCLUSION

Spinal deformity in the growing child represents an area of significant concern. A thorough evaluation includes a history and physical exam as well as radiographs. Patients with small curves may be followed without treatment. Patients with larger curves and significant growth remaining require treatment to prevent curve progression, either in the form of bracing, casting or surgery. While newer surgical techniques allow successful treatment of patients who fail conservative treatment, current research is directed toward growth modulation and determination of etiologic factors. An in-depth understanding of the causes of scoliosis will facilitate the formulation of treatment plans that maximize spinal flexibility and function.

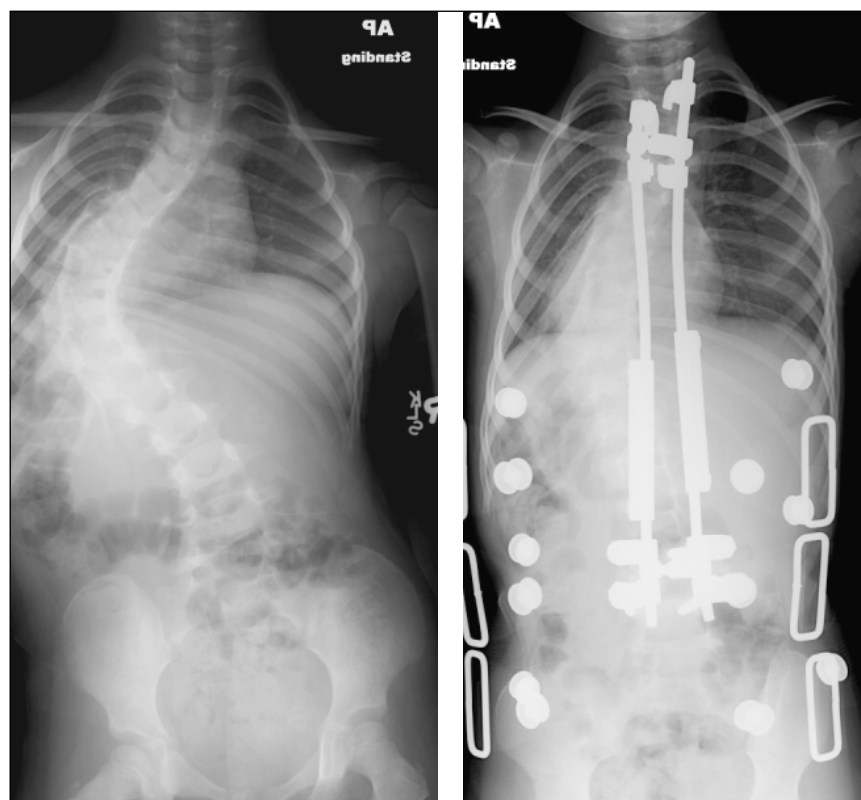


Figure 9. Infantile scoliosis. This four year old patient failed to respond to brace/cast treatment. A. Preoperative film showing severe scoliosis. B. Postoperative film after subcutaneously growth rod placement. There is substantial improvement in Cobb angle, thoracic height, and spinal balance. Fusion is performed only at the top and bottom anchor sites, theoretically allowing the rods to be lengthened every six months as an outpatient procedure, until final fusion at an older age.

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# Pediatric Femur Fractures: Treatment In the Year 2007

Patricia Solga, MD

**As the longest and strongest bone in the** human body, the femur is designed to provide the ability to ambulate without fracture for many decades. The evolution of *Homo sapiens* mandated physical qualities that allowed for bipedal gait, and children require fourteen to sixteen years to achieve this skeleton. Therefore, the orthopedic surgeon is obliged to restore not only anatomic qualities, but also functional qualities following femoral fractures.

The proper ratio and alignment of both the upper and lower bones of the leg are necessary to achieve suitable mechanics for walking. While these requirements are achieved throughout normal growth, if an injured femur is left to grow abnormally, these qualities are compromised. Fractures in different parts of the femur can affect growth and development in profound ways. Mechanisms of injury and the fracture patterns that follow dictate orthopaedic treatment. This treatment must take into consideration the complex matter of the potential for skeletal growth unique to children, which belies the commonly held view that the ability to treat their femoral fractures requires little understanding and minimal experience. Treatment by a pediatric specialist is often needed to restore adequate function and growth potential in a safe and cost effective manner.<sup>1</sup> In addition, family needs and the psychological requirements of both the child and family

must be met. It is not enough to render care to the child's bone but ignore the whole child and his family. How well and how quickly these goals are met require meticulous care. All of these factors must be built into the treatment plan and execution by the competent physician.

A brief review of the normal growth and development of this all-important bone is given here: At four to six weeks of embryologic development the limb buds appear, first the upper then lower extremities. From proximal to distal, that is from the hip to the toes, the limb develops in an ordered fashion. Some mesenchymal tissue differentiates into primitive cartilage, which is then converted to bone by the concurrent development of the blood vessels that invade the cartilage and stimulate the production of bone. Joints are formed by programmed cell death, thereby separating the femur from the acetabulum and the femur from the tibia and fibula.

The entire bony femur is enveloped in thick vascular soft tissue called the periosteum. Its counterpart in certain cartilaginous portions of the long bone is the perichondrium. The thickness of these soft tissues diminishes as the child matures and is found as a thin and much less well vascularized structure in the adult bone. The child's periosteum provides for both stability and rapid healing of fractures.

In describing the femur geographi-

cally, the epiphysis is the most proximal and distal portion of the femur. It is covered by articular cartilage and it grows wider in unison with the acetabulum proximally and distally with the tibia, thus developing the hip and knee joints. The epiphyseal portions of the bone rest upon the metaphyseal bone which is a well vascularized area both strong and elastic, allowing the weight of the body to be distributed under the epiphysis. It tapers gradually to the next anatomic portion of a long bone, the diaphysis which has a thick cortex that gives it enormous strength to resist the application of strong forces.

The thinnest and most vulnerable part of the long bones is the physis. The physis is a very small area of the long bone which separates the epiphysis from the metaphysis. This specialized area is comprised of unique cartilage that, in an orderly fashion, provides for growth at either end of the long bone. While injury to any portion of the child's bone can have dire consequences, the physis is the most vulnerable area in this regard.

Femoral shaft fractures are far less common than fractures of the clavicle, wrist, or tibia, however, from the hip to the knee any femur fracture can result in a shortened or deformed limb. The severity of the fracture, the age of the child,

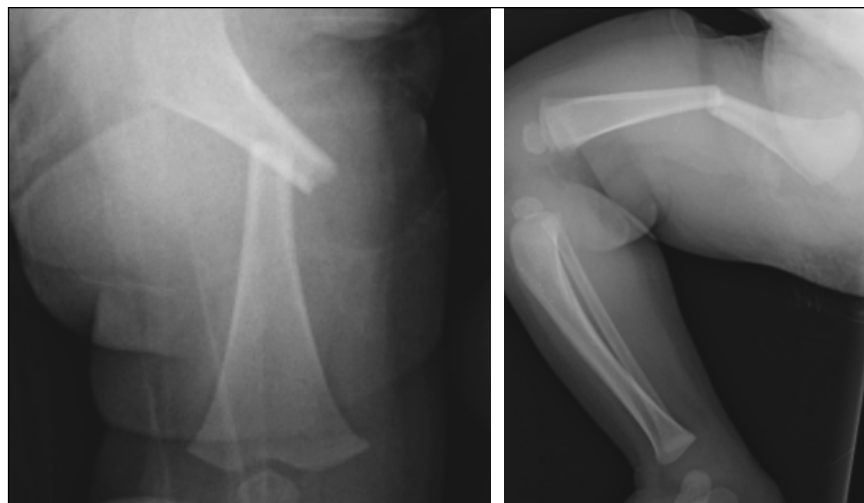


Figure 1a & 1b: AP/lateral infant femur fracture amenable to Pavlik harness treatment.

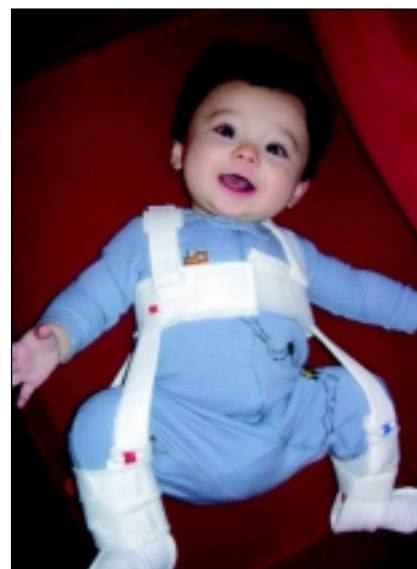


Figure 1c: Infant treated in Pavlik harness.



