GERINOTES

SECTION ON GERIATRICS, AMERICAN PHYSICAL THERAPY ASSOCIATION

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PRESIDENT'S PERSPECTIVE: LET'S NOT TAKE A PASS ON SHAPING OUR FUTURE

John O. Barr, PT, PhD

While the momentum is still moving forward, I feel it critical to make all Section on Geriatrics (SOG) members more directly aware of the innovative activities that the APTA and some of our Section members have been participating in to shape the future of our profession. On February 27-28, 2009, the APTA conducted the Physical Therapy and Society Summit (PASS) retreat at the Lansdowne Resort in Leesburg, VA. PASS was the result of a House of Delegates motion, initiated by the Massachusetts Chapter and adopted in 2006, that stated: *That the American Physical Therapy Association (APTA) convene a summit in or by 2010 with annual reports to the House of Delegates that shall focus on how physical therapists can meet current, evolving, and future societal health care needs. The consideration of innovative processes, technology, or practice models by this Summit on Physical Therapy and Society shall not be constrained by existing law, regulation, education, or reimbursement policy. Summit participants shall include but not be limited to leaders within physical therapy, health policy, public policy, academia, engineering, theology, and information technology.* Planned by a ten-person steering committee which included SOG members Steve Wolf, PT, PhD, FAPTA and Sara Knox, PT, DPT the summit was a first-of-its-kind event for the profession. The mission of the summit was to determine areas of opportunity to empower physical therapists to be leaders in: (1) integrating innovative technologies and practice models and (2) establishing collaborative multidisciplinary partnerships that address current, evolving, and future societal health care needs. Among the nearly 100 invited participants were leaders from physical therapy (eg, SOG members David Lake, PT, PhD, Chuck Gulas, PT, PhD, GCS, and me), medicine, academia, engineering, bioscience, information technology, health care policy. Caregivers also participated, bringing an important patient/client perspective.

Prior to the retreat, participants assigned to topical teams (ie, education /professional preparation; health care access, systems and funding; practice models; research; and technology) that discussed ideas and relevant literature via a Ning community web site. During the retreat, the "think tank" atmosphere designed by the steering committee was supported by a professional facilitator and a graphic recorder. The summit keynote address, "*Society's Expectations for Healthcare in a Time of Challenge and Opportunity,*" was given by Clem Bezold, PhD, Founder and Chairman of the Institute for Alternative Futures. Provocative themes from pre-summit activities were voiced by topical team leaders. Innovative perspectives on technological drivers of change and drivers of systemic change were presented by national-level panelists both external to and from within the profession. Meeting in small groups, participants discussed potential innovations and brainstormed on opportunities to move the profession forward in each of the topical areas. Topical teams further prioritized their top opportunities in relationship to serving societal needs, offering leadership opportunities, and requiring innovation and alliances, collaborations, and partnerships. During the concluding Public Commitments and Final Reflections session, I had the opportunity to remind participants about the dramatic societal needs being created by the aging of our population and of the dire forecasts from the Institute of Medicine's report, *Retooling for an Aging America: Building the Health Care Workforce*, published in April 2008.

A wide range of opportunities were identified for physical therapists to take the lead in making a difference relative to current and future societal health care needs, including:

1. Promoting multidisciplinary collaborations within the health care community that address critical patient problems and/or challenges faced by other health care professions.
2. Developing forums that translate the outcomes of technology application efforts to the physical therapy profession and encourage/promote physical therapist involvement in the development of new technologies.
3. Creating national standardsguidelines for postprofessional trajectories that allow physical therapists to take on more visible roles in health policy, preventions, and other areas not typically accounted for in postprofessional physical therapy education.
4. Reviewing the profession's ability to capitalize on opportunities of health care reform and be open to restructuring if needed, and aggressively continue to become a prominent voice in the discussion that leads to new health care delivery models.
5. Fostering multidisciplinary partnerships to meet patient/client needs and leveraging social determinants of health, particularly in the area of prevention.

Further information can be found at the Pass Information Page (www.apta.org/pass), which includes graphic recording montages, speaker Powerpoint presentations, a bibliography of readings, and bio-sketches of PASS participants. Hopefully some of you attended "Authoring Future Success – Findings from the Physical Therapy & Society Summit (PASS) and Implications for the Physical Therapy Profession," during the Annual Conference in Baltimore. The PASS Steering Committee is drafting talking points and a formal communication plan to keep the momentum from the summit going and to generate further interest and participation in the mission of PASS. SOG members and leaders are encouraged to examine and reflect on these resources in order to stimulate discussion within and specific actions by the Section that can help to shape the future of our profession.

Dr. Barr is a Professor in the Physical Therapy Department at St. Ambrose University, Davenport, IA. He also serves on the Editorial Board for the Journal of Geriatric Physical Therapy.

EDITOR'S MESSAGE
CEU ISSUE, ANOTHER MEMBERSHIP BENEFIT TO YOU AND OTHERS - SPREAD THE WORD

Carol Schunk, PT, PsyD

We are proud to bring you the second CEU issue of *GeriNotes*. We had over 150 therapists and assistants qualify for CEUs for the November 2008 issue so the SOG Board voted to continue this benefit to our members. This issue focuses on Musculoskeletal Considerations for the Older Adult with the opportunity to earn .4 CEUs with completion of the post test and course evaluation. The 6 articles contain directly clinical applicable information to improve the treatment of patients with a musculoskeletal diagnosis. The selection of this topic was made by the *GeriNotes* Editorial Board during our Board Meeting at CSM in February. The decision was influenced by a discussion of the need to continue to focus on the APTA Guide Practice Patterns as we continue the CEU modules.

As should always be the case, we learned a few lessons from the first CEU issue. To improve the process and the content I enlisted the talent of Editorial Board member, Sandy Levi, PT, PhD to review and edit the test questions. This assures the questions are of high quality following standardized test writing guidelines. Also I had readers who read the articles and took the quiz provide feedback on the process to make the final product the best ever. That is the good news, the bad news is we did have to raise the cost to those participating to $10/credit hour for a total of $40, still a deal if you consider the convenience and comfort of not having to leave home. I hope everyone takes advantage of the opportunity to earn CEUs.

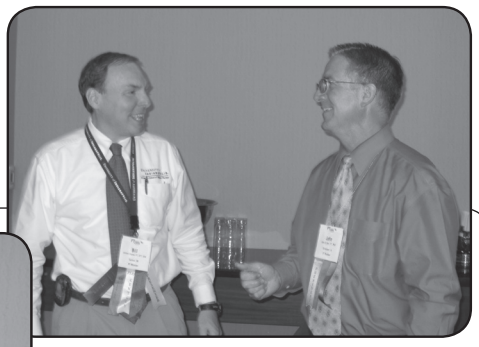
Given the number of baby boomers and the increased vitality and activity of this generation, many more therapists are dealing with older adults. Some of those involved with this population may identify themselves with another specialty area such as sports or orthopedics or neurology as opposed to geriatrics. I would encourage members to share this issue with those therapists. The articles are applicable to a wide range of therapists, not just those who are members. Not only will they gain from the information but may also see (with your encouragement) the benefit of belonging to the Section on Geriatrics. In the last year I have passed on articles not only to other therapists but also to clergy and social workers in my agency….Spread the word!!

MY THANKS TO:

Test Question Editor - Sandy Levi

Readers - Kerri Bednarcik
- Carleen Lindsey
- Jessie Van Swearingin

SECTION LEADERS AT BOARD MEETING AT APTA ANNUAL CONFERENCE IN BALTIMORE



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MUSCULOSKELETAL CONSIDERATIONS WITH AGING POPULATIONS

A Section on Geriatrics Continuing Education Module

OVERVIEW

Therapists who work with older adults must be versed in musculoskeletal considerations specific to physical therapist examination and intervention. An awareness of the physiological changes with aging and the types of musculoskeletal conditions encountered by physical therapist is essential for those involved with the older adults. Increasing your knowledge in this subject matter will improve the effectiveness and safety of patient intervention and examination, a prime goal of all physical therapists and assistants.

MODULE CHAPTERS

I. Guide to Physical Therapist Practice: Preferred Practice Pattern 4 Musculoskeletal by Heitzman and Moffat
II. Bone Health by Brewer
III. Joint Replacements by Langhenry
IV. Special Considerations When Working with the Older Athlete by Singer and Francis
V. Prescribing Effective Exercise for Bone Health by Kemmis
VI. Malnutrition: Vitamin D Deficiency by Schneider and Healey

AUTHORS

See specific biographies following each chapter

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Rachel Schneider, SPT
Melissa Singer, SPT

REFERENCE LIST

References can be found at the end of each chapter in the module.

OBJECTIVES

The reader will be able to:

1. Describe 2 distinct functions of the skeleton related to human function and maintenance.
2. Explain the positive and negative factors influencing bone turnover across the lifespan.
3. Discuss the concept of "whole bone strength" including density, microarchitecture, mineralization, shape, mass, and microdamage.
4. Describe new technology and options for hip and knee joint replacements.
5. Determine whether there is a protective effect in the aging process for the former and lifelong competitive athlete when compared to nonathletic, age-matched controls."
6. Utilize the 5 essential elements of patient management as described by the Guide to PT Practice.
7. Prescribe safe and effective exercise programs for aging adults with osteoporosis to prevent fracture.
8. Prescribe exercise programs for aging adults with osteoporosis to return to optimal function following a fracture.

TARGET AUDIENCE

Physical Therapists and Physical Therapist Assistants

CONTACT HOURS/CONTINUING EDUCATION UNITS

Completion of the CE Module is equivalent to 4 contact hours, which converts to .4 Continuing Education Units

CONTINUING EDUCATION CERTIFICATE OF COMPLETION

A Continuing Education certificate will be provided to each participant after successful completion of the course requirements (post test and module evaluation) and payment of a processing fee. The Section on Geriatrics is a recognized component of

the American Physical Therapy Association. The Section on Geriatrics has not applied to any state licensure agency for prior approval of this course. The module has all the components (content, objectives, qualified instructors, reference lists, and post test) which will allow participants to submit the certificate of completion to meet CE requirements in most chapters. Please seek individual approval for this course from the states of Texas, Ohio, Oklahoma, and Nevada.

HOW TO SUBMIT CEUs

To obtain CEUs for this continuing education unit, participants must complete the post test as well as the evaluation form on page 8. A processing fee of $40 for SOG members and $80 for non members is required. To apply for CEUs send the post test and the evaluation form to the Section on Geriatrics along with payment. Applications must be postmarked no later than December 31, 2009. Upon submission of materials and a passing score of 80% or higher on the post test, the Section will mail you a continuing education certificate for .4 CEUs. Those with incomplete submissions will be notified via e-mail and given the opportunity to re-take the exam.

CANDIDATES FOR SOG OFFICES

Below is a list of candidates for offices. Complete bios of candidates will be printed in the September issue of *GeriNotes*.
Voting will begin October 1, 2009

Treasurer:
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Anne Coffman

Director:
Mary Thompson
Bob Thomas
Nora Francis
Linda Eargle

Nominating Committee:
Patrice Anthony
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Dr. Avers is the Recipient of the Joan Mills Award, Section on Geriatrics (1991) as well as a past President of the Section on Geriatrics of the APTA and current Editorial Board member of the Journal of Geriatric Physical Therapy.

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MUSCULOSKELETAL CONTINUING EDUCATION UNIT POST TEST

INSTRUCTIONS: To obtain CEUs for this continuing education unit, participants must complete the post test as well as the evaluation form on the back of this page. See specific instructions for submission of the completed post test on next page. Please circle the correct answer for each question.

1. A 58-year-old female was referred to a physical therapist following surgical repair of a hip fracture. Her past medical history included right ankle fusion 9 years ago and left forefoot fusion 2 years ago on the opposite side. Her medications were Atenolol, Celebrex, Femiron, Levoxyl, Fluoxetine, Lipitor, Lotensin, and Omeprazole. She experiences pain in her right hip with walking. She lives with her husband. Her goal is to walk from her home to the local university football games.

   The physical therapist obtained this information during which stage of the 5 essential elements of patient/client management?
   a. examination
   b. evaluation
   c. diagnosis
   d. prognosis
   e. intervention

2. The most favorable type of mechanical loading to increase bone strength is:
   a. high impact loading
   b. strength training
   c. variable loading
   d. short-duration stimuli

3. Maximal available knee range of motion available with a hi-flex fixed implant is"
   a. 0-125°
   b. 0-135°
   c. 0-145°
   d. 0-155°

4. Compared with the traditional metal on polyethylene bearing surfaces of total hip replacement implants, the major advantage of large head metal on metal is:
   a. decreased risk of fracture of the femoral component
   b. decreased metal ion release
   c. decreased risk of dislocation

5. Compared to the general population of older adults, older adults who participated in elite athletics as young adults have
   a. more severe sarcopenia
   b. less total body fat
   c. slower rates of declines in VO2 max
   d. more severe osteoporosis

6. Whether or not they continue to participate in physical activity throughout their lives, older adults who participated in elite athletics as young adults are LESS than other adults to have DECLINES in:
   a. bone mineral density
   b. VO2max
   c. muscle force output
   d. ventricular wall thickness

7. Vertebral compression fractures typically cause all of the following EXCEPT:
   a. functional limitations or disability
   b. increased morbidity and mortality
   c. increased spinal mobility
   d. hyperkyphosis

8. An exercise prescription for a patient/client with osteoporosis should:
   a. emphasize exercises for bone strength, posture, and balance
   b. emphasize spinal flexion and extension stretching exercises
   c. avoid high-intensity weight-bearing exercises
   d. avoid whole-body resistance training exercises

9. Vitamin D deficiency increases with increasing age due to:
   a. reduced epidermal levels of vitamin D precursor
   b. reduced frequency and intensity of exercise
   c. increased sun exposure compared to younger populations
   c. increased calcium re-absorption

10. Among older adults, Vitamin D deficiency is most likely to cause:
   a. decreased mass of antigravity muscles needed for walking
   b. decreased distal muscle strength needed for fine motor control
   c. decreased proprioception needed to prevent falls
   d. decreased upper extremity range of motion need to reach

MUSCULOSKELETAL PHYSICAL THERAPY CE UNIT EVALUATION FORM

Please rate the following questions	1= strongly disagree				5= strongly agree
1 The course material met the stated objectives	1	2	3	4	5
2 The information will be useful in my practice	1	2	3	4	5
3 The articles were well written and informative	1	2	3	4	5
4 The authors were knowledgeable for this topic	1	2	3	4	5
5 I am satisfied with this unit as a CE course	1	2	3	4	5
6 I would like future CE courses in GeriNotes	1	2	3	4	5

Please offer any additional comments or course topic suggestions below: _____

_____

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SUBMISSION FOR CONTINUING EDUCATION CREDITS

To obtain CEUs for these continuing education participants must complete the post test as well as the evaluation form on this page. Return page 7 and 8 with a processing fee of $40 for SOG members and $80 for non members. Submission must be postmarked no later than December 31, 2009. Upon submission of materials and a passing score of 80% or higher the Section will mail you a CEU certificate for .4 units. Those submitting incomplete material will be contacted via e-mail.