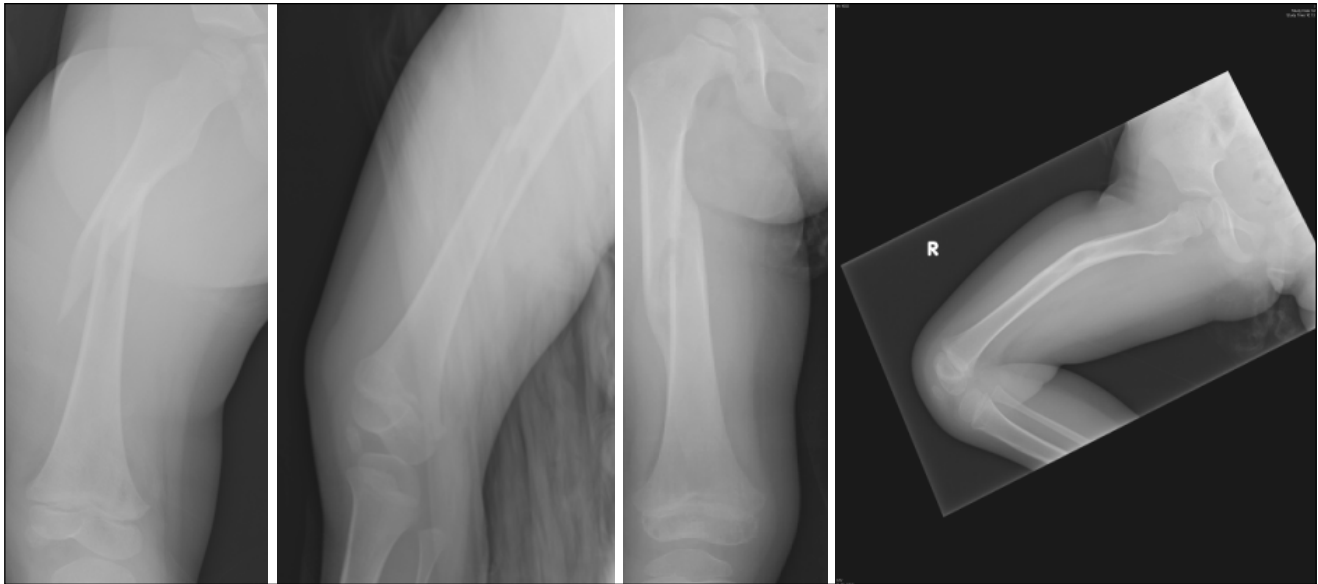


Figure 2a & 2b: AP/lateral toddler femur fracture amenable to immediate spica cast treatment.  
Figure 2c & 2d: AP/lateral toddler femur fracture treated in spica cast healed and remodeling.

and the location of the injury are the three factors which determine appropriate treatment. Beginning with birth and excluding conditions such as osteogenesis imperfectus that can cause intrauterine fractures, femoral shaft fractures can be caused by traumatic delivery, although they are exceedingly rare. Historically, tongue blades were applied to the limb with circumferential wraps to provide struts to hold the leg still and aligned. This treatment has disappeared from modern methods. A safer and more effective treatment involves the use of the Pavlik harness, which is a splint that is widely used to treat development dysplasia of the hip. The harness has the advantage of providing comfort for the newborn and ease of care allowing rapid healing while keeping the femur in acceptable position. It allows easy access to the baby's body and, therefore, hygiene is simplified. In addition, medical care such as vital sign monitoring is easily achieved. (Figures 1 a,b,c)

Aside from the neonatal period, the Pavlik harness can also be used to treat femoral shaft fractures in babies. This technique is especially useful for treating a baby because it confers the advantage of being able to evaluate the cause and nature of the fracture. For example, the harness can be removed when the baby is undressed in order to assess possible child abuse or to facilitate emergency treatment. However, the Pavlik cannot be used in an older baby because of the

baby's size and strength and the relatively longer time to healing of the fracture

Children between the ages of approximately six months to two to three years can usually be treated with a spica or body cast. While the use of a body cast can horrify the family and mystify an inexperienced medical community, the cast is a safe and efficient treatment when properly applied in the right circumstances. Generally, the principles of cast treatment dictate that the joint above and below the injured bone be immobilized. It is more challenging to immobilize the humerus and the femur, the bones closest to the torso. Derived from the Greek word for wheat, a proper spica cast is applied with the torso attached to the lower extremity in a criss-crossed fashion that mimics the shape of a shaft of wheat.

Fiberglass is rolled over an impervious pantaloons that is covered with cotton material while the child is held in proper position. The pantaloons provide a moisture barrier to prevent body secretions from soaking through the cotton and pooling under the fiberglass.<sup>2</sup> The cast is trimmed to expose the perineum to permit hygiene.

In the simplest case, a non-displaced fracture that is not unduly shortened or angulated is best treated with a spica cast applied with the child sedated or anesthetized.<sup>3</sup> (Figures 2 a,b,c,d & 3a,b)

Whether the cast is applied in the emergency room or the operating room, discharge of the child requires post-casting instructions for care of the child in the cast, appropriate visiting nurse visits, and follow-up visits. These are require-

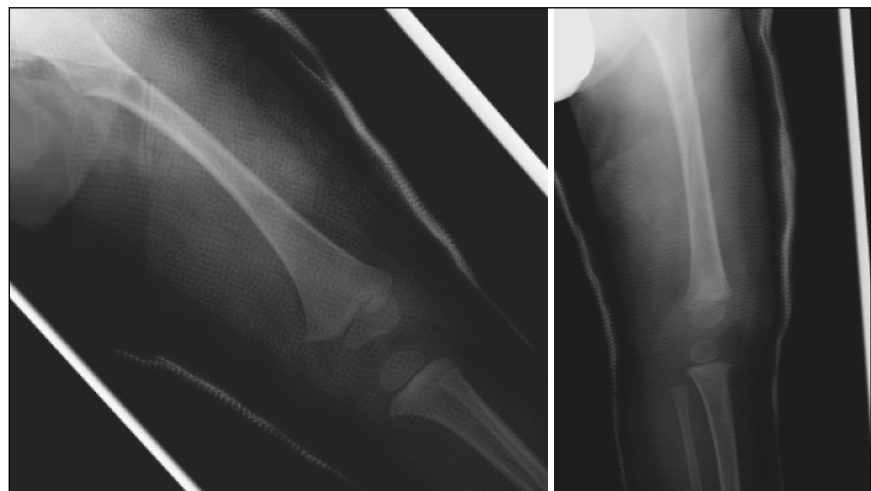


Figure 3: AP/lateral child non-displaced femur fracture in spica cast.

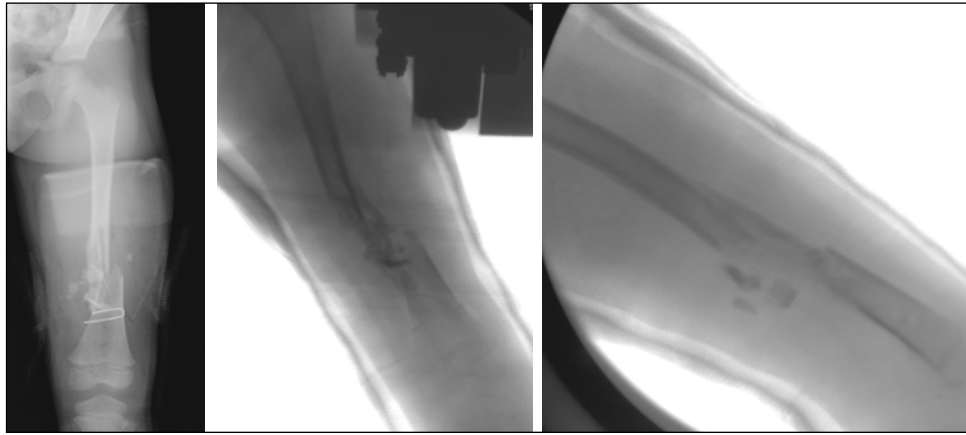


Figure 4a & 4b: AP/lateral child open femur fracture from gunshot wound with sciatic nerve injury treated with skeletal traction and spica cast. Figure 4c lateral in spica cast after 3 weeks of skeletal traction.

ments to ensure a well-healed fracture without complications. The child must be closely supervised and proper perineal care must be provided. The child must be positioned with the head and chest above the cast to prevent aspiration. This is especially true when a child has an undeveloped gag reflex, which may be the case in a child with neurological impairment. Under the right circumstances, a spica cast is a safe and reliable method of treatment of femoral shaft fractures and is well tolerated by the child and often permits return to day care or school. Pain diminishes predictably, minimizing the need for analgesics; and most children and families adapt to a short-term change in lifestyle. However, when child care is compromised by finances or when day care or school cannot accommodate the child, the family can experience enormous strain. A spica cast in the wrong circumstances can cause potentially dev-

astating complications. Thus, it is important for primary care physicians and residents to understand spica cast treatment of femur fractures.<sup>4</sup>

When a child is beyond the appropriate age for immediate casting, or in special circumstances, skeletal traction is indicated. In the case of a severely displaced fracture, skeletal traction which involves (Figures 4 a,b,c) placement of a threaded pin below the fracture, with weights attached to keep the bone out to length and in a reduced position is necessary. For many decades, skeletal traction was the standard treatment of any femoral shaft fractures in children from five or six and through the teenage years. After four to six weeks of skeletal traction a spica cast was applied. Traction can be a definitive form of treatment or preparation for surgical treatment. After the pin is applied the limb is then either positioned with the hip and knee in

extension or with the hip and knee at ninety degrees to one another. Improper placement of the pin in either the femur or tibia carries significant morbidity if the growth plate is injured.

After the age of about four or five, use of a spica cast for primary treatment of femur fractures has few advantages and has fortunately been supplanted by surgical management. Over the past two decades, surgical treatment has emerged as the standard of care.

As is the case in any new treatment, including orthopaedic surgical treatment, experimental use of a new technique with new devices precedes common clinical usage. Once approved in adults, these techniques including devices and instruments are sometimes found to be useful in treating fractures in the immature skeleton with modifications to address the physiologic characteristics of children. Pilot studies substantiating safety and efficacy allow these new methods to be applied to children's fractures and, in particular, to fractures of the femur.

Principles of fracture management in children share common points with adult fracture management: return to normal anatomy and function. Child and adult fractures should be treated rapidly, with minimal morbidity to the patient and predictably good results. There has been substantial progress in surgically treating common femoral

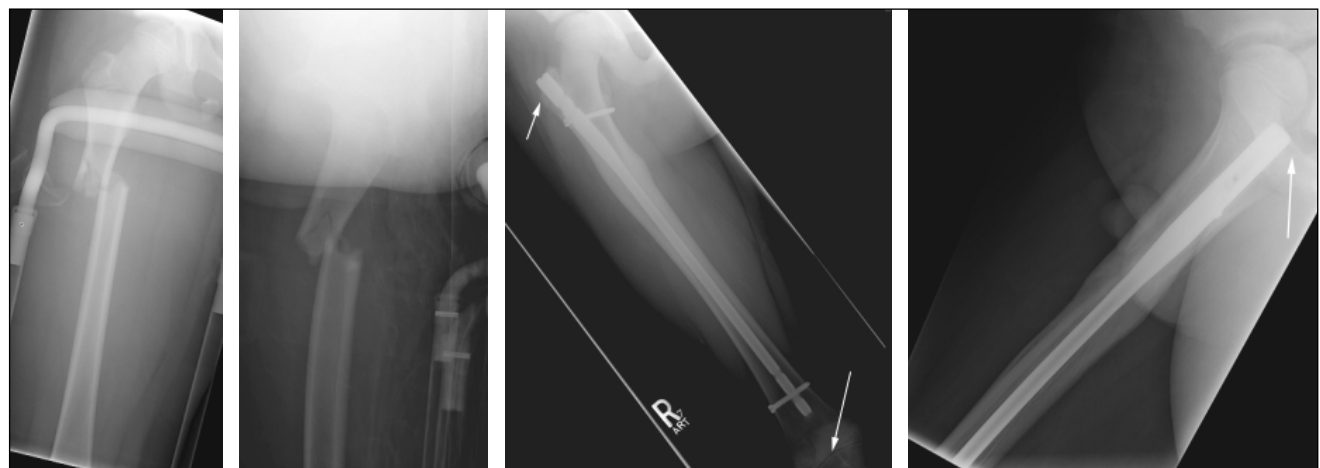


Figure 5a & 5b: AP/lateral teenage femur fracture for rigid intramedullary nail treatment. Figure 5c: AP post operative. The proximal arrow points to trochanteric entry site to avoid avascular necrosis, distal arrow points to growth plate. Figure 5d: Lateral post operative. The arrow points to the posterior portion of the greater trochanter. Note the insertion site is anterior, thus avoiding the femoral neck vessels



Figure 6a & 6b: AP/lat adolescent femur fracture amenable to titanium elastic nails. Figure 6c & 6d AP/lat post operative.

shaft fractures in children older than four or five, which in many circumstances has eliminated the need for traction and casting.

Over the last two decades, external fixators, with pins placed above and below the fracture and held in the correct position during the healing, was first applied to adults now to children. It remains one of the three standard surgical treatments for children.<sup>5,6,7,8</sup> This treatment provides for rapid stabilization of femur fractures in the setting of multi-system trauma. Open fractures and/or derangement of soft tissues are relative indications for external fixators. This treatment can be used safely in children generally older than four or five, by which time the cortex is thick enough to achieve adequate purchase by the pins. While alignment and stability can be quickly achieved by external fixators, the risk of complications is not negligible or infrequent. As in any treatment of a femur fracture, the caregivers require education and support during treatment. In the right social setting, this treatment allows the child to return home and often to school immediately.

Similar to external fixation, open reduction and internal fixation with plates and screws can provide rapid and satisfactory treatment of femoral fractures.<sup>9,10</sup>

Similar risks as with external fixator treatment are seen. Hardware removal of plates and screws requires more complicated surgery than that of removing several external pins. Thus, this type of treatment is reserved for very select cases.<sup>11</sup>

Harkening back to the review of bone development, by the age of twelve to thirteen the femur is more like an adult bone in its shape and strength. It supports a much larger frame as puberty advances. We recognize physiological differences in children of different ages but, in general, late adolescents and teenagers are often candidates for rigid intramedullary nail treatment.<sup>12,13</sup> Use of this device has many advantages, including quick placement with few complications. These nails provide rigid stability allowing for early weight bearing without risk of loss of alignment or shortening. Young people, as with adults, often can return to their premorbid state quickly. Pediatric modifications to rigid nailing reduced the risk of compromising blood supply to the femoral head leading to the serious consequence of avascular necrosis.<sup>14,15,16,17</sup> Circulation to the femoral neck and head is vulnerable to inappropriate placement of the insertion point necessitating pediatric implants and equipment as well as specific surgical techniques. (Figures 5 a,b,c,d)

The challenge to provide rapid and safe treatment for children between the ages of four or five and eleven or twelve has been met by the invention and implementation of titanium elastic nails.<sup>18,19</sup> This treatment has revolutionized the treatment of femur fractures in this population and carries with it enormous advantages for the well being of the child and family. The shape and quality of the femur in this age range allows for straight forward treatment with these nails that poses only minimal morbidity to the patient. Very briefly stated, the fracture is lined up and small entry holes are made either at the level of the upper metaphysis or the lower metaphysis of the femur. Meticulous attention to the relationship of these entry holes to the growth plate is required to prevent damage. With proper choice of entry, first one nail then the second nail are bent into a slight curve and driven across the fracture ends. The thick strong periosteum of the femur allows rapid healing even though fixation is not rigid. The shape of the femur and the proper contouring of the nails stabilize the femur in good alignment. (Figures 6 a,b,c,d) In special circumstances, a spica cast is applied for two or three weeks in order to help maintain the alignment when a fracture is deemed potentially unstable or if the child is too young to be kept at quiet activities during

the early stages of healing. Even unusual pathologic fractures through a bone cyst or non ossifying fibroma can often be treated with elastic nails. In general, most children are discharged from the hospital within a day or two and, depending on the fracture pattern and age of the patient, weight bearing can begin in days to weeks. The femur heals at a rate similar to one treated in a cast, but the benefits are substantial. Minimal rehabilitation is needed and the child is returned to his pre-morbid state quickly and with minimal disruption to family life.<sup>20</sup> While removal of nails was always considered mandatory after one or more years, new studies suggest that removal of the nails is entirely elective.

Even though differences exist in the age of the child, the mechanism of injury and the fracture patterns, the use of elastic nails has revolutionized the treatment of femoral fractures in children.

In summary, while brace and cast treatment are still used to manage femoral shaft fractures in young children, older

children are best managed by appropriate surgical intervention. The most important change in treatment has been the safe and reliable use of titanium elastic nails.