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GUIDE TO PHYSICAL THERAPIST PRACTICE: PREFERRED PRACTICE PATTERN 4 MUSCULOSKELETAL

Jill Heitzman, PT, DPT, GCS, FCCWS; Marilyn Moffat, PT, DPT, PhD, FAPTA, CSCS

In 1995, the *Guide to Physical Therapist Practice* was first published by the American Physical Therapy Association. This document was spearheaded by Dr. Marilyn Moffat, then President of the APTA, and is a culmination of years of work by experts within the field of physical therapy. The document addresses what is considered "best practice" with relation to the most used or appropriate interventions. The 5 essential elements of the patient/client management model include examination, evaluation, diagnosis, prognosis, and intervention. For the first time the language was standardized and this model now forms a framework for the provision of physical therapist patient/client management from the initial visit through discharge.[1] Utilizing the disablement model and evidence-based practice model, the *Guide to Physical Therapist Practice* provides the physical therapist with many tools for data collection and documentation and provides the best intervention(s) to ensure optimal patient outcomes and assist in reimbursement. Since 1995, this document has been used both within the APTA profession/organization and within the general population to reinforce who we are as physical therapists and what services we provide to the populations we serve. In this way, the *Guide to Physical Therapist Practice* has become the benchmark to which legal cases, insurance companies, state practice acts, and many more have referred when reviewing specific cases, practices, and advancements.

Unfortunately, though the benefit of the *Guide to Physical Therapist Practice (Guide)* has been well documented, many practicing physical therapists still do not use this tool in their daily clinical practice. This article will address the use of the *Guide* as related to the musculoskeletal practice patterns. A discussion of the essential elements of the patient/client management model in relation to the musculoskeletal practice patterns will be presented. By understanding the terminology and the components of each essential element, the physical therapist should be able to apply the practice patterns in their daily practice.

TERMINOLOGY

The first step in using the *Guide,* is to understand some basic terminology. Patients and clients are two terms that need clarification. Patients are "individuals who are the recipients of physical therapy and direct intervention."[2] Clients, on the other hand, are "individuals who are not necessarily sick or injured but who can benefit from a physical therapist's consultation, professional advice, or services. Clients are also businesses, school systems, and others to whom physical therapists offer services."[2] This would include organizations or people to whom you provide consultation, screening, and/or education programs. Two other terms that are frequently misused are examination and evaluation. These terms have been standardized in the *Guide*. Examination is the first component of an initial patient/client interaction and is "the process of obtaining a history, performing relevant systems reviews and selecting and administering specific tests and measures."[2] After the examination, the physical therapist performs the evaluation, which is "a dynamic process in which the physical therapist makes clinical judgments based on data gathered during the examination."[2] The terms goals and outcomes have also been confusing for the physical therapist. A goal is related to "the remediation of impairments" whereas outcomes relate to "the minimization of functional limitations, optimization of health status, prevention of disability and optimization of patient/client satisfaction."[2] A goal is a step by step advancement to achieve the outcome.

Another issue that is often overlooked by the practicing physical therapist is utilization of patient first language in all documentation. This means that the patient has the disease process not the patient is the disease process. An example would be to use "patient with osteoporosis" rather than "the osteoporotic patient."

PRACTICE PATTERNS

When beginning to look at the *Guide*, an understanding of how each practice pattern is organized will enable the therapist to use all aspects more effectively. Each of the 4 practice patterns is subdivided to further classify the condition by severity, chronicity, and structure involvement. The patterns' subdivisions begin with those conditions that put the patient/client at risk for future injuries and progress to the more involved cases. Looking at the Preferred Practice Pattern #4 for the musculoskeletal system, the early practice pattern A (Primary Prevention/Risk Factor Reduction for Skeletal Demineralization) is based on those at risk for developing osteoporosis; B (Impaired Posture) is for those with developing postural changes; and C (Impaired Muscle Performance) for those with developing muscle weakness. Progressing further into the Musculoskeletal Practice Patterns, there are progressive involvement of "Impaired Joint Mobility, Motor Function, Muscle Performance and Range of Motion Associated With…"—D(…Capsular Restriction), E (…Ligament or Other Connective Tissue Disorders), and F(..Localized Inflammation). Practice Pattern 4G adds Reflex Integrity and these impairments are "Secondary to Spinal Disorders." The Patterns H-J refer to these impairments related to more specific disorders and are "Associated With Fractures, Joint Arthroplasty, Bony or Soft Tissue Surgical Procedures," respectively. Practice Pattern K focuses on Impaired Gait, Locomotion, and Balance and Impaired Motor Function Secondary to Lower-Extremity Amputation. Each pattern lists which diagnoses are included and which are excluded and then lists the current ICD-9 codes to assist the physical therapist in assigning proper coding for reimbursement. By accurately determining into which practice pattern the patient's/client's signs and symptoms most accurately fit, the physical therapist can be more effective in providing interventions that achieve the optimal outcome

within the time frame allocated by most Insurance carriers. (NOTE: Patients may be categorized in more than one practice pattern, which is acceptable as long as there is adequate documentation and there are appropriate ICD-9 codes to justify classification into more than pattern).

The next step in using the *Guide* is to understand fully the 5 essential elements of patient/client management. Each element of practice is necessary for developing the proper plan of care and providing supportive evidence to obtain the proper insurance coverage. If any element is skipped, then the physical therapist may miss an important piece of information that could affect the overall outcome and efficiency in achieving that outcome.

PHYSICAL THERAPY EXAMINATION

The physical therapy examination is divided into 3 components--history, systems review, and tests and measures. The history is a crucial first step in obtaining information that guides the rest of the clinical examination. The history can be obtained by an interview with the patient/client and/or their family and by reviewing other information, such as the medical chart, past therapy charts, lab reports, radiographic reports, and pharmacology lists. The patient/client history includes information about the following areas: demographics, social history, living environment, general health status, social/health habits, family history, medical/surgical history, current condition(s)/chief complaint(s), functional status/activity level, medications, work/leisure history, and other clinical tests (the reader is encouraged to look at the history template found in the *Guide* as a great tool to use in their practice). Two areas of the history, medications and other clinical tests, require a little expansion. It is important to remember that knowledge of the patient's/client's medications may provide further information about the patient's medical condition and possible co-morbidities and will be important in determining the effects between the medications and physical therapy interventions of exercise prescription and physical agents (see Ciccone C, Pharmacology in Rehabilitation, for a discussion of the interaction between physical agents and therapeutic drugs[3]). Reviewing other clinical tests (eg, lab results or radiographic findings) provides the physical therapist with a more complete picture of the many components necessary to analyze in order to eventually develop the diagnosis, prognosis, plan of care, and interventions. With a thorough history, the physical therapist is ready to continue onto the systems review.

The systems review component of the examination (which includes a review of the cardiovascular/pulmonary, integumentary, neuromuscular, musculoskeletal, and communication systems) is a very fast look at or screen of the major systems before going into any in depth tests and measures and unfortunately is often overlooked, especially within orthopedic physical therapist practice. Surveys (formal, informal, and list serve conversations) have demonstrated that many physical therapists do not monitor vital signs during physical therapy examination and interventions of patients with musculoskeletal dysfunctions. In the orthopedic/sports physical therapy practices, therapists typically deal with more active patients and report lack of time to monitor the vital signs so they may just look to the nursing notes if in an inpatient environment or skip this altogether. However, without knowledge of how the cardiovascular/pulmonary system is responding to exercise, then the therapist lacks the supportive evidence to prescribe accurate duration and intensity of exercises. How very sad when a potentially healthy individual collapses on the field, in the clinic, or in the community when a simple check of heart rate and blood pressure by the physical therapist during the examination might have sent this patient on to the physician for further workup.

The cardiovascular/pulmonary systems review screen takes but a few minutes and includes heart rate, blood pressure, respiratory rate, and noting any presence of edema. Integumentary screenings are important for all health care providers that come in contact with the patient. This systems review screen includes a quick look at skin pliability, presence of scar formation, skin color and integrity (especially bony landmarks at risk for ulceration), and incision appearance in the case of patients who are seen postsurgical. The neuromuscular systems review screening includes a quick look at gross coordinated movements during balance, gait, transfers, and transitions. The musculoskeletal systems review screen in this portion of the examination is a gross screen that will lead to more specific tests and measures. This includes a quick overview of the patient's gross range of motion, gross strength, gross symmetry, and height and weight. The final component of the systems review is the communication system. Determining the patient's communication (age appropriate), orientation x3, emotional/behavioral responses, learning barriers (hearing, language, cultural), and how the patient/client best learns will provide further information to enable the physical therapist to eventually determine the appropriate tests and measures to be done and to determine the diagnosis, prognosis, plan of care, and interventions.

Once a physical therapist has performed the history and systems review, specific tests and measures are performed. An in depth review of specific test and measures is beyond the scope of this article (see the CD-ROM version of the *Guide* for further information about specific tests and measures for the patients within this practice pattern), but the physical therapist selects those tests and measures that have the strongest measurement properties (reliability and validity) to provide the final information pieces to enable determination of the diagnosis, prognosis, plan of care, and interventions. These tests and measures provide a baseline that can be used later to demonstrate progress toward the patient's/client's goals and expected outcomes. Physical therapists providing services for patients/clients with musculoskeletal system diseases, disorders, or conditions need to consider their functional ability in the home and community and possible need for further evaluation of the home, work, and leisure settings so that integration back into the community is fully realized and potentially reducing the risk for recurrence.

PHYSICAL THERAPY EVALUATION

Once the examination (history, systems review, and tests and measures) is complete, the physical therapist can analyze the data obtained. This enables the therapist to make a clinical judgment that will include the extent of the loss of function, the chronicity of the problems, the multisite/multisymptoms of the dysfunction, the stability of the condition,

the affect of pre-existing conditions, and then determine the current level of function and potential long-term impairment. Future needs at discharge should begin at this point in the initial visit. This is also when the physical therapist determines whether physical therapy is appropriate for the patient at this time.

PHYSICAL THERAPY DIAGNOSIS

The diagnosis will guide the physical therapist in determining the appropriate intervention strategy. The *Guide* describes the diagnosis as a "label encompassing a cluster of signs, symptoms, syndromes or catagories"[2] and is a process whereby the physical therapist organizes all the information from the examination and evaluation to interpret and plan future interventions. These interventions could include referral for more testing including radiographics/labs or referral to other health care providers, such as a social worker for home/interpersonal needs or a dietitian for nutrition needs. During the diagnosis stage of the initial visit, the preferred practice pattern will be assigned. This will assist the therapist in determining the prognosis and interventions.

PHYSICAL THERAPY PROGNOSIS

Once a physical therapist has assigned a practice pattern to the patient's cluster of signs/symptoms, the *Guide* can assist in making a decision regarding the predicted optimal level of improvement in function and amount of time (frequency and duration) needed to achieve this function. Each practice pattern lists an "Expected range of number of visits per episode of care"[2] and should be appropriate for 80% of the population.[1] Other impairments that have been determined as a result of the examination may increase the number of expected visits and will need to be clearly documented. At this point, the physical therapist may determine that the patient/client fits into more than one practice pattern based on findings during the examination. The plan of care can now be developed and will include the goals, specific interventions, duration, and frequency of the intervention and criteria for discharge.

Physical Therapy Intervention

Each practice pattern lists acceptable, evidence-based, frequently used interventions, and resultant goals for the various diagnoses encountered within that practice pattern. The specific intervention(s) selected for any patient/client is the result of that clinical decision making that was based on the data gathered during the examination and the resultant evaluation, diagnosis, and prognosis. The physical therapist must also consider the setting within which the intervention(s) will be provided and who will be providing the intervention. The *Guide* defines the physical therapy intervention as a "purposeful and skilled interaction of the physical therapist with the patient/client or other individuals involved in the care using physical therapy procedures and techniques in order to produce changes in the condition to achieve the goals and outcomes."[2] These interventions may include direct hands on therapy provided by the physical therapist or physical therapist assistant, or may include instructions to the patient/client or caregiver for home follow through. Clear documentation must exist that includes what the skilled intervention was and how this related to the overall goals and outcomes (see APTA Guidelines for Documentation also included in the *Guide*).

CONCLUSION

If a therapist uses the 5 essential elements of patient/client management as listed in the *Guide to Physical Therapist Practice,* there should be sufficient documentation to determine if the outcomes are achievable and improve patient satisfaction. When the need is present for further interventions to achieve the outcome, the physical therapist now has the tools to support their request. The *Guide* is not meant to be a cookbook practice of physical therapy but is intended to provide guidelines for progressing through the patient/client management model in all patients with involvement of the musculoskeletal system.

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Dr Moffat is past president of APTA and current president of the World Confederation for Physical Therapy. She served as chair of the exercise task force for the Section on Geriatrics developing the Certified Exercise Expert for the Aging Adult series of which she is the lead faculty member. She is a professor at New York University and has written numerous books and articles and lectures internationally on issues related to the aging adult.

ELEMENTS OF PATIENT/CLIENT MANAGEMENT

- **EXAMINATION**
- **EVALUATION**
- **DIAGNOSIS**
- **PROGNOSIS**
- **INTERVENTION**

BONE HEALTH ACROSS THE LIFE SPAN

Kathy Brewer, PT

INTRODUCTION AND DEFINITIONS

The human skeleton serves both a structural function—providing mobility, support, and protection for the body—and a reservoir function, as the storehouse for essential minerals. It is not a static organ, but is constantly changing to regenerate itself and sustain function across the lifespan.

B. Lawrence Riggs, MD of Mayo Clinic presented an Overview of Bone Health during the proceedings of the Surgeon General's Workshop on Osteoporosis and Bone Health held on December 12-13, 2002 in Washington, DC. Dr. Riggs stated "The key to healthy bones is maintaining optimal levels of bone mass."