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## Transitional Care

*John Kleckley, MD*

**An 88-year-old woman with a history of diabetes mellitus,** congestive heart failure, hypertension, a recently repaired hip fracture, chronic kidney disease, and non-adherence to prescribed medical care plans was admitted to the hospital with hypotension, shortness of breath, weight gain, and decreased urine output. The patient was found to be in acute renal failure superimposed on chronic renal insufficiency. Dialysis was recommended; however, the patient and family refused, and the patient was made **comfort measures only (CMO)** for hospice and expired. Chart review of hospital discharge summaries showed 11 hospital admissions over the previous two-and-one-half years. There were five admissions for congestive heart failure, three for hypoglycemia and one for hyperglycemia; the patient was hypertensive on 8 admissions, suggesting non-adherence to her medications. Her serum creatinine was 0.7 on the first admission. Four discharges were to two different skilled nursing facilities. Ten physicians oversaw her care, including six attendings, four outpatient primary care physicians, and two physicians in the nursing homes. There were at least 15 changes in the doses of antihypertensive medications and of insulin.

That review does not include 1) the large number of other medication changes; 2) the numbers of residents, interns, nurses, and therapists who also participated in her care; or 3) review of charts from outpatient offices and nursing homes. This patient's course is not atypical. In an increasingly complex, disjointed health care system, patients and practitioners navigate through many transitions, which in turn give rise to many opportunities for errors.

The American Geriatrics Society Health Care Systems Committee in 2003 defined transitional care as a set of actions designed to ensure the coordination and continuity of health care as patients transfer between different locations or different levels of care within the same location. These locations include hospitals, sub-acute and post-acute nursing facilities, the patient's home, primary and specialty care offices, assisted living facilities, long-term care facilities, and any other location or setting involved in a patient's care. Ideally, transitional care is based on a comprehensive plan involving doctors, nurses, and therapists who are trained in chronic care. They should have up-to-date information about the patient's goals, preferences, and clinical status. The care plan should include logistical arrangements, patient and family education, and coordination among health care professionals.

Transitional care is highly dependent on the "handoff," which is the communication of essential information and the plan of care from one setting to another. Many problems occur in this transfer of information. Practice settings often operate as "silos" with no knowledge of the problems, medications, services provided, or patient preferences from the previous setting. Care plans, names of providers, follow-up appointments, laboratory and diagnostic

tests, and medications are not accurately transferred. Often the patient and/or the caregiver are the only common thread from one setting to another. Also, there is little financial incentive to improve care transitions. Medicare reimbursement is directed to the setting in which care is delivered, rather than to outcomes of an individual episode of care. Likewise, quality assurance efforts are directed toward individual settings rather than the transitions surrounding a single episode. Few quality indicators assess system or clinician performance.

At many points along the path of a transition, breakdowns, with negative consequences, can occur. Patients and caregivers are often not told important components of the care plan, or what to expect at the next setting, or what clinical improvement or deterioration to expect. Medication errors are the most frequently documented problems in transitions. Patients are seen by multiple physicians from different specialties, and prescribed many medications. Often physicians are unaware that other doctors are prescribing medications. Many medications are stopped during a hospitalization, and the patient is not told whether or not to resume the medications at discharge. Medications begun for acute problems during hospitalization are often needlessly continued. Follow-up appointments are not communicated to the patient, or transportation is not arranged to insure the patient makes it to the appointment. Follow-up testing is not communicated to the patient or the next care provider. Advance directives that were painstakingly outlined during a prolonged hospitalization or nursing home stay are not passed along to the next setting.

Barriers to effective care transitions can be organized into three levels: the delivery system, clinician, and patient. The healthcare delivery system is fragmented into independent institutions, often without formal relationships. There is little attention or incentive to understand or follow the other's care plans. Each institution has its own medication formulary, negotiated to reduce their own costs, not those of the patients. There is no unified medical record system, and the receiving location often is not provided with adequate information from the delivery location. The **Health Insurance Portability and Accountability Act (HIPAA)**, designed to protect patient privacy by placing limitations on the sharing of information, often makes the transfer of needed vital information more difficult.

Clinicians now rarely provide care across multiple settings, more often relying on institution-based physicians, such as hospitalists. Changes in reimbursement have made it difficult for primary care physicians to follow their patients outside of the office. Financial incentives induce acute care hospitals to transfer patients very quickly to skilled nursing facilities for rehabilitation and recuperation. These transfers create opportunities for mistakes when information is incomplete. Case managers and social



workers are assigned to specific care settings, rather than providing longitudinal oversight across multiple locations. As a result, a patient can have more than one case manager per episode of care, who may represent an institution's interests rather than the patient's.

Patients and caregivers rarely understand the health care process. They often will not take an interest, ask questions, or complain until there is a problem. Some of the blame lies with the former paternalistic culture of medicine that led patients to feel comfortable and safe deferring all to the doctor who could manage all, and knew all. This was more feasible when a physician could realistically follow a patient through all settings of care. This is no longer the norm, yet many patients have unrealistic expectations about their condition or plan of care; conversely some patients have no expectations. Also, many patients feel uncomfortable questioning doctors about the cause of hospitalization (e.g., why did the patient have the fall that led to the hip fracture). Perhaps the most difficult situation, and the one responsible for the most errors, is when patients have an incomplete understanding of the health care process. This can lead to innumerable errors at any point along the transition process because patients don't ask questions since they don't see that they need to.

The American Geriatrics Society Health Care Systems Committee outlined five interventions to achieve more effective transitional care. First, clinical professionals must prepare patients and their caregivers to receive care in the next setting and involve them in decisions related to the formulation and execution of the transitional care plan. Patients must know what to expect in the next care setting, be able to provide input into the care plan and know how to manage their condition. They should ask appropriate questions about their condition, and how to contact their providers with questions. Second, bi-directional communication among clinical professionals is essential. A common plan of care that includes an updated problem list, medications, allergies, advanced directives, contact information, and baseline physical and cognitive function must be provided verbally, electronically, or through a paper record.

Third, policies should be developed that promote high-quality transitional care. Policymakers need to realize the importance of outcomes of care in transitions, and implement quality-improvement strategies that hold both "sender" and "receiver" accountable for successes and failures. Education in transitional care should be provided to all professionals involved in the transfer of patients across settings. Fourth, core competencies in the collaboration of care must be established and monitored by institutions, licensing boards, and certification boards. Finally, research should be conducted to improve the process of transitional care. Patients and caregivers must be empowered to understand their own needs and manage them. Research is needed to develop ways to improve health professionals' effectiveness in transitional care, and these systems must be tested.

This area of "Transitional Care" is emerging as a central focus in geriatrics. Clinicians, researchers, and health policy analysts are starting to focus on ways to link a disjointed system open to errors. In a subsequent special issue of *Medicine & Health/Rhode Island* focused on Nursing Homes (July 2007), we will discuss this research, with proposed improvements.

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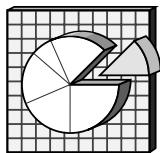
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## Arthritis and Associated Health Conditions and Risks Among Rhode Island Adults In 2005

*Jana Hesser, PhD, Yongwen Jiang, PhD, and Patricia Rajotte*

**Arthritis, which comprises over 100 different diseases and conditions,** is the nation's leading cause of disability. Though arthritis becomes more common with age, it affects people of all ages. About 1 of every 5 US adults has arthritis, an estimated 46 million people.<sup>1</sup> For 2003, national direct costs (medical expenditures) attributable to arthritis and other rheumatic conditions were estimated to be \$81 billion; for Rhode Island these costs were estimated to be \$327 million.<sup>2</sup> The number of people with arthritis, and associated costs, will grow as the population ages.<sup>2</sup> This report presents survey data on arthritis and associated health factors among Rhode Island adults.

### METHODS

Arthritis rates were calculated using self-reported data from Rhode Island's 2005 **Behavioral Risk Factor Surveillance System (BRFSS)**, a telephone survey administered in all 50 states and 4 US territories with funding and specifications from the **Centers for Disease Control and Prevention (CDC)**.<sup>3</sup> The BRFSS monitors the adult population for access to health care, certain health conditions, and behaviors that contribute to the leading causes of disease and death in the US. It is the main source of state arthritis data.

From January through December 2005, the Rhode Island BRFSS conducted random-digit dialed telephone interviews with 3,976 adults ages 18 and older. Survey data are weighted to be representative of the age, sex and race composition of Rhode Island's adult population. A person was identified as having doctor-diagnosed arthritis if s/he responded "yes" to the standard BRFSS screening question for arthritis: "Have you EVER been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"

Data on the prevalence of arthritis among different demographic groups were calculated for persons ages 18 and older. Because the large majority of Rhode Island adults with arthritis are ages 45 and older and higher rates of arthritis are associated with middle and older age, the analysis of data on health status, health risks, health conditions, and arthritis management was limited to adults ages 45 and older (reducing sample size to 2,464), an age criterion used in other studies based on BRFSS data.<sup>4,5</sup> "Error" bars on the charts represent the 95% confidence limits around the estimates, meaning there is a 5% chance the true value is NOT included within the span of the error bar.