Structural Function

Bone mass is determined by a variety of intrinsic factors such as genetics, age, and gender, as well as extrinsic factors including nutritional status (eg, levels of calcium, protein, and Vitamin D), activity levels, environmental risk factors (eg, smoking, alcohol consumption), presence of certain diseases, and use of certain drugs (eg, corticosteroids). It varies over time in individuals, depending upon how much new bone is being formed and how much is being lost (resorption). There is a higher rate of formation than resorption during their childhood years (particularly around puberty), providing for bone growth in both length and architecture. It is important for adolescents to reach their peak bone mass in order to maintain bone health throughout life. This is accomplished by maximizing appropriate nutrition and mechanical forces through physical activity in order to stimulate optimal structural design to maximize strength. Consequently, adolescent lifestyle patterns can influence young adult bone strength. Relatively stable levels of bone mass are typical during adulthood, when resorption and formation are comparatively equal. A large decline in bone mass occurs in older adults.[1] Women experience a period of rapid net bone loss, up to 20% in the first 5 to 7 years postmenopause. Men also lose bone after age 50, although it occurs more gradually through the final decades of life.

Bone is mechanosensitive and adapts its size, strength, and mass in response to loading. Structural properties include bone size, geometry, material distribution, and internal architecture. Both the amount of bone and its intrinsic architecture or outward shape are principally determined by the mechanical forces that act on the skeleton.[2] The loads applied to the skeleton generally are a combination of compression or tension (outward-pulling) forces with bending or torsional (twisting) moments. The resistance to bending and torsional loading is particularly important, as the highest stresses in the appendicular skeleton are due to these loading modes, common to dynamic activity. While the highest stresses on the vertebral skeleton are due to compression loading and designed for postural support.[3]

The shape of the specific bone is at least as important as its mass in providing this strength. Bone may be modified throughout life in response to the extrinsic factors as described above. The mass and architecture of the bones can be improved by mechanical loading or weakened by inadequate amounts of loading and weight bearing.[1]

Peak bone mass refers to the genetic potential for bone density. About 85% to 90% of adult bone mass is acquired by age 18 in girls and 20 in boys. Trabecular bone loss begins at age 30-40. Cortical bone loss begins at age 40-50. Consequently, high bone mass achieved as a young adult will provide greater potential for higher bone mass to be sustained in later in life and in the presence of age related bone loss are more likely to remain above the fracture threshold. Inadequate calcium consumption and physical activity early on could result in a failure to achieve peak bone mass in adulthood.[4]

Maximal structural function requires that the body's frame be both light and strong. This is accomplished through the variance in bone tissue. Cortical bone is the outer dense shell that makes up roughly three-quarters of the total skeletal mass and defines the shape, provides strength, sites for firm attachment of the tendons, and muscles and protection without excessive weight of the bone. Cortical bone (also known as compact bone) is made up of dense deposits of minerals—chiefly calcium phosphate—and Type I collagen. These are arranged in concentric circles around a central Haversian canal through which blood and lymph vessels as well as nerves pass. The remaining 25% is a delicate network of connecting plates and rods called trabecular bone, providing a large bone surface for mineral exchange. Intrinsic strength of trabecular bone (also called "spongy bone") results from the rods and plates aligned in a pattern that provides maximal strength without too much bulk. Trabecular bone is particularly abundant in the spine and at the ends of the long bones, helping to maintain skeletal strength and integrity under continuous stress from motion and weight-bearing.

Reservoir Function

Calcium and phosphorus are essential for the functioning of other body systems, and are predominately store housed in the skeleton. The maintenance of a constant level of calcium in the blood as well as an adequate supply of calcium and phosphorus in cells is critical for the function of all body organs, but particularly for the nerves and muscle. In order to ensure adequate supply of these minerals, regulating hormones interact with bone, intestine, and kidney to mobilize calcium and phosphorous from the bone and supply them for other vital functions. Bone requires ample supplies of these minerals to maintain sufficient strength and function, however, the skeleton then becomes a resource or reservoir for withdrawal of these same elements in times of need for other vital neuromuscular function. Consequently the skeleton serves two different purposes that are in competition with each other. Too many withdrawals weaken the bone and can lead to the most common bone disorder, fractures.[1]

Hormonal control of bone turnover

Bone remodeling, specifically the balance between formation and resorption, is the biologic process that mediates changes in the traits that influence bone strength.[3] To respond to its dual roles of support and regulation of calcium and phosphorus, as well as to repair any damage to the skeleton, bone is constantly changing. Old bone breaks down and new bone is formed on a continuous basis through a process called osteogenesis.

The osteoclasts are derived from stem cells in the bone marrow, and are large multinucleate cells (differentiated from macrophages) that dissolve the mineral and break down the bone matrix. This is called bone resorption, causing a net loss in bone substance. Osteoblasts secrete collagen and mineral to form a scaffold or bone matrix of new bone tissue. They lay down bone in an orderly manner that adds strength to the matrix. The tissue of the skeleton is replaced many times during life. Turnover is not paced equally. Osteoclasts resorb in one month what osteoblasts take 3 months to replenish. Physical inactivity (ie, bed rest) can cause loss of 1% of bone mass per week. To maintain adequate bone balance requires an intricate regulatory system that involves specialized cells communicating with each other. Serum calcium levels stimulate specific gland cells to regulate the production of calcium-regulating hormones which in turn influence bone cells. These cells must respond to many different signals, both internal and external, mechanical and hormonal, and systemic (affecting the whole skeleton) and local (affecting only a small region of the skeleton).[3]

A summary of hormones affecting growth and remodeling follows[1]:

- Growth hormone-drives the growth of bones until the adult size is reached.
- Parathyroid hormone - promotes the number and activity of osteoblasts.
- Estrogens- until the end of puberty, estrogens are needed for maturation of the skeleton. The estrogen induces osteoclasts to self-destruct by apoptosis and in this way slows up the destruction of bone. Consequently, there is a marked increase in calcium resorption in the presence of estrogen withdrawal, typical of menopause.
- Calcitonin and thyroid stimulating hormone both inhibit the activity of osteoclasts.
- Calcitriol (1,25[OH]$_2$ vitamin D$_3$.- needed for the deposition of calcium into bone.
- Osteoprotegerin is a protein secreted by osteoblasts and their precursors that also inhibits the production and activity of osteoclasts.
- Leptin, which regulates the balance between osteoblast and osteoclast activity.

Bone is a composite material, consisting of crystals of mineral (calcium and phosphate called hydroxyapatite) bound to protein, primarily collagen. This provides both strength and resilience so that the skeleton can absorb impact without breaking. A structure made only of mineral would be more brittle and break more easily, while a structure made only of protein would be soft and bend too easily. Very small changes in the shape of the bone can act on the cells inside bone (the osteocytes), which produce chemical signals that allow the skeleton to respond to changes in mechanical loading.[1]

AGING CHANGES

Childhood

Through the lifespan, bone is dynamic in response to growth, maintenance, and aging. Over 90% of adult height is reached at age 11.5 for girls and 13.5 for boys (peak height velocity or PHV). Peak mineral accrual occurs about 1 year later. At PHV – only 60% of lumbar spine and total body mineral content and 70% of femoral neck mineral content has been accumulated. During the 4 years that surround PHV – over 35% of total body and lumbar spine and 27% of femoral neck bone mineral is laid down. This is similar to the amount of bone mineral that most adults lose in their lifetime. This 4 years surrounding PHV is the optimum time to achieve peak bone mass, though bone continues to grow in length up to age 25.[5] However, the critical elements needed for healthy bone growth are compromised by these facts: Only 4 of 10 boys and 2 of 10 girls (age 12-19) consume the RDA of calcium (=1300mg). Only 19% of all high school students are physically active for 20 minutes or more, 5 days a week, in physical education classes. Of children aged 9 to 13 years, 61.5% do not participate in any organized physical activity during their nonschool hours and that 22.6% do not engage in any free-time physical activity. Participation in all types of physical activity declines strikingly as age or grade in school increases.[6] Consequently, the activity and nutrition in childhood and adolescents has significant positive or negative influence on bone health throughout life. The fact that peak bone mass, the greatest opportunity for bone mineral content to be developed, occurs in youth, reflects why osteoporosis has been labeled a pediatric disease that has consequences in later life.

Dr. Stuart Warden in his 2009 CSM presentation provided some specific guidelines for building strong skeletons in young children. These include: engaging in weight bearing and high impact activities (ie, gymnastics, dancing), engage in 40 minutes of general physical activity each school day (200 min/week), strength training exercise (at least 75 min 3 days per week) to increase lean body mass and total bone mineral content, use of plyometrics (jumping from boxes or jumping rope) at least 10 minutes/day 3 times per week, maintaining adequate calcium intake.[2]

Adolescence

Skeletal benefits are most effective when initiated pre- and postpuberty, however, longitudinal studies demonstrate that active adolescents have ~10% greater bone density in young adulthood (age 20-30) than nonactive adolescents. Engaging in daily physical activity from age 13-16 has been found to be significantly related to BMD at the hip and spine at age 28 in both men and women. During the high school years, women engaging in organized sports such as swimming and long distance running showed less benefit to bone mass than those women participating in high impact sports such as volleyball and gymnastics. [2]

A 10-year study of young women age 12-33 determined influence of adolescent lifestyle patterns on bone strength, calcium intake, exercise history, and oral contraceptive use were assessed. Body mass index and body composition were measured. Data suggest that exercise is the predominant lifestyle determinant of bone strength for this cohort.[8]

The process of bone maturation is described in the Surgeon General's Report as follows: during childhood bones

resorption occurs inside the bone while formation of new bone occurs on its outer (periosteal) surface. At puberty, formation can occur on both the outer and inner (endosteal) surfaces allowing the bones to get thicker. With further maturity, resorption occurs on inner surfaces while formation occurs on outer surfaces, this partially compensates for the loss of strength due to the thinning of the cortex. The size and shape of the skeleton are in part mandated genetically, but are also significantly affected by the loading or impact that occurs with physical activity. Ultimately bones achieve a shape and size that fits best to their function. In other words, "form follows function."

Once bone growth is complete, the remodeling process continues throughout life. Remodeling repairs the damage to the skeleton that can result from repeated stresses, and also prevents the accumulation of too much old bone, which can lose its resilience and become brittle. Remodeling also becomes increasingly important for the function of the skeleton as the bank for calcium and phosphorus by the time that bone reaches its peak mass. Resorption particularly on the surface of trabecular bone, can supply needed calcium and phosphorus when there is a deficiency in the diet or for the needs of the organism. When calcium and phosphorus supplies are ample, the formation phase of remodeling can take up these minerals and replenish the bank. Ten to 15% of skeleton is demineralized and can be renewed each year. Normal balance equals a turnover of 10% cortical and 30% to 40% trabecular bone remodeled per year. Modeling and remodeling continue throughout life so that most of the adult skeleton is replaced about every 10 years.[1] Bone remodeling, specifically the balance between formation and resorption, is the biologic process that mediates changes in the traits that influence bone strength. [3]

The exercise prescription for optimizing peak bone mass and structure during adolescent years is to encourage consistent weight bearing exercise with unique mechanical loads including dynamic, multidirectional, and high impact activity at least 60 minutes, 3 times per week.[2]

Adulthood – maintenance and factors predicting and sustaining bone health

There is predictable bone loss with age. Genetic influences account for ~75% of variation in peak bone mass and rate of bone loss. In women, there is a more rapid bone loss of 2% to 3% per year over the 5 to 10 years after menopause. This results in up to 20% bone loss in the first 5 to 7 years postmenopause. Bone mass continues to decline with age but at a slower rate than during the early menopausal years. Men also lose bone mass but at a more constant and gradual rate. The overall rate of bone loss for men and women is the same, but because men start with typically higher bone densities, they don't get into trouble as quickly. Consequently, osteoporosis is an issue for men typically age 70 and beyond unless there are other underlying risk factors. [7]

The American Society for Bone and Mineral Research, Sept. 2002 reports the predominant factors that determine postmenopausal BMD are:

1. Mass at the time of skeletal maturity
2. Age at menopause
3. Rate of bone loss with age

Computer model analysis of bone remodeling revealed that a 10% increase in peak BMD is predicted to delay the development of osteoporosis by more than 13 years. Accordingly, peak BMD may be the single most important factor in the development of osteoporosis.

Age related decline in the material properties of bone are in part a redistribution of the cortical and trabecular bone.[3] In remodeling, bone on the surface of trabeculae or in the interior of the cortex is removed and then replaced at the same site. Consequently, the shape of the bone does not change. This process is vital for bone health, and occurs particularly in response to weakening of the bone. Thus with aging, if excessive amounts of bone are removed from the inside, some new bone can be laid down on the outside, thus preserving the mechanical strength of the bone despite the loss of bone mass.[2] This translates to an increase in the diameter of long bones but a decrease in cortical thickness. This increase in the outer diameter helps to maintain the resistance to bending and torsional loads.[3]

The bone response is highly site- and stimulus-specific and the greatest bone adaption occurs in response to dynamic loading characterized by variances in frequency, strain rate, duration, and rest times. The ability of bone to withstand mechanical forces is most strongly (75-80%) related to mineral mass and density.[2] High-load, short-duration stimuli induce a "minimal effective strain stimulus" encourages maximum bone growth.[9] Physical activity may account for 10% to 20% of the variation in adult bone mass. It is further estimated that a 5% to 10% increase in peak bone mass translates to a 25% to 50% reduction of osteoporotic fracture risk in adults. Consequently, maximizing and sustaining peak bone mass with appropriate health maintenance throughout the lifespan may be a more effective strategy than attempting to retard bone loss in later life. [10]

Factors affecting bone health

Bouxsein describes the role of bone matrix properties in bone strength in 3 domains: mineralization, collagen characteristics, and microdamage. The degree of matrix mineralization dictates the stiffness and strength of bone. The ability of bone to absorb energy is relative to the level of mineralized content present. Drugs which have effects on matrix mineralization will be reflected in BMD measurements and likely contribute to the anti-fracture efficacy of these agents. There is emerging evidence in the role for age- and disease-related changes in collagen content and structure. In normal bone, the mineral provides stiffness and strength, whereas collagen affords bone its ductility and ability to absorb energy before fracturing. Fracture risk independent of BMD status suggests that modifications of collagen may have significant influence on bone mechanical properties contributing to age-related skeletal fragility.[3]

Although microdamage initiates activation of remodeling, presumably to repair, throughout the lifespan, physiologic loading of the skeleton produces fatigue damage in bone. Bouxsein states that there is ongoing debate regarding the optimal level of bone turnover to balance the prevention of architectural deterioration while preserving the ability of bone to maintain calcium homeostasis, respond to altered mechanical loading, and to repair microdamage. More research is needed to clarify the role of microdamage in age-related fragility fractures. [3]Fractures occur when the loads applied to bone exceed its strength. Therefore strategies to reduce fractures should consider interventions aimed at maintaining or increasing whole bone strength (ie, size or mass, shape or architecture and the intrinsic properties of the materials that comprise the bone while reducing

loads applied to bone that might cause microdamage and bone fatigue). [3]

Maintaining appropriate nutritional status is also crucial for maintaining healthy bone. The importance of vitamin D, calcium, and the effect of comorbid conditions on nutritional status is information readily available but beyond the scope of this review. It is estimated that the risk of fractures can be minimized by 50% if vitamin and nutrient requirements are met in the first 2 to 3 decades of life. [9]

Recommended calcium and vitamin D intake	
Calcium	**Age Daily Needs**
1-3 years	500 mg
4-8 years	800 mg
9-18 years	1,300 mg
19-49 years	1,000 mg
50+ years	1,200 mg
14-18 years, pregnancy/ breastfeeding	1,300 mg
19-49 years, pregnancy/ breastfeeding	1,000 mg
Vitamin D	
Experts recommend a daily intake of between 800 and 1,000 international units (IU) of vitamin D for most adults age 50 and older. Some people will need even more. Adults under age 50 should get a daily intake of between 400 and 800 IU.	
Source: http://www.nof.org/awareness2/2007/images/Bone_Tool_Kit.pdf	

In 2004, the American College of Sports Medicine presented a position statement titled "LIFE-LONG STRATEGY TO HELP PREVENT OSTEOPOROSIS" focused on strategies for children and adults for performance of the most effective physical activities to promote bone health. These exercise recommendation for both children and adults can be found at: http://www.acsm.org/AM/Template.cfm?Section=Search&template=/CM/HTMLDisplay.cfm&fContentID=4191.

Several principles guide exercise prescription for maintenance of bone health.

1. *Specificity:* Activities selected for osteogenic effects should stress those skeletal sites most at risk for osteoporotic fractures.
2. *Overload:* There must be a progressive increase in the intensity of the exercise for continued improvement, but applied skeletal loads must be within the structural capacity of the bone to sustain the given stress.
3. *Reversibility:* The positive effect of exercise on bone and muscle will be slowly lost if the exercise program is discontinued. The exercise must be continuously maintained in order to preserve the positive impact on bone mineral density.
4. *Initial Values:* Those with the lowest bone mass and weakest muscles will have the greatest improvement; those with average or above average bone mass and muscle strength will have the least.
5. *Diminishing Returns:* There is a biological ceiling to exercise-induced improvements in the functioning of any physiological system. As this ceiling is approached, more and more effort is required to attain smaller gains.[9]

Understanding and applying the components of bone health and maintenance (mechanical loading, adequate nutritional intake) along with additional precautions to minimize harmful stresses through proper posture, safe movement, and body mechanics as well as fall prevention strategies, is an appropriate approach for adults in the absence of disease or medical conditions which may compromise bone strength.

OSTEOPOROSIS

Again, quoting B. Lawrence Riggs, MD, "The primary bone disease affecting Americans is age-related osteoporosis. Individuals with this disease are more prone to fractures. Fracture risk is increased by the following: low bone density, previous fractures, microstructural damage, high bone turnover, and trauma (eg, due to a fall). Fortunately, osteoporosis is preventable and treatable and therefore should not be considered an inevitable part of aging.

Literally, osteoporosis means 'porous bone.' Bone density decreases if bone cells are destroyed faster than they are replaced by natural processes. Eventually, this increases bone fragility and risk for fracture. There are 2 main kinds of 'primary' osteoporosis:

- Type 1 - Postmenopausal in women, caused by estrogen deficiency.
- Type 2 - Age-related, mainly among women and men over the age of 70.

There are also 'secondary' forms of the disease, arising from (for example) long-term use of corticosteroid drugs, kidney failure, cystic fibrosis, or advanced cancers.[11]

The first hurdle in osteoporosis management is awareness. In May 2000, the National Osteoporosis Foundation in the USA published the results of a Gallup Survey of 1,039 women with osteoporosis. Only 33% of respondents reported they had taken preventive steps before being diagnosed with osteoporosis. The main preventive measure had been to take calcium supplements with their diet. Nearly half the sample believed that "osteoporosis is an unavoidable part of aging for women." Nearly half were unaware of the existence of preventive medication. Of the interviewees 86% had never talked to their doctor about preventing osteoporosis before it was diagnosed.[11]

There are 3 main tasks: (1) Screening by the doctor. (2) Lifestyle changes by the patient before osteoporosis sets in. (3) Preventive medication, prescribed by the doctor, taken by the patient.[12]

An individual's knowledge of BMD testing results substantially influences health related behaviors to improve bone health. Jamal et al reported a prospective study regarding lifestyle behaviors influencing bone health in 669 healthy premenopausal women age 18-35. Each received an interview questionnaire assessing lifestyle behaviors, BMD testing (20% were low), and written education. The questionnaire was repeated 1 year later. Results demonstrated that those women with low BMD were more likely to report increased milk intake and supplemental Ca, and less likely to smoke, consume alcohol, and drink >3 caffeinated beverages/day.[13]

In a similar study, 701 women age 50+ referred to community osteoporosis prevention program, followed for 3 years. Fifty eight percent of these women measured normal bone mass, 24% had moderately low bone mass, and 18% severely low bone mass. Behaviors after bone densitometry were characterized as follows with greater changes related to lower bone density test results: pharmaceutical intervention initiated, increased exercise, decreased caffeine intake, stopped smoking, increased dietary calcium and supplement, increased implementation and compliance to fall prevention & safety behaviors. [14]

Awareness and screening may be two simple, cost effective tools that can impact preservation of bone health. "Prevention, detection, and treatment of

osteoporosis should be a mandate of primary care and a routine part of physicals. Bone density tests are now widely available and should be offered to high risk women to detect low bone density BEFORE their bones weaken and fractures occur." C. Conrad Johston Jr. MD, NOF President. [11]

FIVE STEPS TO BONE HEALTH AND OSTEOPOROSIS PREVENTION

EAT RIGHT:
Get your daily recommended amounts of Calcium and Vitamin D.

EXERCISE:
Engage in regular weight-bearing and muscle strengthening exercise.

MAINTAIN A HEALTHY LIFESTYLE:
Avoid smoking and excessive alcohol consumption.

TALK TO YOUR HEALTH CARE PROVIDER:
Talk to your healthcare provider about bone health.

GET TESTED:
Have a bone density test and take medication when appropriate.

Data from the National Osteoporosis Foundation Web site:
http://www.nof.org/osteoporosis/index.htm

Weight bearing physical activity can maintain or improve bone mass, even after osteoporosis has developed. Physical activity and other balance and mobility exercise may also reduce the risk of falls that may result in injury and/or fracture. Therefore, even frail, older adults should be encouraged to participate in appropriate activities to maintain and improve their gait and balance, strength, and confidence, along with appropriate medical management.

SUMMARY

Maintenance of bone health is a life long, dynamic process. The greatest opportunity to develop peak bone mass is in youth, and we need to be providing both education and opportunity for our children to build strong bones! However, across the lifespan it is never too early and never too late to make lifestyle changes which positively impact bone strength, mobility, safety, and function.

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ADDITIONAL WEB SITES

www.acsm.org
(American College of Sports Medicine)
www.asbmr.org
(American Society of Bone and Mineral Research)
www.cdc.gov
www.endocrineweb.com
www.fitbones.org
(Arizona Osteoporosis Coalition)
www.fore.org
(Foundation for Osteoporosis Research & Educ)
www.4women.gov
navigator.tufts.edu
(nutrition information)
nutritiononestop.com
(nutrition information)
www.nof.org
www.obgyn.net/osteoporosis
www.osteorec.com
www.osteo.org
(NIH osteoporosis and related bone diseases)

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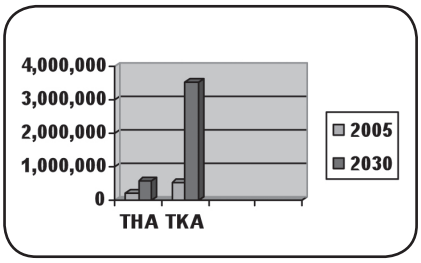
HIP & KNEE JOINT ARTHROPLASTY UPDATE -- WHAT ARE THE SURGEON'S CHOICES?

Mary Langhenry, PT, OCS

In the 1960s, at the beginning of total joint arthroplasty, it was a straight forward decision for a surgeon with an osteoarthritis of the hip patient to receive a total hip replacement. In the 1970s, the patient with osteoarthritis of the knee received a total knee replacement. There was basically one common approach: standard long incision, device (stainless steel), bearing surface (plastic), and type of fixation (cemented). The procedure was reserved for patients over age 70 as the anticipated prosthetic survivorship was 10 years. Hence, patients were told to wait as long as possible, so a revision would not be necessary. Technologic advances and improved surgical techniques have been made along the way; and most recently, there have been many more options available to the surgeon in regards to incision and implant. There is also the option of using navigation in the operating room. It is a full menu from which to choose! As an integral part of the rehabilitation team, the physical therapist originally only had to be concerned about whether their new patient had undergone a hip or knee replacement. Although the treatment was individualized, the basic rehabilitation concepts and expected outcomes were the same and well known. Currently, with so many more options available to surgeons and patients, the physical therapist must stay educated. If the goal is to rehabilitate these patients to their optimal level with the best possible outcome, it is our responsibility to know all the items on the menu, their capabilities, and expected outcomes.

It is well documented that the prevalence of OA in our society is increasing. People are living longer, requiring more surgeries. And, the number of "baby boomers" requesting intervention at an earlier age is growing. The AAOS projection study predicts that the number of first-time knee replacements will increase 673% (to 3.5 million a year) between 2005 and 2030, and the number of first-time hip replacements will increase by 174% (to 572,000 a year).[1]



Joint Replacement Trends
first-time replacements

The net result is an extensive amount of rehabilitation that will be in demand. Get educated, get ready, and know what the surgeon "ordered" for your patient.

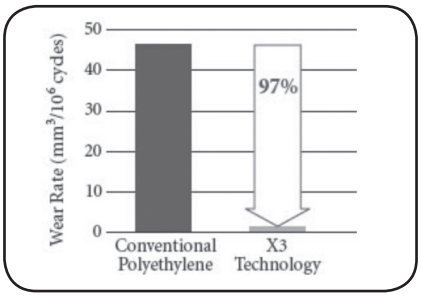
THE HIP MENU

Just as the total hip replacement becomes more common in younger and more active patients, and as patient life expectancies continue to increase, the orthopedic industry has been challenged to extend the life span of components.

BEARING SURFACES:
Traditional-metal on polyethylene
Ceramic on polyethylene
Ceramic on Ceramic
Large head metal on metal

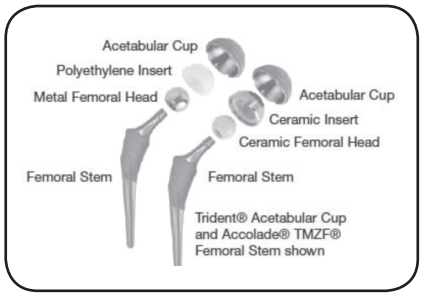
Bearing Surfaces

The conventional arrangement of a metal ball into a polyethylene liner and metal shell has been shown to have positive results with 85% survivorship at 10 years. Over time, these components may wear, eventually leading to a revision. Osteolysis, or bone resorption, can also occur due to the body's response to the microparticle debris generated by wear. New, advanced polyethylene (cross-linked poly) has demonstrated extremely low wear rates in the laboratory, and it is expected, over time, to have similar wear performance in the clinical setting.[2]



Ceramic use as a bearing surface began in the early 1970s in Europe. In 1995, an improved alumina ceramic was developed that had increased purity and strength over the first generation materials, aluminum oxide. The extreme hardness of this type of ceramic offers greater scratch resistance and lower wear versus conventional plastic-on-metal hip systems in the laboratory (1,000 times less).[3]

The complication found with ceramic use is the risk of a fracture of the ceramic. Multiple studies suggest that the risk of hip fracture is approximately 1 in 5,000. The use of ceramic demands absolute accuracy in component positioning as well. The symptomatic drawback of ceramic is a 3% occurrence rate of squeak. Additionally, ceramics are more expensive. The alumina-based ceramic head on a standard polyethylene liner resulted in an accelerated rate of polyethylene wear. Such is not the case with ceramic on ceramic, FDA approved in 2002. The optimal ceramic bearing surface with the potential for greater than 25 years of survivorship is Delta Ceramic –a combination of alumina and zarconia, on a highly X-linked polyethylene bearing.[4]



As the baby-boomers demand solutions to early onset pain and decreased quality of exercise ability, the industry has also designed a large head, metal-on-metal device. The large head allows for a reduction in dislocation. Larger femoral heads are designed to allow for more motion and enhanced joint stability than smaller femoral heads. These reproduce the anatomical size of the head of the femur and are designed for natural hip performance. The metal-on-metal coupling while enhancing prosthetic longevity has the potential disadvantage of metal ion release. Just as polyethylene wear debris may be liberated from particle generation so too may metal ions be released from a metal-on-metal or hard bearing surface. The potential side effects of systemic liberation of metal ions are still under study.

Implants

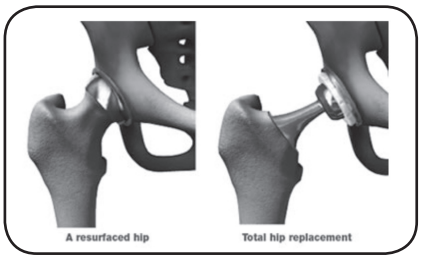
The traditional total hip devices themselves have been altered to allow for multiple modular components, variability in angulation of the stems, and coating on the stems. All of these allow the surgeon options for anatomical variations, fixation, and therefore survivorship.

IMPLANTS:
Total Hip Arthroplasty
Hip Resurfacing
Short Stem Total Hip Arthroplasty

Contemporary prosthetic fixation is cementless in over 85% of hip replacement done in the Unites States; 10 years ago the majority were cemented.