### RESULTS

In 2005, 28% of Rhode Island adults 18 and older, about 234,000 people, had doctor-diagnosed arthritis; women (32%) reported arthritis more often than men (24%) (Figure 1). The prevalence of arthritis increased markedly with age. In 2005, 61% of Rhode Island adults aged 65 or older (approximately 91,500 adults) had arthritis, compared with 4% of those ages 18 – 24. (Figure 1) Although Rhode Island's arthritis rates for age groups under 65 were comparable to national median rates, the state's rate for those 65 and older (61%) was significantly higher than the national median of 56%.<sup>3</sup>

A significantly higher proportion (31%) of White non-Hispanics than either Hispanics (8%) or Other non-Hispanics (17%) reported doctor-diagnosed arthritis, a difference which could be due in part to the higher proportion of older adults in the White non-Hispanic population. (Figure 1) However, even among adults ages 45 and up the significant difference between non-Hispanic whites and Hispanics persisted. Arthritis rates did not differ significantly by education or income.

Among those ages 45 and older, a greater proportion of persons with than without doctor-diagnosed arthritis reported fair or poor general health (27% vs. 11%), 14 or more days of poor physical health in the prior month (21% vs. 9%), and 14 or more days of poor mental health in the prior month (13% vs. 7%). (Figure 2) They also more often reported any kind of activity limitations because of physical, mental or emotional problems (34% vs. 12%), as well as 14 or more days of activity limitation in the prior month (11% vs. 4%). Adults with doc-

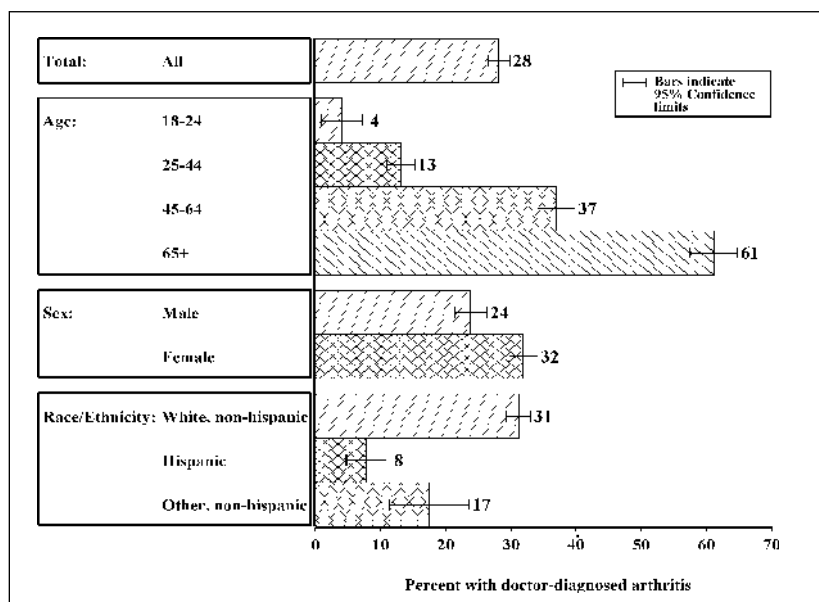


Figure 1. Demographic Characteristics of Rhode Island Adults Ages 18 and Older With and Without Doctor-Diagnosed Arthritis

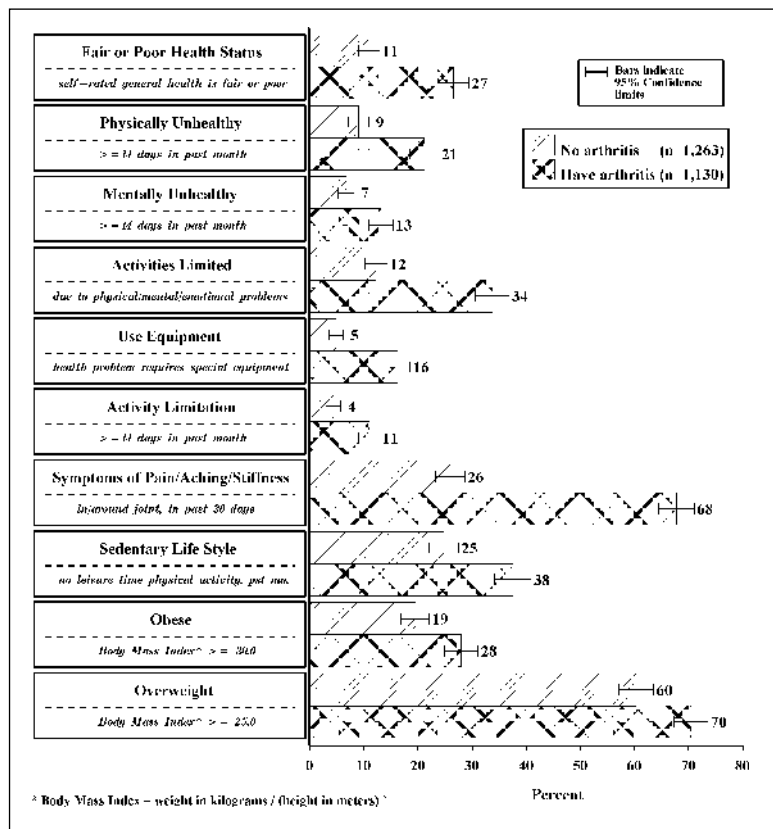


Figure 2. Health Status and Health Risks Among Rhode Island Adults Ages 45 and Older With and Without Doctor-Diagnosed Arthritis

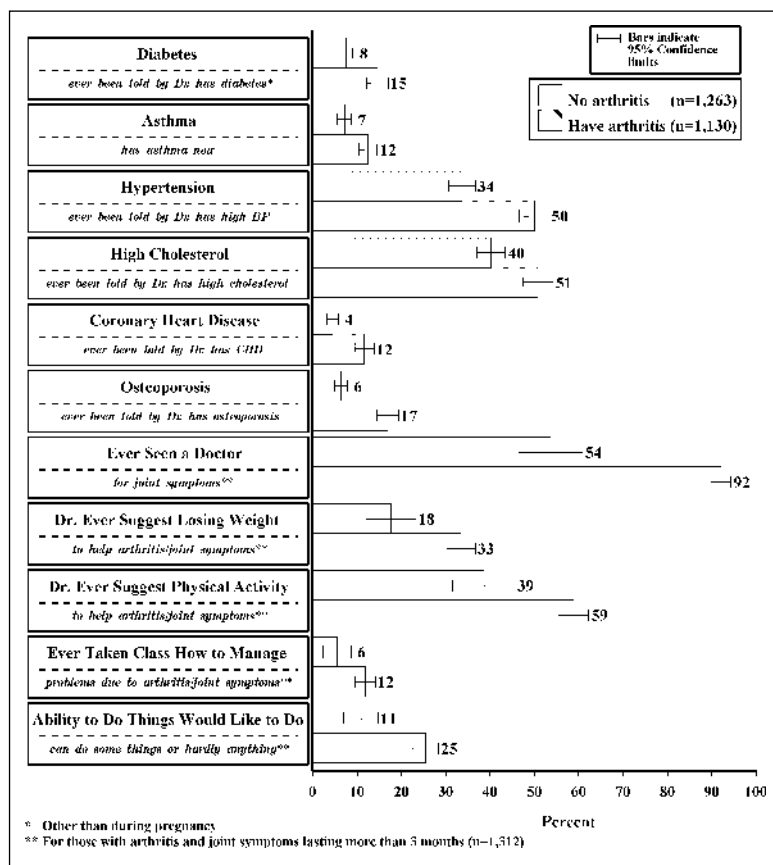


Figure 3. Health Conditions and Arthritis Management Among Rhode Island Adults Ages 45 and Older With and Without Doctor-Diagnosed Arthritis

tor-diagnosed arthritis more often reported having a health problem requiring the special equipment (16% vs. 5%) and experiencing joint symptoms of pain, aching or stiffness in the prior thirty days (68% vs. 26%).

Older adults with arthritis more often reported being sedentary (38%) than those without arthritis (25%), and a higher percentage were overweight (70% vs. 60%) or obese (28% vs. 19%). (Figure 2) A significantly higher proportion of people with arthritis than without reported having diabetes (15% vs. 8%), asthma (12% vs. 7%), high blood pressure (50% vs. 34%), high cholesterol (51% vs. 40%), coronary heart disease (12% vs. 4%), and osteoporosis (17% vs. 6%). (Figure 3) These differences persisted even when controlling for age.