Another option available now for the younger, active lifestyle (baby-boomer) is hip resurfacing. Resurfacing a hip is similar to capping a tooth. The head of the femur is reshaped and resurfaced with a metallic cap as opposed to being sacrificed. Being a bone conserving procedure on younger patients, this allows for a future conversion to a total hip replacement as a primary procedure as opposed to a revision. The cap or head is cemented. Although there is currently a trial of uncemented or press-fit resurfacing heads, the standard practice is the cemented head. The shell is cementless, press-fit. Hip resurfacing uses a large head, metal-on-metal construct and therefore, reduces the risk of dislocation and allows for a high level of sport. Patients have been known to return to ironman and marathon competition, basketball, and skiing although not necessarily with physician approval. Dr. Mitchell Sheinkop, Professor Emeritus and Head of the Joint Arthroplasty Program at the Neurologic and Orthopedic Hospital of Chicago, having performed over 500 resurfaced hips, recommends that patients do not run long distances on their resurfaced hips, but does allow skiing, basketball, tennis, and return to work for the laborer without restriction. Hip resurfacing has been used in the U.S. since FDA approval in 2006. The current systems are FDA approved and available are the Birmingham Hip Resurfacing system by Smith and Nephew and the Cormet system by Corin and distributed in the U.S. by Stryker. The ReCap system by Biomet and Conserve resurfacing system by Wright Medical are currently seeking FDA approval. While full coverage is available for the standard total hip prosthesis, Medicare does not reimburse for hip resurfacing. The BHR (Birmingham), used in the UK for 10 years has demonstrated exceptional clinical results. High survival rates of 98% or better were achieved in clinical centers around the world.[5]

Cormet is a registered trademark of Corin PLC.



The candidate for hip resurfacing is a skeletally mature individual with good bone quality (especially noted in females) and OA. Hip dysplasia and avascular necrosis patients are possible candidates depending on their severity. Hip resurfacing is not recommended for patients with the following conditions: infection, poor bone quality, multiple cysts, allergy to metal (jewelry), extreme overweight (overload on device that would lead to failure), skeletal immaturity, women in child-bearing years, weak immune system due to disease or certain medications (eg, corticosteroids), and kidney failure. The potential risks and complications: femoral neck fracture (immediate extreme pain and inability to weightbear), acetabular malposition, impingement of the iliopsoas tendon, crepitation during motion, nerve injury, leg length inequality, and all those potential co-morbidities associated with a conventional THA. Hip resurfacing is a technical surgical procedure with an estimated learning curve of 100 cases for an experienced surgeon who does several hundred standard cases a year.[6]

What about the patient who wants the benefit of the large metal-on-metal bearing surface but is not a candidate for resurfacing? New on the market is what we call the "tweener." The Microplasty of Biomet, the May Conservative of Zimmer and Short Citation design of Stryker, offer a 90 mm length stem as contrasted with the standard 135 to 145mm length femoral stem. These options provide flexibility offering a large metal-on-metal bearing surface or a ceramic-on-cross-linked polyethylene bearing surface. With this relative bone-sparing procedure, patients get the benefit of hip resurfacing without the potential risk of a femoral neck fracture.

Incisions or Approaches

The menu doesn't stop there. Another choice for surgeons is which approach they utilize to perform the surgery. The big buzz word since 2001 has been "Minimally Invasive Surgery" (MIS). From the

public's view MIS means a "small incision/ small scar." This is an 8-10 cm incision verse the traditional 20-25cm incision. To the surgeon and equally important to PTs, is what happens below the incision. The difference is what musculature is involved or not involved at all. This "window" must allow the surgeon enough visualization for correct component placement. The desired result is less soft tissue dissection and muscle-sparing when compared to the traditional incision. This in return allows for decrease blood loss, decrease pain, shorter hospital stay, and quicker rehabilitation. While patient satisfaction is greatly increased with small scars; the true advantage if minimally invasive surgery is avoidance of muscle damage. A condensed description:

Physical therapists should know what approach was used during surgery to direct their rehabilitation in regards to muscle strengthening, timing of strengthening, and precautions.

APPROACH:	SURGICAL EXPOSURE:
Anterolateral	Requires release of the ant 1/3 of gluteus medius
Posterolateral	Requires release of the short external rotators; spares the gluteus medius
MIS - Anterior	Interval between fascia lata and rectus femoris muscles
MIS - Posterior	Interval between sartorius and tensor fascia lata
MIS - Two Incision	Has fallen out of favor because of inherent increased risk of complication
MIS – Anterior Intermuscular	Muscle sparing but requires special operative table
MIS - Direct Anterior (supine position)	Using an "inter-nerval" plane, between the tensor fascia lata laterally and the sartorious and rectus femoris medially. Less limp post-operative compared to other approaches

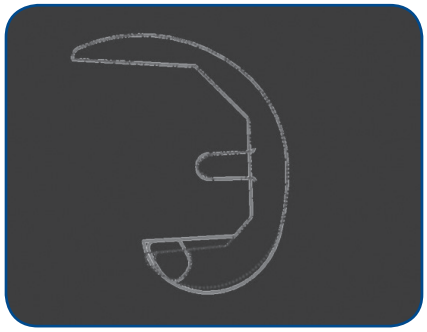
THE KNEE MENU

Modern technology also brings us more options for the knee joint. There have been countless improvements over the years in regards to technique, instrumentation, and implants. Again, think of our younger, more active, population requiring a joint replacement verse the elderly, sedentary population. Their needs are drastically different.

Implants

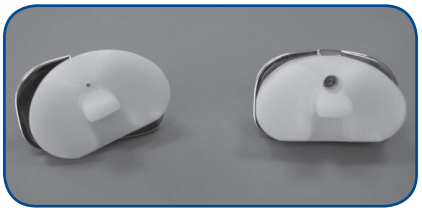
The traditional TKA has been very successful; in well over 90% of cases it is complication-free and results in significant pain relief and restoration of mobility. A postoperative range of motion of 0-120° satisfies a majority of the population. While survivorship has been 12 to 13 years with 87% excellent results and 93% rated "good" with the new highly cross-linked polyethylene and improved implant metallurgy, clinically it is expected to see survivorship approach 20 years.[7]

But, what about the patient whose flexion needs are greater than 120° (eg, yoga practitioners, gardeners, grandparents who would like to play with their grandchildren on the floor, and people who have a high flexion demand for activities of daily living to name a few)? The industry introduced a hi-flexion prosthesis to address these issues. This component is made to allow and withstand 145° of motion. The femoral component has a longer and wider posterior CAM to withstand the forces in deep flexion.

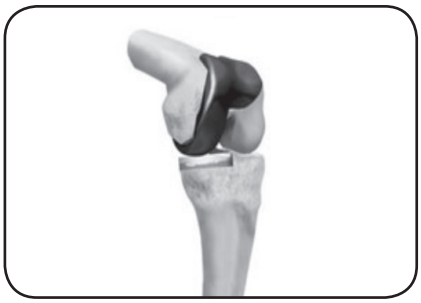


The polyethylene has a deeper cut-out for receiving the femoral component and preventing dislocation in extreme flexion. Finally, there is a cut-out in the femoral component and polyethylene anteriorly to allow room for the patellar tendon also in deep flexion and prevent patellar dislocation.

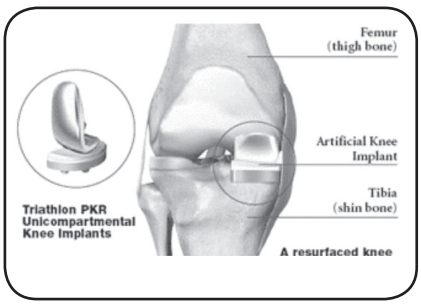
The mobile-bearing knee takes this a step further. The MBK was designed specifically for the Middle Eastern and Eastern Rim populations that culturally require squatting or kneeling and the Asian population that sit cross-legged. The mobile-bearing knee has the same femoral and patellar component as the hi-flex knee but the tibial component is different. The tibial tray has a peg superiorly that accommodates the polyethylene. This polyethylene is not fixed on the tibial tray but rather rotates around the peg to provide the normal rotatory component as in an anatomical knee. It is this 30° of rotation each way that allows for the additional flexion of up to 155° and is intended to substitute for the anterior cruciate ligament function. The high flexion, mobile-bearing knee has been FDA approved and available since 2008.



For those patients that do not have tricompartmental disease, there are other options available. The bicompartmental device, Journey Deuce made by Smith-Nephew, replaces the medial and patellar compartments only. Sparing the lateral compartment allows for an easier conversion to a total knee replacement. Long term outcomes are still unavailable with the bi-compartmental knee prosthesis.



Bicompartmental



Unicompartmental

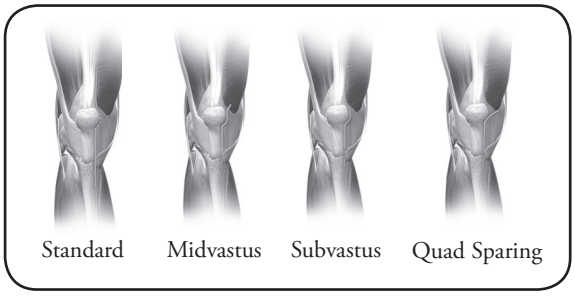
Implants	ROM Available
Total Knee Arthroplasty	
Total Knee	0-120°
Hi-Flex Fixed	0-145°
Mobile Bearing	0-155°
Bicompartmental	0-130°
Unicompartmental	0-135°

For those patients that have unicompartment disease, medial or lateral tibial-femoral arthritis without patella-femoral involvement, the unicompartmental device is available. While not new as an implant alternative, interest dwindled with poor outcomes; the design has since been upgraded and it has been back on the market, satisfying customers. This implant spares two of the compartments again for revision reasons while sparing the ACL and offering more physiologic function. There are several comments to make about the unicompartmental knee replacement. First, they are not successful if there is any PF disease. A patient will continue to have PF pain if that is an issue. Second, these devices are implanted to maintain a specific A-P long leg alignment. A medial replacement will be kept in a varus alignment and a lateral replacement will be kept in a valgus alignment. This is to prevent overloading or progressive wear of the opposite compartment. Unicompartmental devices allow for 0-135° of motion. There is also a mobile-bearing uni device.

Another new "buzz" word is "gender-specific." Along with our wonderful world of communication come more educated patients. Through marketing techniques, prosthetic companies are targeting patients by using terminology of "gender-specific." Industry recognized that while the majority of patients with osteoarthritis of the knee, fewer women undergo knee replacement than men. There are differences in male and female knee anatomy. Females have a narrower femur in the coronal axis. So, the idea of having separate male and female components is logical because of the risk of the femoral component being too wide for the female. But until recently, knee prostheses were manufactured without gender specificity and 15% of women complained of pain postoperatively attributed to soft tissue impingement. The current manufactures of these are Zimmer's Gender Knee and Stryker's Triathlon Knee. Due to marketing techniques by the manufacturers, patients are requesting these devices.

Minimally Invasive Surgical (MIS) Approach

The MIS technique involves a difference in the soft tissue and musculature incisions than that offered in a traditional procedure. Just as the gluteus medius is the basis for hip incision nomenclature, the vastus medialis is the key to the knee. An MIS implies a smaller skin incision, 9-12 cm, when contrasted to the standard 16-20 cm parapatellar approach. The decision as to which type of incision is employed by the surgeon is based on the anatomy of the VMO and where it inserts into the patella. As well, a patient's body type, Body Mass Index, and degree of degenerative joint change play a role. The surgical approach through the skin is medial parapatellar. The surgeon then may totally spare the VMO and only incise retinaculum (quad sparing) or the capsular incision may be below the VMO (subvastus). The third alternative is the mini-midvastus incision. In all 3 approaches, the patella is subluxed instead of everted. Utilization of these approaches prevents or limits quadriceps violation, and in turn, affects their postoperative rehabilitation.



CONCLUSION

In conclusion, the world of treating hip and knee arthroplasties is no longer straightforward for the physical therapist. In addition to the routine, personalized care therapists provide, it is critical to be educated on current technology so the therapeutic intervention can be as specific as possible. Knowing devices and approaches are crucial to setting goals and optimizing treatments. Communication with the surgeon and their staff is a key element. Technology is changing fast, the menu is large, and it is prudent to stay educated about these changes.

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WEB SITES

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Returning from a bike ride in Chicago, Mary Langhenry, PT, OCS and Floyd Landis after his hip resurfacing procedure.

Mary Langhenry graduated from Marquette University in Physical Therapy in 1986. She has 23 years of clinical experience throughout the continuum of care, from acute and rehab hospital care, to home care, and finally in outpatient orthopedics where she has spent most of her clinical career. Mary received her board certification as a Clinical Specialist in Orthopedics in 2000 through the American Physical Therapy Association. Since then she has worked in research specific to hip and knee joint arthroplasty with Dr. Mitchell Sheinkop at Rush University Medical Center and the Neurologic and Orthopedic Hospital of Chicago. She has lectured locally and internationally for the last 6 years on rehabilitation for joint arthroplasty and is a guest lecturer at several universities. Her current research involves arthroplasty outcomes, hip resurfacing and the mobile bearing knee.

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Course 2: Exercise Prescription, Consensus Guidelines
Course 3: Special Populations, Complementary Exercises, Motivation, Drug and Nutritional Considerations, Marketing

Locations:	Course 1	Course 2	Course 3
Montgomery AL	March 28-29, 2009	Aug. 29-30, 2009	Oct 17-18, 2009
San Marcos, CA	July 18-19, 2009	Dec 5-6, 2009	CSM 2010
Boston, MA	November 21-22, 2009	April 10-11, 2010	PT2010

Courses provide formal didactic education, supervised and mentored skill development, followed by home-based reflection and critical thinking. Mastery is assessed by home-based examination (Courses 1-3) and onsite skills test for the content of the first 2 courses during Course 3.

For further information, visit http://geriatricspt.org or contact the Section on Geriatrics Office at geriatrics@apta.org.

ADVANCED PROFICIENCY FOR THE PTA
GERIATRICS

Recognizing that the field of Geriatrics crosses all four categories of work, the APTA Board of Directors approved the addition of geriatrics as a category of work for Advanced Proficiency at their November 2008 annual meeting. Recognition is given to PTA's for their education, leadership and outstanding contribution to the PT/PTA team in their chosen field.

The benefits of attaining Recognition of Advanced Proficiency in a given area of work include:
1. Increased confidence in the provision of patient care
2. External recognition from APTA
3. Reinforcement of life-long learning
4. Distinction that assists with career advancement

All applicants must provide evidence of a minimum of 60 hrs of continuing education with 75% (45 contact hours) of the education within the selected category of work (musculoskeletal, neuromuscular, geriatric, pediatric, integumentary, and cardio-pulmonary). The Advance Proficiency in Geriatrics requires that these continuing education contact hours be directly related to the older adult and should include content in two or more of the following areas: musculoskeletal, neuromuscular, integumentary, cardiopulmonary.

Successful applicants will receive a Certificate of Advanced Proficiency suitable for framing and a lapel pin. This achievement will be recognized publicly in PT Magazine and at the PTA Recognition Reception held at APTA's Annual Conference. Should you have questions, contact:

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1111 North Fairfax Street
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PTARecognition@apta.org

Physical Therapist Assistants who meet the following minimum requirements are eligible for recognition:

1. Current member of APTA.
2. Five (5) years of work experience that must include a minimum of 2,000 hours total and at least 500 hours in the past year in one of the following categories of advanced proficiency: Musculoskeletal, Pediatric, Geriatric, Neuromuscular, Cardiovascular/Pulmonary, or Integumentary.
3. Completion of at least 60 contact hours (6 CEUs) of continuing education in physical therapy within the last five (5) years. Continuing education must include a minimum of:
   - 6 contact hours (.6 CEUs) per year for the five years prior to application
   - 75 % or forty-five (45) hours must be in the selected category of advanced proficiency
     - o For pediatrics and geriatrics, this must be directly related to the specific age group and include content from two or more of the following areas: musculoskeletal, neuromuscu lar, integumentary, and cardiopulmonary.
   - Continuing education must be related to physical therapy and within the scope of work ofthe PTA as defined by APTA standards, policies, and positions and the Guide to Physical Therapist Practice. Continuing education may include topics that are both clinical and nonclinical.
4. Consistent, above-average job performance within the PT/PTA team verified through a letter of reference from a supervising physical therapist.
5. Evidence of involvement in at least three activities that demonstrate the applicant's leadership abilities and contributions to their employer, profession, and/or community.

SPECIAL CONSIDERATIONS WHEN WORKING WITH THE FORMER AND LIFELONG OLDER ATHLETE

Melissa Singer, SPT; Nora J. Francis, PT, DHS, OTR

This article is from the class, "Linking Evidence to Geriatric Practice in Physical Therapy Student Education" at Northeastern University, which has produced several articles that have been published in previous issues of GeriNotes. The project provides opportunities for students to link geriatric professional literature to practice within a course that presents special issues in providing physical therapy care to older adults. One of the course objectives is that students will be able to analyze the professional literature on selected topics that are relevant to providing physical therapy care for older adults. This objective is addressed through the assignment of a Geriatric Physical Therapy Topics paper, which is designed to provide students with an opportunity to examine and analyze current professional literature on topics that are especially applicable to providing care for older adults.

The students are provided with a list of 21 potential topics that are presented in the form of a clinical question. Students select and research the identified topic and write a paper that includes: (1) a brief introduction of the topic and its importance to the care of older adults; (2) an in-depth, specific discussion of the topic; (3) a discussion of the implications of the researched topic on the physical therapy management of the older adult client; and (4) suggestions for future research.

The following is a Geriatric Physical Therapy Topics paper submitted by a student who researched the clinical question, "What *are the special considerations when working with the older athlete?"*

INTRODUCTION

Over the next 20 years, the number of older adults over 65 years old will exceed 70 million, becoming the fastest growing segment of the U.S. population.[1] With the increased age of the general population comes an increase in age-related health conditions. However, the conditions for which older adults are at highest risk, such as cardiovascular disease, osteoporosis, hypertension and diabetes, can be prevented by physical activity.[2] It is estimated that only 13% of older adults over 65 years old participate in vigorous physical activity for 20 minutes per day, 3 days per week.[3] Those older adults who engage in regular physical activity enjoy a higher quality of life with a decrease in overall mortality.[2]

One important subgroup of the older adult population is the former elite athlete. This group of talented athletes competed at the highest level of their respective sport, contending for championships in world class events and practicing vigorously throughout their adolescence and young adulthood. One concern is that the former athlete is at a higher risk for musculoskeletal pathology with age. However, another hypothesis is that there is a protective effect that delays or lessens the effect of typical age-related pathology. Several competitive athletes continue to participate in vigorous physical activity throughout their entire lives while others retire from exercise all together when they have finished competing in their sport. The purpose of this paper is to determine whether or not there is a protective effect in the aging process for the former and lifelong competitive athlete when compared to nonathletic, age-matched controls. Further, the application of these principles to physical therapy intervention will also be examined.

DISCUSSION OF LITERATURE

In order to determine the effect of competitive athletics on the older adult, the cardiovascular and musculoskeletal systems will be analyzed. Due to the nature of elite athletics, there is a large demand on both of these systems, which must be continuously functioning at a very high level for the athlete to be successful. The musculoskeletal system will be further categorized into the effect of athletics on bone density and osteoporosis, osteoarthritis, and skeletal muscle changes.

Cardiovascular System

It is well known that a sedentary lifestyle is associated with a greater risk of cardiovascular disease (CVD). One study examined whether former NFL football players would have a decreased risk of CVD compared to sedentary controls.[4] Sixteen football players from the 1958 Baltimore Colts championship football team participated in the study. When surveyed regarding their physical activity levels as a professional athlete, they were an average of 3 times more active than the control group. However, after age 65 there was no variation in physical activity between the two groups. Additionally, VO2 max test results did not demonstrate a significant difference between the athletes and controls. While the differences between the athletes and controls narrowed with age, the difference in body composition was substantial. The former football players had an average of 26% less total body and visceral fat compared to the controls which puts them at a considerably lower risk for CVD and diabetes, since both diseases are associated with high amounts of visceral fat.[4]

Endurance training puts a large demand on cardiovascular muscles. Prolonged training can be associated with ventricular dilation, increased ventricular wall thickness, increased stroke volume and a decreased heart rate which are characterized by the term "athlete's heart."[5] These cardiovascular changes have been identified in both young male and young female athletes as well as older adult male lifelong athletes. The aim of one study was to determine whether or not the "athlete's heart" could be identified in postmenopausal female former endurance athletes.[5] Twenty postmenopausal former endurance athletes, most of whom still participated in regular physical activity, were compared to 20 age-matched controls during a maximal bike ergometry test. The athletes achieved a higher maximum workload with a slower increase in heart rate during the test when compared to controls. However, there was no increase in ventricular wall thickness. The study hypothesized that there are gender related cardiovascular differences which could include hormonal differences as well as varying intensities of physical activity.

Since absolute cardiac output and systolic pressure are generally lower for women, the older adult woman might not be able to achieve a sufficient stimulus for ventricular wall hypertrophy.[5]

Cardiovascular training as an adolescent and young adult helps to improve cardiovascular and general systemic function in the older adult as long as they continue to be physically active. Athletes who did not continue their physical activity into adulthood did not maintain their elite level of cardiovascular fitness as indicated by their similar test results when compared to sedentary controls. However, those who continued to be physically active demonstrated superior cardiovascular function which is correlated with improved health. Therefore, persistent cardiovascular related activity throughout a lifetime helps to decrease the risk of chronic disease.

Osteoporosis and Bone Density

Weight bearing exercise has been emphasized as a technique to build and maintain strong bone integrity and decrease the risk of osteoporosis which is prevalent among older adults. When compared to average older adult males, vigorous older adult athletes between the ages of 70 to 81 years old had an average of 19% to 28% higher trabecular bone density.[3] When examining former professional football players, the athletes had 20% greater bone mineral content and 6% higher bone mineral density (BMD) when compared to controls.[4] Additionally, the former football players had higher lumbar spine BMD (31%), femoral neck BMD (17%), and greater trochanter BMD (16%) than controls.[4] The study concluded that high impact sports such as football may increase bone formation and therefore BMD to help protect against osteoporosis as an older adult.[4]

Osteoarthritis

Since the majority of injuries sustained during athletics are musculoskeletal in nature, it is logical to be concerned about joint integrity in the aging athlete. One study examined the effects of limb-loading of the lower extremity in various sports to determine whether the high impact nature of athletics increases the risk of osteoarthritis (OA) or has a protective effect to delay the onset of pathology in older adulthood.[6] Nearly 1000 former male elite athletes representing endurance, power sport, and team sport competition between 1920-1965 participated in the study. Subjects were mailed a questionnaire that evaluated the nature of any hip or knee injuries during their athletic careers. They were also asked to evaluate current hip or knee disability based on physician diagnosis and their response to several questions which assessed impairment of daily function. The overall risk of hip disability among athletes in any sport was lower than controls, even when adjusted for age, occupation, and BMI. The risk of knee disability was higher for team and power sport athletes when compared to endurance athletes and controls. The risk of hip OA among all athletes was the same compared to controls but the athletes had a higher risk of knee OA before age 45.[6] The study recognized that a major limitation is that subjects with significant athletic injuries early in their career are more likely to quit their sport which might underestimate the pathology associated with lower limb loading. It is also possible that although there may be radiographic evidence of OA, the associated loss of function may not be present due to increased aerobic capacity and fitness levels. Additionally, the direction of joint loading in each sport could be important in predicting long term pathology. For example, loading in the sagittal plane could be a lot less harmful than the medial-lateral knee joint loading in team sports and wrestling.[6] It was concluded that there is a higher risk of knee pathology than hip pathology in older adults as a result of elite competition but that several factors including current physical activity level and the nature of the original injuries can largely influence function.[6]

Skeletal Muscle Structure and Function

Age related muscle atrophy begins at approximately age 50 for the general population.[7] A decrease in physical activity and insufficient dietary intake can accelerate the process while overloading muscle groups during weight training can help both to prevent atrophy and achieve hypertrophy of muscles.[7] Aging is also associated with a loss of muscle force output and power due to a decrease in type II motor units. When comparing lifelong elite weight lifters from 40 to 88 years old to untrained controls, the elite athletes generated a higher peak power across all ages. However, the elite group showed a greater slope of decline in their performance compared to the controls.[7] When examining older adult endurance athletes, elite VO2 max levels were significantly higher but declined at similar rates to sedentary controls. However, elite runners who no longer participated in physical activity demonstrated a rapid decline in VO2 max which was eventually the same as an untrained subject.[7]

Sarcopenia is also a pathology of concern for older adults. One study found that 58% of average males over 75 years old were diagnosed with sarcopenia.[4] However, none of the former football players in the study had a diagnosis of sarcopenia. Rather, the athletes had a 13% increase in muscle mass when compared to controls.[4] The greater amount of muscle mass acquired as an elite athlete and in some cases, maintained with physical activity throughout adulthood could provide a protective effect against muscle loss and the resultant sarcopenia.

In contrast to the cardiovascular system, the musculoskeletal system seems to maintain a protective effect throughout an elite athlete's life. Bone mineral density and muscle mass in the former elite athlete tend to be greater than sedentary, age-matched controls regardless of current physical activity habits. Continued physical activity increases the protective effect, however, and can help to slow age-related decline in the BMD and muscle mass. Force output does decline with age, but is maintained at a higher level than controls if an athlete continues to lift weights. Additionally, the knee is impacted by pathology endured as an elite athlete at a greater magnitude than the hip.

IMPLICATIONS ON PHYSICAL THERAPY MANAGEMENT OF THE OLDER ADULT FORMER ELITE ATHLETE

The cardiovascular and musculoskeletal benefits of physical activity throughout an athlete's life are clear. Several studies discussed the differences between former athletes who remained active throughout their adult lives and former athletes who discontinued athletic activity upon retirement. While some studies indicate that the benefits of elite status persisted throughout life such as muscle mass and bone density, other studies indicated that only those athletes who continued to be active continued to use the benefits of their former competitive status.

One reason that athletes might stop exercising is due to a fear of exacerbating old injuries. However, sedentary behavior is far more dangerous than continuing to exercise on a body that has endured years of competitive sports.[3] Several adaptations can be made to exercise programs to incor-

porate low impact activities to decrease pain and improve function. Aquatic therapy and light resistance exercise can be a great alternative to heavy weight lifting and high impact running. The willingness to comply with a lifelong exercise program is thought to be even more important than the type of exercises performed.[6] Decreased aerobic capacity and decreased muscular strength are common complaints that eventually lead to disability. It is therefore important to address both of these issues with older adult patients regardless of the nature of their athletic background.

When treating the lifelong athlete, it is important to help them recognize the change in fiber type from fast to slow fibers which will eventually decrease force output. If an athlete is still participating in contact sports, more powerful younger athletes can increase the incidence of lengthening muscle contractions which increases susceptibility to injury.[7] Plyometric training has been recommended to incorporate lengthening contractions into their training programs to improve strength and power generation.[7] Proper education and injury screening is important to maximize the benefits of the exercise.

The former elite athlete who maintains a vigorous activity level can enjoy several protective effects of lifelong exercise. Education about proper technique and normal age-related decline is important so that the athlete knows what to expect with aging and how to best take care of his or her body. The former athlete can also mistakenly believe that their previous level of activity in young adulthood will protect them for the rest of their lives. It is imperative that the patient understands that they can only maintain those benefits through persistent physical activity throughout older adulthood. Physical therapy can be an important tool to help the former elite athlete to initiate and adhere to an aerobic and resistance exercise program that can ultimately improve their quality of life.

FUTURE RESEARCH

There are several areas of future research to be addressed. A longitudinal study of today's athlete would be beneficial to track the training program while participating in elite athletics and the transition out of elite training. The researchers would then be able to track the athlete's physical activity levels throughout each decade of life to determine whether or not their training plan has helped to protect against age related pathology. With the addition of Title IX in 1972 there was a large increase in the number of female athletic programs. The women who participated in sports during that time period are just recently entering older adulthood so there is only a limited amount of studies focused specifically on females as compared to the studies on former elite male athletes. Therefore, more research should be conducted on the former female elite athlete. Another interesting study would be to examine the effect of a career ending injury on physical activity. It could be hypothesized that a career ending injury would deter a former athlete from participating in further physical activity due to fear or permanent impairment. One final suggestion would be to compare the effect of elite competition 50 years ago to today's elite athlete. Athletic performance has consistently improved throughout the years producing bigger, faster, and stronger athletes and therefore creating even more injuries that might have long term implications on pathology as an older adult.