People ages 45 and older with doctor-diagnosed arthritis or with joint symptoms of pain, aching or stiffness lasting more than 3 months were asked several questions about management of their symptoms. (Figure 3) Ninety-two percent (92%) of persons with doctor-diagnosed arthritis had seen a doctor about their joint symptoms, compared with 54% of people who reported persistent symptoms but not doctor-diagnosed arthritis. Thirty-three percent (33%) of people with arthritis had been advised by a doctor to lose weight; and 59% had been advised to exercise, compared with 18% and 39% respectively of persons with persistent joint symptoms but not doctor-diagnosed arthritis. Only 12% of people with arthritis had ever taken a class on symptom-management compared with 6% of others with joint symptoms. A quarter (25%) of people with arthritis compared with 11% of those with persistent joint symptoms said they could do only some or hardly any of the things they like to do. (Figure 3)

## DISCUSSION

Adults with doctor-diagnosed arthritis were more at risk for multiple indicators of poor health and impaired quality of life than other adults, even when those other adults included people with persistent joint symptoms of pain, aching and stiffness. It is likely that some percentage of people with joint symptoms, even without a doctor diagnosis of arthritis, have arthritis, though perhaps not as severely as those who have been diagnosed. It is also possible that people with symptoms are not diagnosed because of limited access to health care. Continued analysis of the BRFSS data on arthritis will examine those adults who do not have doctor-diagnosed arthritis but do have persistent joint symptoms.

The CDC has funded the **Rhode Island Arthritis Action Program (RIAAP)** since 1999. The RIAAP works in partnership with the Arthritis Foundation, the University of Rhode Island Physical Therapy Program, the Department of Human

Services, the Department of Elderly Affairs, and the Department of Health's Disabilities and Health Program. In collaboration with its multiple partners, the *Rhode Island Arthritis Action Plan 2001 – 2005*<sup>6</sup> was created to identify and coordinate strategies to reduce the burden of arthritis in the state. This spring the Arthritis Planning Council expects to update the state plan and develop action steps. The RIAAP works to promote self-management education, weight management, physical activity, and proper use of arthritis medications.

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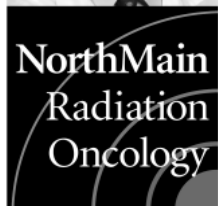
## ACKNOWLEDGEMENT

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# Point of View

## Retiree-Volunteers and the Abbreviations Study

**A few years ago, a friend, who was Director of Volunteers** at The Miriam Hospital, kept insisting she could find something interesting and challenging for us to do there. We are long time members of the AARP, a nurse who became a homemaker when her children arrived and never went back to nursing, and a retired kindergarten/reading teacher. Neither of us could imagine there could be anything challenging that we could do. We volunteered as a team, and were soon involved with many unusual and interesting projects.

One of the projects took us to the office of Quality Management, where we met the Director and worked with her staff. As that project was winding down, she and the medical director of Quality Management explained a new study being introduced at The Miriam to raise the hospital's awareness of JCAHO Standards.

The study is referred to as the Abbreviations Study. Its purpose is to eliminate use of unsafe abbreviations that physicians and nurses have been using for years, because of serious errors that can occur when read incorrectly. We were given the list of abbreviations and shown how to go through patient medical records, looking for any of these abbreviations. On special summary sheets, made to make the job easier, we list the patient's number, date of discharge, the type of inappropriate abbreviation used, number of times used, and by whom. The person using an unsafe abbreviation is notified by the hospital records department. We now know that physician's signatures are a special type of hieroglyphic,

so it is difficult to read them. A woman in the records department is terrific at figuring them out.

The data are entered into a computer program that permits automated aggregation and reporting. The results are analyzed and acted on by the Quality Management and Medical Records staff.

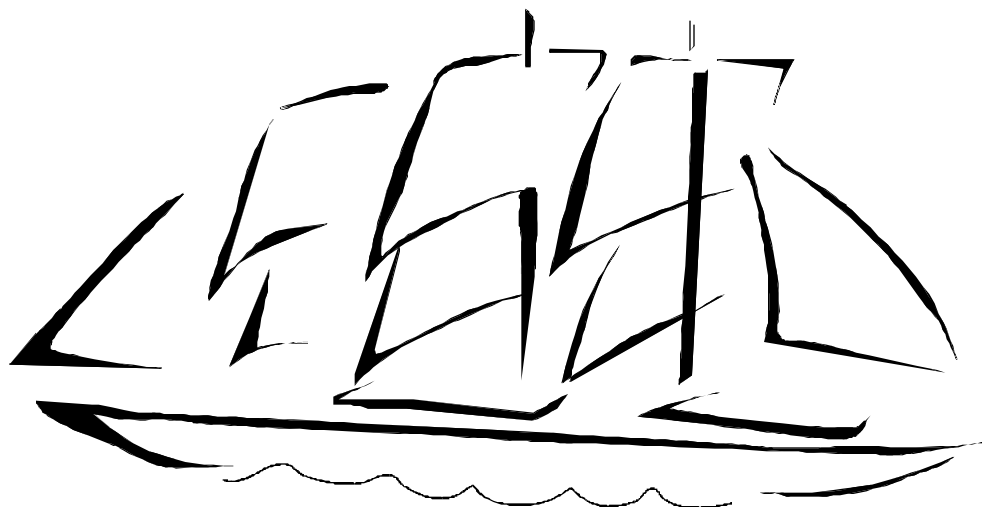
When our study began in mid 2005, only about a quarter of the charts reviewed were totally free of the prohibited abbreviations. However, after a year and a half of feedback and directed communications, nearly 80% of the medical records are free of inappropriate entries. In addition to finding fewer charts with inappropriate abbreviations, when found, there was a 45% per chart reduction in the use of the most frequently found unsafe abbreviation, (QD).

When we began going to the Medical Records department, the staff were pleasant but seemed skeptical. Now they have come to realize that we are there to help make a difference. They have named us "The Tuesday Ladies" and we look forward to seeing and working in their department each week.

In a very small way we feel we have made a contribution to The Miriam Hospital and the safety of its patients. And in a very large way we know that "AARP oldies" can make significant contributions through volunteering.

— JOYCE BINYON

— MAUREEN MCGARRY







# Images In Medicine

## Malignant Gastric Ulcer on Multidetector Row CT and Endoscopy

Brian D. Midkiff, MD, MPH, Philip A. McAndrew, MD, and William W. Mayo-Smith, MD

This 78-year-old Caucasian woman presented with epigastric pain for which endoscopy was performed. Direct endoscopic visualization demonstrated a suspicious, solitary ulcer of the posterior body and thickened folds of the antrum. Multidetector row CT examination of the abdomen with intravenous and low-density oral contrast material showed a gastric mass at the posterior mid-body with a large central ulcer (arrow) as well as inflammatory thickening of the gastric antrum (arrowhead) and no evidence of local invasion or nodal disease. Biopsy performed at endoscopy demonstrated a low-grade marginal zone B-cell lymphoma.

Lymphoma involves the stomach more frequently than any other segment of the gastrointestinal tract. Primary gastric lymphoma is usually confined to the stomach and regional nodes and is most commonly a non-Hodgkin lymphoma of B-cell origin. On cross-sectional imaging, gastric lymphoma typically presents as diffuse wall thickening. However, it may also manifest as focal disease or malignant ulceration, as seen in this case. Primary gastric lymphomas may be high-grade or low-grade. Low-grade tumors, such as lymphoma of mucosa-associated lymphoid tissue (MALT), follow a more indolent clinical course and are associated with 5-year survival rates of up to 60%.

Low-density oral contrast material and intravenous contrast material aid in visualization of the bowel mucosa at multidetector CT. In this patient, low-density oral contrast allowed superb CT characterization of the gastric mass and malignant ulcer. The CT image shown, which was obtained using a 64 detector row scanner, demonstrates findings which correlate well with the endoscopic images. The large mass, central ulcer, and antral wall thickening are well seen. When used appropriately, low-density oral contrast material aids in the CT investigation of mucosal pathology, including evaluation for depth of disease, perforation, local invasion and distant metastatic disease.



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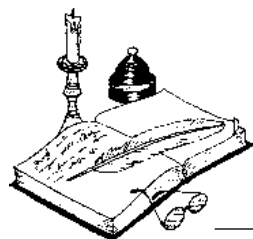
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# Physician's Lexicon

## A Well-Nourished Vocabulary

If recent health surveys are accurate, obesity has become one of America's leading contributors to morbidity. Esthetic standards of adiposity may change over the years [from "pleasingly plump" to "athletically lean"] but the statistics showing a significant relationship between excessive body weight and subsequent longevity are incontestable. A number of English words have accumulated to define the clinical phenomenon of overweightness.

Adipose is derived from the Latin, *adiposus* meaning filled with oil which in turn is an offspring of a Greek verb, *aliphein*, meaning to anoint, and from which the English words aliphatic, lipid, lipidosis, lipemia and lipectomy are derived.

Obesity is a direct descendant of the Latin, *obesus*, which in turn is from the

Latin *ob-edere* [the *ob-* prefix generally means toward and the *edere* root means to eat and gives rise to such English words as edible but not structurally similar words such as edifice or edify.]

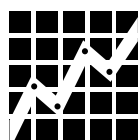
Corpulent is from the Latin, *corpulentia* meaning grossness of flesh and its root, *corpus*, is the basis of English words such as corporation, corpuscule, corps and corpse, but not corporal, the non-commissioned rank, which descends from the Italian, *caporale*, meaning a chief [cf. *capo*].

Steatosis is from a Greek word meaning tallow and gives rise to steatorrhea [fatty stools], steatoma [a sebaceous tumor], steatitis and steatopygia [excessively fatty buttocks; the *-pygia* root meaning rump and appears in the word, pygidium, defining the posterior body part of insects.]

Gross, meaning thick, comes from the Latin, *grossus*. The thick Roman coin called *dinarius grossus* evolved over the centuries to the current German coin called *groschen*.

Many of the vernacular words describing obesity, terms such as fat, stout, plump, bulky, chubby, portly, overweight and pudgy, are derived from older north European Teutonic sources. Finally, the nourished part of the term, well-nourished, comes from the Latin, *nutrire*, meaning to nurse.

— STANLEY M. ARONSON, MD



RHODE ISLAND DEPARTMENT OF HEALTH  
DAVID GIFFORD, MD, MPH  
DIRECTOR OF HEALTH

## VITAL STATISTICS

EDITED BY COLLEEN FONTANA, STATE REGISTRAR

### Rhode Island Monthly Vital Statistics Report Provisional Occurrence Data from the Division of Vital Records

Underlying Cause of Death	Reporting Period			
	April 2006	12 Months Ending with April 2006		
	Number (a)	Number (a)	Rates (b)	YPLL (c)
Diseases of the Heart	247	2,744	256.5	4211.0
Malignant Neoplasms	183	2,287	213.8	6,319.0**
Cerebrovascular Diseases	44	453	42.3	615.0
Injuries (Accidents/Suicide/Homicide)	41	445	41.6	6,757.5
COPD	68	488	45.6	377.5

Vital Events	Reporting Period		
	October 2006	12 Months Ending with October 2006	
	Number	Number	Rates
Live Births	1,295	13,247	12.4*
Deaths	824	9,935	9.3*
Infant Deaths	(10)	(88)	6.6#
Neonatal Deaths	(9)	(71)	5.4#
Marriages	752	6,989	6.5*
Divorces	272	3,117	2.9*
Induced Terminations	338	4,750	358.6#
Spontaneous Fetal Deaths	61	882	66.6#
Under 20 weeks gestation	(56)	(819)	61.8#
20+ weeks gestation	(5)	(63)	4.8#

(a) Cause of death statistics were derived from the underlying cause of death reported by physicians on death certificates.

(b) Rates per 100,000 estimated population of 1,069,725

(c) Years of Potential Life Lost (YPLL)

**Note:** Totals represent vital events which occurred in Rhode Island for the reporting periods listed above. Monthly provisional totals should be analyzed with caution because the numbers may be small and subject to seasonal variation.

\* Rates per 1,000 estimated population

# Rates per 1,000 live births

\*\* Excludes 1 death of unknown age



## MEDICAL MALPRACTICE TOPICS

INFORMATION FOR RHODE ISLAND PHYSICIANS FROM BABCOCK & HELLIWELL

# PROTECTING AGAINST THE UNTHINKABLE

## Employment Practices Liability

John Tickner, CPCU, President, Babcock & Helliwell

You and your practice could be sued for alleged discrimination or sexual harassment by an employee, or even by someone applying for a position. Here are a few actual examples:

- A female doctor sued a practice claiming she was not offered a partnership after five years. The partnership settled for \$22,500 and paid \$5,000 in legal fees.
- A female employee resigned and sued for sexual harassment in part because one of the owners of the practice gave her a scarf on Valentine's Day. A jury awarded the plaintiff \$82,000.
- An accounting clerk in a medical office said she was being forced to have sexual relations with one of the directors and threatened to sue. The practice opted to settle for \$35,000 rather than face a costly trial.

It may come as a surprise to learn that most practices have no insurance to protect against such lawsuits. In the 1990s, when federal laws were enacted to protect workers, insurance companies excluded certain coverage in their basic policies and instead offered an option called Employment Practices Liability Insurance (EPLI) coverage. EPLI typically covers you, the practice, current and former employees, appointed directors, trustees, and officers. It generally provides payment for defense costs, litigation, and settlements for:

- Discrimination on the basis of race, religion, age, sex, national origin, disability, or any other protected class
- Harassment, sexual or other
- Failure to employ or promote
- Wrongful discipline or termination
- Negligent evaluation or deprivation of career opportunity
- Wrongful infliction of emotional distress
- Breach of oral or written employment contract

(It should be noted that EPLI will not pay for punitive damages or civil or criminal fines.)

When EPLI was first introduced, it was expensive, and most practices did not purchase it. Initially there were few claims, and over the years the cost of the coverage has dropped. At

the same time, the number of lawsuits filed by employees against their employers has risen dramatically. Today, there are more than 25 federal and state laws and hundreds of regulations that apply to almost every relationship in the workplace. One-third of all civil suits filed in the United States are employment-related claims.

While most suits are filed against large organizations, this is not just a problem for large medical facilities. No practice is immune to such lawsuits. According to CNA Insurance, the average cost of an EPLI claim against a smaller company is approximately \$50,000 when payment is made to the plaintiff. Even frivolous claims cost time and money to defend.

Our agency now recommends that all medical practices with employees seriously consider purchasing EPLI coverage. The cost of coverage depends on the number of employees and on various underwriting factors. You should discuss this optional coverage with your own insurance agent.

In addition to purchasing adequate insurance coverage, you can reduce exposure to employment practices liability lawsuits by following these loss-control techniques:

- You should have a written policy against any form of harassment and have procedures in place for complaints.
- A written policy handbook should be given to all your employees and should reserve your right to change policies. However, be aware that the laws regarding such handbooks are complex.
- Make sure job applications address all of the legal issues.
- Employee evaluations should be based on objective criteria and goals.

Your attorney can help with these forms and can provide guidance on appropriate interviewing and testing procedures.

*John Tickner, CPCU, is president of Babcock & Helliwell, a privately held independent insurance agency established in 1892 that provides professional insurance-related services of all kinds. Babcock & Helliwell is an agency for ProMutual Group, New England's largest medical malpractice insurance provider and the second-largest provider in Rhode Island.*

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### NINETY YEARS AGO, MARCH 1917

Francis I. McConnor, LLM, in "Industrial Accident Compensation Legislation: The Medical Phase," bemoaned the lateness of this legislation. "Why were we more than a quarter of a century behind...Europe in...providing accident insurance for the working people...who are unable to look after themselves?" In 1884, Bismarck had introduced the first compulsory legislation; Austria, Norway, Great Britain; Belgium, Medico, Quebec, Switzerland, Peru, Roumania followed. The Rhode Island bill advocated: "An injured workman should be allowed during the period of disability an amount equal to 66 and 2/3% of his weekly wages, with a maximum of \$15 and a minimum of \$5."

William L. Harris, MD, in "Decadence in Medical Economics," responded to critics who charged that the workmen's compensation legislation primarily bolstered physicians' coffers. Dr. Harris retorted: "Our idealist cannot dream himself into food and clothes and housing, unless the substance of his dreams has expression in the proper management of the business side of his profession."

J.C. Rutherford, MD, reported on "A Case of Gangrenous Arthritis of the Knee of Diabetic Origin." A 52 year-old man presented with a carbuncle on his head. He had had glycosuria for 10 years, had lost his right eye in an accident in 1878, had an external urethrotomy in 1892, was circumcised in 1907. After the carbuncle was lanced and the diseased tissue removed, the wound healed, after 100 days. The patient complained of tenderness in his left knee. "The pain was so severe and so constant that only by taking large doses of morphia, frequently repeated, could he get any relief at all." The patient was referred to Dr. Joslin, who "advocated starvation for 3 days, followed by a strict diabetic diet." Dr. Harris rejected that advice, "first, as the patient was sugar-free I did not consider such treatment necessary, and second, I felt that starvation would, in his greatly weakened condition, be fatal." As for amputation, Dr. Joslin said no, that the patient would succumb to shock. Eventually, the mid-thigh amputation was performed. There was no odor or pus in the knee, and the nearby blood vessels were healthy. The patient improved, was fitted to a prosthesis, gained weight, and returned to work. One year later, the patient felt so well that he stopped his diabetic diet.