CONCLUSION

The depiction of an elite athlete embodies hard work, talent, and dedication to a sport. While those same qualities are still within the former elite athlete, the older adult must understand that though he or she was a competitive athlete during young adulthood, the maintenance of physical activity is still extremely important to achieving the health benefits of exercise. Competitive sports can be helpful in improving cardiovascular and musculoskeletal function, but the true benefits are achieved from being a lifelong athlete. Age-related decline in function may not be inevitable. The protective effects of vigorous physical activity throughout an athlete's entire life can help to reduce bone and muscle loss as well as maintain cardiovascular function. The improvement in function of all body systems is associated with a higher quality of life which can arguably be the most important component to successful aging.

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PRESCRIBING EFFECTIVE EXERCISE FOR BONE HEALTH

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INTRODUCTION

Osteoporosis affects 44 million Americans of which 10 million have been diagnosed with osteoporosis and 34 million have low bone mass (LBM) that puts them at risk for the disease. Of those diagnosed with osteoporosis, 80% are female and 20% are male.[1]

FRACTURES

Osteoporosis is responsible for more than 1.5 million fractures each year including approximately 300,000 hip fractures, 700,000 vertebral fractures, 250,000 wrist fractures, and over 300,000 fractures at other sites. Following hip and vertebral fractures, both morbidity and mortality are increased.[1] Vertebral fractures have many negative consequences including:

- Loss of height[2]
- Increased thoracic kyphosis which worsens over time[3]
- Breathing difficulties, abdominal pains, and digestive discomfort
- Decreased quality of life,[4] mobility, and energy[5]
- Pain and deterioration of physical function[6]
- Increased long-term morbidity and mortality[7]

Increased thoracic kyphosis is associated with significantly higher multisegmental spinal loads and greater trunk muscle forces in upright positions, which are likely to accelerate degenerative changes, dysfunction, and pain.[8]

In the year following a vertebral fracture, almost 20% of women will experience another vertebral fracture.[9] Unfortunately, many of these fractures may be asymptomatic. Of those vertebral fractures identified on X-ray, only 28% with a severe deformity and 14% with a milder deformity were actually reported by the participant.[10] A vertebral fracture causes a height loss of approximately 1 cm, therefore, the physical therapist should suspect fractures if there is ≥1½ inch height loss from the patient's/client's maximal recalled height.

In a prospective study of community-dwelling older women, followed for an average of 13.5 years, it was determined that in those women with vertebral fractures, the risk for death increased 1.5-fold with each standard deviation increase in kyphosis index measured by flexicurve.[11]

FALLS

More than one third of US adults ≥ 65 years fall each year[12] and > 90% of hip fractures in this population are caused by falls,[13] most often by a fall sideways onto the hip.[14]

Women with osteoporosis and thoracic hyperkyphosis have been shown to have reduced muscle strength, increased mediolateral body sway, increased gait unsteadiness, and an increased risk of falls.[15]

RETURN TO FUNCTION AFTER A FRACTURE

The data for return to function following an osteoporotic fracture are dismal. In women over 50 years old who suffer a hip fracture, 24% die in the year following their fracture, 20% of those who were ambulatory before their hip fracture require long-term care afterward, and at 6 months after a hip fracture, only 15% of patients can walk across a room unaided. Women with a hip fracture are at a 4-fold greater risk of a second hip fracture. Though men suffer fewer fractures, the 1-year mortality following hip fracture is nearly twice as high as the rate for women.[16]

Magaziner and colleagues compared community-dwelling older adults who suffered a hip fracture to those without fracture. They found increased disability in walking across a room (10 feet), transferring, and grooming, at 12 and 24 months following the fracture.[17] In the fracture group, at 24 months after the hip fracture, assistance was required by 90% to climb 5 stairs, by 83% to get in and out of a bath/shower, by 63% to get on/off of a toilet, by 54% to rise from an armless chair, and by 53% to walk 1 block.[18] Also notable was a greater decline in BMD in the contralateral hip following hip fracture compared to those without a fracture, with 12-fold and 5-fold decreases at the femoral neck and total hip, respectively during the 12-month postfracture period.[19] When considering optimal return to function, it is important to appreciate the environmental demands of community mobility in older adults. Shumway-Cook and associates determined that those without mobility impairments performed the following: drove themselves to errands, traveled unaccompanied, could walk 1000 feet per errand, were able to maintain walking speed of those around them, could carry packages weighing approximately 7 pounds, negotiated 2 flights of stairs, navigated around obstacles, walked on grass, changed directions and head orientation, reached in multiple directions, and avoided collisions with pedestrians.[20] In spite of the demands necessary to function well in the community, physical therapist interventions often come up short. In a survey of home care physical therapy following hip fracture, Mangione and colleagues found that most joint-specific therapeutic exercises involved only active range of motion with few using any resistance.[21]

The purpose of this article is to describe evidence-based exercise guidelines for those with low bone mass or osteoporosis to prevent fracture and to provide physical therapy intervention strategies to promote return to optimal function following a fracture.

INDIVIDUALIZING THE EXERCISE PRESCRIPTION

Physical therapists should perform a comprehensive examination using tests and measures with strong clinimetric properties to support rehabilitation for optimal function and fall prevention. Though a complete discussion is beyond the scope of this article, Table 1 presents a selection of tests and measures that could be used for the patient/client with LBM or osteoporosis.

FOCUS OF EXERCISE

Exercise prescription for those with LBM and osteoporosis should be individualized and may include several components with the ultimate goal of decreasing the risk of an osteoporotic fracture. A comprehensive program will include

Table 1. Tests and Measures for the Patient/Client with Low Bone Mass or Osteoporosis

Purpose of Test	Test	Comments
Detection of vertebral compression fractures	Height measurement	To assess maximum height standing and compare with the recalled maximal height of the patient/client. Test should be performed with a stadiometer, and if height has decreased by ≥ 1½ inch, an X-ray should be performed to confirm or rule out vertebral fracture(s).
	Rib-pelvis distance[22]	To detect occult lumbar vertebral fractures.
	Wall-occiput distance[23]	To detect occult thoracic vertebral fractures.
Posture	Flexicurve	To measure thoracic kyphosis non-invasively. An instructional DVD is available from APTA Section on Geriatrics at **www.geriatricspt.org**.
Balance	Berg Balance Score[24]	To assess activities to provide information about how the patient/client performs common tasks. Test can also expose impairments to guide interventions (i.e., poor mechanics while picking a slipper up from the floor may suggest decreased lower extremity strength or ROM). Helps to predict fall risk.
	Dynamic Gait Index[25]	To assess the likelihood of falling in aging adults and to assess gait characteristics.
	Four Square Step Test[26]	To assess rapid stepping movements in 4 directions and obstacle avoidance. Is a quick, easy test of fall risk with strong clinimetric properties.
	Activities-specific Balance Confidence Scale[27] and Falls Efficacy Scale[28]	To assess confidence or fear of falling: ABC for higher functioning aging adults and FES for frail elders.
Gait and locomotion	Gait Speed	To assess walking speed and mobility. Helps to predict functional decline and disability.
Lower extremity strength	Timed Chair Rise Test[29]	To assess strength, specifically of the quadriceps muscles.
	Heel Rise Test[30]	To measure functional strength of the gastroc-soleus muscle group.

exercises that improve bone strength, improve posture and body mechanics, and decrease the risk of falls. In those who have had a fracture, the goals are to promote return to optimal function and prevention of future fractures. Table 2 summarizes the components of the exercise prescription for those with osteoporosis.

Increasing and Maintaining Bone Density

Two forms of exercise have been shown to improve bone density and bone strength through the lifespan: weight bearing exercises and resistance training. Weight bearing exercises should be prescribed based on the individual's abilities and clinical condition. Jump-training programs have been shown to increase bone mass at the hip and spine in prepubescent children.[31] High-impact activities, with forces equal to running, have been shown to increase bone density at the lumbar spine and hip in premenopausal women.[32,33] Moderate intensity aerobics and high-impact aerobic and step-training (on a 20 cm high bench) exercises were effective in offsetting the decline in bone mineral density in postmenopausal women.[34] Moderate resistance training has been shown to reverse bone loss in postmenopausal women.[35] Resistance training must provide an overload stimulus to bones for positive results. Weight bearing and resistance training can increase bone density during childhood, adolescence, and early adulthood, whereas the expectation in postmenopausal females and older men is to stave off the natural decline in bone density.

Posture and Body Mechanics

Physical therapist interventions can alter thoracic kyphosis and postural deviations. Progressive resistive back-strengthening exercises performed in postmenopausal women resulted in increased back extensor muscle strength, increased BMD, and decreased incidence of future vertebral compression fractures.[36] A physical therapist-led multidimensional group exercise program in older women (mean age 72 years with an average thoracic kyphosis of 57°) resulted in improvements in posture (decrease in thoracic hyperkyphosis), spine extensor muscle strength, and physical performance. The program used high-intensity progressive resistive exercises, foam roller exercises, and stretch straps. It targeted: (1) the strength of the spinal extensor muscles; (2) the range of motion of the thoracic spine, shoulders, and hips; and (3) postural alignment.[37]

Physical therapist interventions should attempt to decrease kyphosis through exercises and postural training. A comprehensive physical therapy intervention for posture and body mechanics should focus on impairments related to poor posture and incorrect body mechanics including specific, targeted strengthening and stretching exercises, as well as skills-training practicing various tasks the patient/client performs during household, work, and leisure activities. Common exercise programs, such as yoga and Pilates, may need to be modified based on precautions and contraindications for those with osteoporosis as described below. Specific exercises may address key elements listed in Table 2.

Fall Prevention

Fall prevention programs must include a comprehensive examination and physical therapist prescribed interventions may focus on neuromuscular risk factors. These factors include impaired balance, decreased muscle strength, increased thoracic kyphosis, and reduced proprioception. A patient/client reporting a previous fall or presenting with impairments in transfers and mobility are at increased risk for subsequent falls.

Exercise interventions, when prescribed at an appropriate intensity to create challenge, have been shown to improve balance and decrease the risk of fractures. High-intensity strength training exercises have been shown to preserve bone density, improve muscle mass, strength, and balance in postmenopausal women.[38] Strength, balance, agility, and jump training improved bal-

Table 2. Focus of Exercise Prescription for Those with Osteoporosis

Focus of the Exercise Prescription	Key Elements
Increasing and maintaining bone density	• Weight bearing exercises • Resistance training • Must be of sufficient intensity, frequency, and duration to overload the bone for positive effects
Posture and body mechanics	• Strengthening of spine and hip extensors, spine and scapular stabilizers, abdominals (taking care not to increase thoracic kyphosis), and muscles of the upper and lower extremities • Stretching of the muscles, ligaments and joints of the cervical and thoracic spines, the anterior thorax and shoulder girdle, and the hips, knees, and ankles
Fall prevention	• Balance-challenging and agility activities again being sure the intensity, frequency, and duration is sufficient to overload the system • Lower extremity strength and power exercises with a focus on the musculature about the knee and ankle • Activities performed primarily in standing • Static and dynamic balance activities
Return to function after a fracture	• Appreciate the demands of community living and aim for optimal function • Consider extended outpatient rehabilitation to improve function • Focus on strengthening and fall prevention following hip fracture and targeted posture exercises following vertebral fracture

ance and prevented functional declines in home-dwelling elderly women.[39] Tai Chi has also been shown to be effective in increasing balance in the elderly.[40]

A program including calisthenics, balance training, muscle power training, and walking performed 3 times per week for 5 months improved flexibility, body balance, muscle power, and walking ability and reduced the incidence of falls in elderly participants compared to non-exercising controls.[41] Balance training in elderly women with osteoporosis that included dynamic and static positions performed for 1 hour, 1 time per week for a total of 40 classes guided by a physical therapist, along with a home program of the same exercises performed 3 times per week for 30 minutes, improved functional and static balance, mobility, and reduced falling frequency.[42]

Fall prevention requires multifactorial interventions, with exercise being the key component. An exercise program should be individually prescribed and should include the key elements provided in Table 2. Exercises and activities should be high-intensity with sufficient challenge to yield the desired outcomes.

Return to Function after a Fracture

Extended outpatient rehabilitation, including 6 months of intensive rehabilitation with whole-body progressive resistive training, improved physical function, mobility (strength, gait speed, balance), self-reported disability, and quality of life in frail, elderly community-dwelling patients following a hip fracture.[43] Physical therapist interventions following vertebral fractures should focus on postural correction and body mechanics training as described above. These interventions, which are aimed at return to optimal function after a fracture, should include the key elements described in Table 2.

PHYSICAL ACTIVITY AND EXERCISE PRECAUTIONS FOR THOSE WITH OSTEOPOROSIS

Physical therapists should be aware of Red Flags for suspicion of low bone mass or osteoporosis based on the alerts provided in Table 3.

Patients/clients with low bone mass and osteoporosis should be instructed in safe activities and exercise. These should be individualized based on the person's overall condition. Guidelines for safe activities include:

- Avoiding those activities that place high loads through the vertebral bodies, such as heavy overhead lifting or dropping hard to a chair and thus jarring the buttocks and spine when sitting
- Maintaining best, upright posture and optimal spine and extremity alignment
- Choosing appropriate modes for exercise (ie, machines, free weights, bands, body weight)
- Avoid spine flexion
- Avoid end-range loaded trunk rotations
- Avoid activities that increase risk of a fall

CONCLUSION

Physical therapists have the knowledge and expertise to prescribe safe and effective exercises for those with low bone mass or osteoporosis. A comprehensive examination (history, systems review, and tests and measures), evaluation, and development of plan of care should be performed to allow an individualized exercise prescription. The exercise program should address several areas that can decrease the chance of osteoporotic fracture. Table 4 provides a summary of exercise guidelines for those at risk of or diagnosed with osteoporosis. For those patients who have sustained a fracture, physical therapist interventions should include the goals of return to optimal function and reducing the risk of subsequent fracture.