Figure 1 in the article entitled "Biohybrid Limbs: New Materials and New Properties," (p.4) of the January 2007 issue was not credited. The scanning electron micrograph images were courtesy of J. Dennis Bobyn, PhD, Jo Miller Orthopaedic Research Laboratory, Montreal General Hospital, McGill University.

### FIFTY YEARS AGO, MARCH 1957

Philip Cooper, MD, Harold L. Stein, MD, Goldwyn F. Moore, BS, and Harold W. Harrower, MD, discussed "Effect of Cigarette Smoking on Excretion of Uropepsin and Concentration of Plasma Pepsinogen" [research supported by part by a grant from the Tobacco Research Committee]. The study followed 20 patients, all smokers, at the Providence Veterans' Hospital for 13 days. On day 1 patients stopped smoking; for days 6-13, patients smoked at their usual rates, usual brands, smoking 3/4 of the length of each cigarette, and recording the number of cigarettes. Researchers did not find a statistically significant difference of uropepsin between the non-smoking and smoking periods, and found a small but statistically significant difference in the decline in pepsinogen.

A.S. Savastano, MD, and Donald F. Lakin, MD, in "Whiplash Injuries," noted: "The prognosis is generally good, but a certain number of cases become malingerers or exaggerate their symptoms until their medicolegal claim is satisfied."

An Editorial, "Treatment of Lung Cancer," cited reprints from two British medical statisticians on the mortality among British doctors. "From their massive studies they have concluded unequivocally that among physicians the rising mortality from lung cancer in smokers compared with non-smokers and in heavy smokers compared with lighter smokers has been a feature of each stage of life."

### TWENTY FIVE YEARS AGO, MARCH 1982

Charles E. Millard, MD, in "President's Corner," contributed "You Should Be A Member of a Hospital Board." He cautioned: "If the physician does not assume a decision-making role, then...his influence on the hospital will amount to nothing."

Herbert Raktansky, MD, Chairman, Impaired Physician Committee, contributed "Physician - Heal Thyself." The American Medical Association estimated that 7-10% of physicians were impaired. The author predicted "excellent prognosis if properly treated."

A. John Eliot, MD, in "Ossifying Fibroma of the Peripheral Skeleton," discussed this rare brain tumor in a 18 year-old girl.

Sumeet Kumar, MD, Division of Hematology and Oncology, Caritas St. Elizabeth Medical Center, Tufts University School of Medicine, was a co-author of "Immunosuppression Strategies in Kidney Transplantation," 2007;90(3):80-3. and of "Considerations for the Inpatient Care of Solid Organ Recipients," 2007; 90 (3):84-8.

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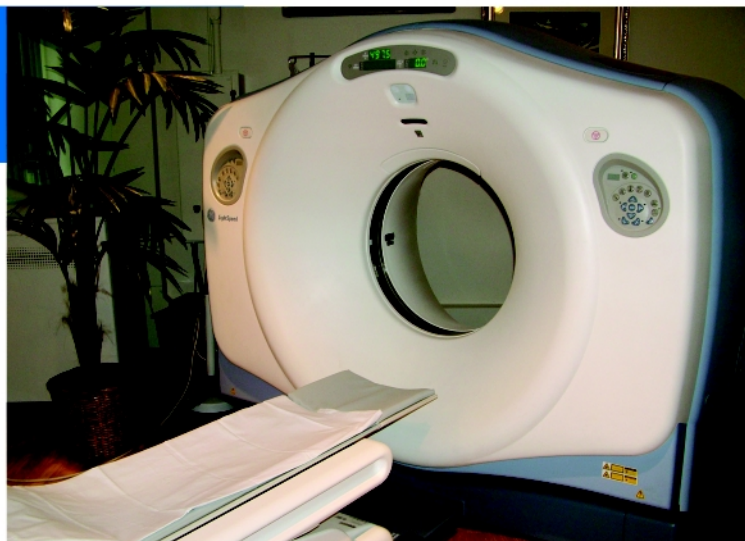
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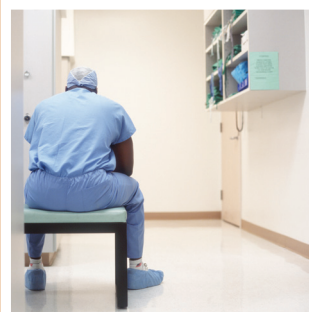
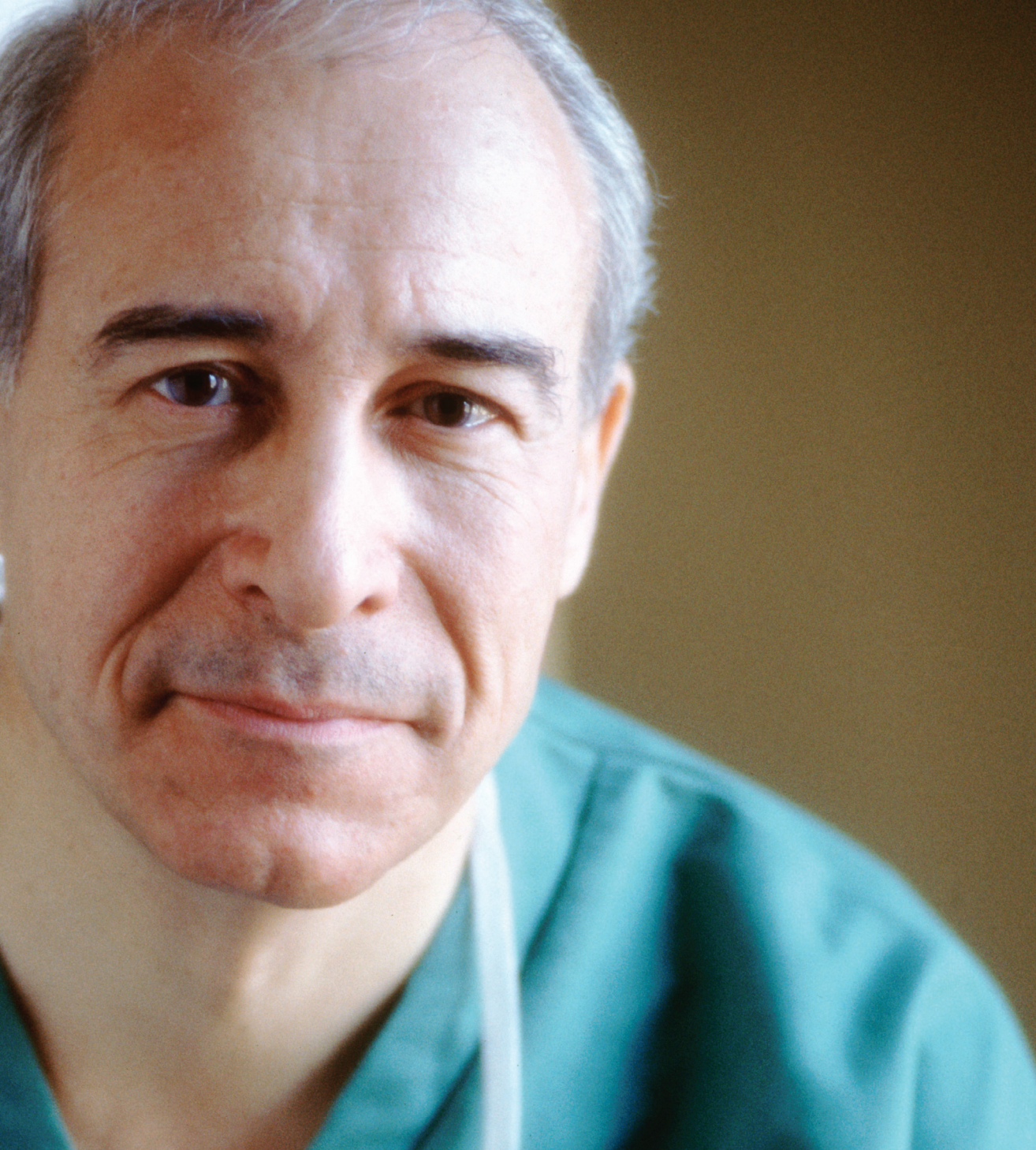


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