Table 3. Red Flag Alerts for Low Bone Mass or Osteoporosis

Red Flag Alerts
• Results from a bone density test done with Dual X-ray Absorptiometry (DXA) that place a person in low bone mass range or osteoporotic range • Person has ≥1 ½ inch loss of height from maximal recalled height • Person's occiput is 7 cm or more from wall when standing with heels against wall and straightening up as much as possible • Person reports a history of fracture during adulthood that was associated with either low trauma (fall from standing height or less) or no trauma (raising a window) • Person has a family history of osteoporosis

Table 4.
Summary of Exercise Guidelines

Weight-bearing, impact exercises • Children and adolescents: 60 minutes of moderate to vigorous activity every day, including high-impact activities • Adults: 150 minutes of moderate activity per week or 75 minutes of vigorous activity per week; can benefit from high-impact activities, dependent on individual status. Also correct faulty posture and provide interventions for balance dysfunction
Resistance training for adults • 2-3 days per week; 1 set of 8-10 repetitions (is adequate as long as muscles are worked to fatigue during the 8-10 reps) of 8-12 exercíses including all major muscle groups; intensity to cause fatigue by 8-10 reps (15-20 reps if frail or increased fracture risk); with proper alignment and form; focus on lower extremity strength for balance and thoracic extensor strength to decrease fractures
Older adults • Follow adult guidelines, adapt as needed, and include fall prevention and balance training most days of the week

Adapted from HHS Guidelines 2008[44]

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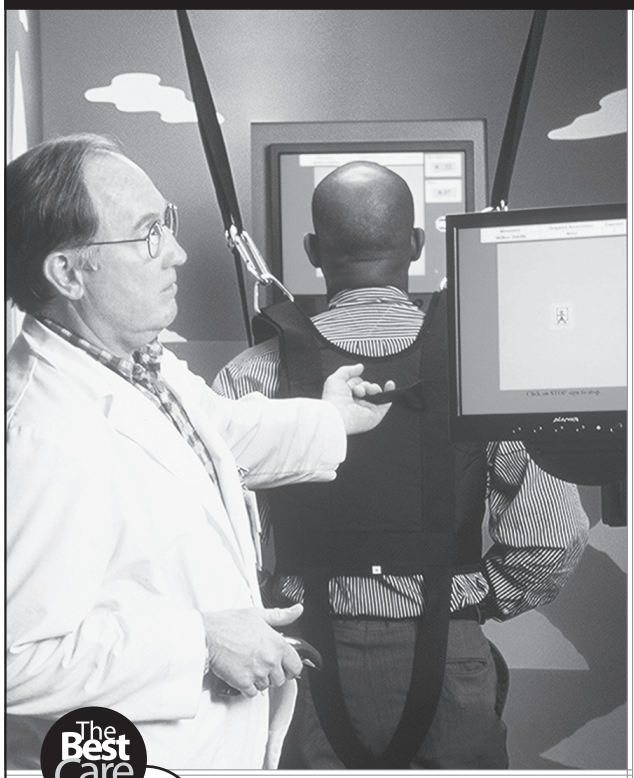

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MALNUTRITION: VITAMIN D DEFICIENCY

Rachel Schneider, SPT; William E. Healey, PT, EdD, GCS

INTRODUCTION

Malnutrition is increasingly being recognized as a major contributing factor to morbidity in elderly patients. Malnutrition is a deficient consumption of nutrients and/or calories.[1] There are a large variety of vitamin deficiencies found in older adults. One of the most commonly researched topics is calcium deficiency and osteoporosis. However, one area of rising research and a cause of great concern within the elderly population is Vitamin D deficiency. Research suggests that clinicians often under recognize and under treat vitamin D deficiency in older adults and therefore this must be explored independently. Daily vitamin D is often inadequate to meet the needs of almost half the general population, particularly those who live in the northern latitudes and especially in the winter.[2] This is especially true for older individuals who already tend to get less sun exposure and consume less food containing vitamin D.[2] For this reason, more studies are focusing on older adults to determine the many outcomes when Vitamin D deficiency is left untreated. In the health care field, blood levels are not routinely obtained even in the presence of clinical features suggesting vitamin deficiency. A review of the literature revealed that while some health care professionals recommend screening all elderly adults for vitamin D deficiency, others, noting the high prevalence, suggest skipping the screening and instead recommending supplementation since currently there is no toxicity at reasonable doses.[3-7] Although there is still no global screening protocol, health care professionals need to be able to recognize, treat, and educate their patients who may present with vitamin D deficiency.

VITAMIN D METABOLISM AND AGING

Vitamin D, in the presence of sunlight, is synthesized in the skin. Exposure to sunlight ideally has the ability to produce greater than 90% of the daily required intake. Another way of obtaining vitamin D is through fortified foods such as dairy products and fish oils. It is important to understand the physiology of vitamin D transport in order to understand the reasons behind this deficiency. Vitamin D is biologically inactive and therefore it needs to be metabolized by the body into more active forms. After being consumed or synthesized by the epidermis of the skin, the vitamin D is transported to the liver. In the liver, vitamin D is converted to 25-hydroxy-vitamin D which is the major circulating form of vitamin D.[2] In the kidney, vitamin D is further metabolized and converted to 1, 25 dihydroxyvitamin D, which produces the metabolically active and most potent form of vitamin D. Vitamin D then exerts its influence on distant target tissue throughout most of the body, mediated by vitamin D receptors. Therefore, it is justifiable to consider vitamin D more of a hormone than vitamin.[2] Once in the body, the metabolite binds to receptors in the intestine where it increases calcium re-absorption. With Vitamin D deficiency and decreased calcium absorption, PTH (parathyroid hormone) releases calcium from the bone resulting in bone loss. Other important receptors for vitamin D include the muscle and heart which will be discussed later.

With aging, there are changes that occur in the many systems of the body resulting in an increased prevalence of vitamin D deficiency. Older adults have reduced epidermal levels of the vitamin D precursor and therefore less efficient conversion of the precursor into vitamin D when exposed to sunlight. They also tend to have less sunlight exposure relative to other populations due to issues such as decreased mobility and dependence on others to leave their homes. Also, aging results in diminished kidney and liver function, decreased functioning cells, and increased disease prevalence, all of which can lead to diminished functioning of these systems, which are involved in maintaining vitamin D levels.[3] Along with kidney and liver changes with aging, the intestinal response also decreases due to a decline in vitamin D receptors in the small intestine resulting in overall decreased absorption of calcium and demineralization of the bone matrix.[3] Furthermore, other research identified that muscle tissue including the heart contains vitamin D receptors which are also declined in elderly and affect muscle contraction and adequate heart function.[6]

With both a decline of vitamin D synthesis in the skin as well as a decline in the body stores of vitamin D, the only other means of adequate intake is fortified foods, which oftentimes do not meet the needs and current recommendation of 1000 IU or more.[3] Determining a need for supplementation can improve the patient's health and quality of life. Therefore, recognizing the risk factors, symptoms, and signs of this deficiency is important. Research has noted that low vitamin D levels are associated with musculoskeletal pain, myopathy, muscle weakness, bone tenderness, fractures, gait abnormalities, falls, and decreased ability to perform ADLs.[3] In addition, the prevalence of vitamin D deficiency in patients with cardiovascular disease, diabetes, multiple sclerosis, and autoimmune diseases is higher than the general population.[3] These are other factors to consider when screening for this deficiency. It seems that physical therapy is one area of the health care field where there is a special opportunity to observe and recognize the many musculoskeletal and cardiovascular symptoms of vitamin D deficiency in a patient based on his/her interview, evaluation, and functional ability to perform tasks in the clinic setting. In addition, corrections of such deficiencies are especially likely to improve the outcome of any PT intervention. Therefore, it is important to review the muscular, bone, and cardiovascular changes with this deficiency that can be detected by physical therapists.

MUSCLE, BONE AND CARDIOVASCULAR CONCERNS

A strong musculoskeletal system is essential for positive functional outcomes in older adults both in their daily lives and in the physical therapy setting. Bone mass in old age is a function of

peak bone mass achieved during the mid 20s.[2] In women, bone mass declines when menopause begins and in males, there is a steady decline from age 50.[2] An insufficiency of vitamin D due to physiological changes will reduce the active transport of calcium across the intestine. As a result, there is decreasing circulating calcium for building bone mass, which is already declining in aging individuals. This loss in calcium promotes parathyroid hormone (PTH) secretion acting on the skeleton and other target tissues in order to mobilize calcium and normalize levels.[2] With the rise in PTH, there is a resulting promotion of bone loss and osteomalacia or softening of bone. This can result in an increased risk for fractures. Furthermore, vitamin D also binds to bone and affects the sensitivity to PTH. Thus, without sufficient vitamin D, there is a diminished appropriate response to PTH. While intermittent secretion of PTH actually strengthens the bones, a continuous secretion increases bone turnover and calcium loss.[3] It is clear that vitamin D deficiency causes a cascade of events leading to bone loss in the elderly population and can impede their ability to perform functional activities.

Aging is also associated with a loss in muscle mass. Each decade women lose .6 kg. of lean tissue and males lose about 1.6 kg.[5] A loss of muscle mass leads to reduced muscle strength and an increased risk of falling and oftentimes fractures due to the already weak bones. Muscle performance is influenced by vitamin D. This is mainly because there are receptors in muscle that allow for binding of vitamin D. This binding activates protein kinase C, which in turn increases calcium release.[4] With more calcium, there is greater ability to contract the muscle. Janssen and colleagues suggested that if this binding process is deficient, there is a resulting impairment of antigravity muscles of the lower limb needed for walking and balance, which could explain the correlation of decreased vitamin D levels to falling.[5] Also, vitamin D deficiency has been more specifically linked to proximal muscle groups.[5] Often patients complain of feelings of heaviness in legs, tiring easily, having difficulty rising from a chair, and difficulty ascending stairs. These are all complaints that should spark concern in a health care professional and should not be assumed as a typical aging process. Not only do vitamin D receptors in muscle tissue decline with age but type 2 fibers decline as well. These are the fast twitch fibers which are the fibers recruited first in order to avoid falls.[4] Without these fibers and declining number of receptors for vitamin D, injuries and hospitalization becomes increasingly common among older adults and performing physical tasks become harder. There is still no clear cut answer on the exact amount of supplementation needed for the elderly population. Yet, it is clear that reducing vitamin D deficiency can lead to greater functional outcomes in performing activities of daily living for today's elders.

Cardiovascular issues, such as congestive heart failure, heart attacks, and high blood pressure, are prevalent concerns of older individuals. Health care professionals need to understand the risks and symptoms of cardiovascular events. Along with exercise, hydration, and other factors, it is increasingly recognized that vitamin D deficiency is associated with decreased cardiovascular function. There are vitamin D receptors in myocardial tissue and vasculature.[6] The heart is actually dependent on the active form of Vitamin D – calcitriol which is circulating in the blood. This active form of vitamin D affects the growth, proliferation, and morphology of cardiomyocytes, which facilitate maintenance of the heart's structure and function.[6] In addition, vitamin D decreases atrial natriuretic peptide, a risk marker that is inversely related to cardiac function and that can contribute to congestive heart failure by its effects of salt retention in the kidney.[4] Without vitamin D, there will be vascular calcification leading to coronary heart disease resulting in an eventual heart attack or thrombosis. This can inevitably lead to death. Hypertension is another geriatric concern. It is possible that since vitamin D affects the heart and vasculature, this condition can be ameliorated by vitamin D supplementation.[7] There is still more research that needs to be done on the effects of vitamin D on the heart, especially blood pressure. However, with these recent findings, it is important to consider vitamin D deficiency as a contributor to heart conditions found in patients especially if other symptoms are present. Since any heart condition can deter a patient from progressing in rehabilitation, recognizing and attending to different heart and vascular problems is vital.

PHYSICAL THERAPY INTERVENTIONS

As a physical therapist, it is imperative to identify and understand the many significant changes that occur within the elderly population and how these many changes might impede rehabilitation and limit the functional outcomes of different individuals. As mentioned above, malnutrition including vitamin D deficiency is common in older adults and results from many physical and physiological factors that must be considered when treating these patients. Understanding the signs and symptoms of deficiency is the first step to helping a patient improve their quality of life. Recent research has discussed the importance of vitamin D on the musculoskeletal system. It has become clear that with adequate vitamin D, older individuals can improve muscle mass and bone mass, which in turn reduces falls and the risk for fractures. Noticing weakness, especially lower extremity proximal weakness, and muscle fatigue is essential to determine that the patient may have vitamin D deficiency and not just general weakness from aging. Without sufficient leg strength, there is a decline in balance and difficulty walking, ascending stairs, and carrying out simple daily tasks. These signs can be observed in the clinic with patients and should be addressed accordingly.

Assessing blood pressure and knowing the signs of coronary heart disease can help determine insufficient heart functioning that may be due to vitamin D deficiency and require further investigation. A thorough patient interview can provide a general idea of the patient's vitamin intake, food intake, history of fractures and recent falls, self-reported changes in muscle strength, and new pain symptoms. It would be important to include balance testing, manual muscle tests of specific proximal muscles, performance of functional tasks, palpation of bone and muscle to determine bruises or fractures that may be present, and blood pressure measurements during an evaluation, especially when vitamin D deficiency is suspected. If determined that there is a

deficiency, a referral back to the physician may be indicated. The patient may undergo a series of tests to determine the deficiency and if there is an issue within any particular structure of the body that may be causing this.

While the patient is receiving a sufficient amount of vitamin D, physical therapy can be helpful. Weight-bearing activities to increase bone mass, balance exercises, muscle strengthening, and education could be incorporated into the treatment for these individuals in addition to their referring therapy diagnosis. In general, it will be difficult for a patient to perform their exercise program if they are weak or ill from vitamin D deficiency. It is important to realize that performing poorly in physical therapy can be due to their deficiency rather than factors such as laziness or depression. Whether a patient presents with decreased strength or congestive heart failure, with sufficient vitamin D they can participate in rehabilitation and ultimately benefit more. Continuing to monitor changes after supplementation is also important and will help determine if this deficiency was in fact one of the causes of the issues noticed in the patient. Making it a priority to investigate this deficiency in a physical therapy setting can improve outcomes as well as help to eliminate a medical condition that requires basic recognition and supplemental treatment, especially in the elderly population.

AREAS TO EXPLORE

Future research is needed to further investigate many of the malnutrition concerns of older adults, including vitamin D deficiency. Future studies of older adults should continue to determine the importance for screening Vitamin D deficiency in this population at risk. It is also important to increase the awareness of the problem in order to establish screening regimens that can be used in the clinic setting, especially if suspected in an individual with risk factors. Furthermore, the adverse effects of vitamin D deficiency is relatively easy to prevent and can be corrected by inexpensive supplementation in combination with dietary changes. Yet, research still has not determined the proper dosage of supplementation in order to enhance vitamin D circulation. There also have not been enough comparisons between men and women and the gender differences that may occur, including the possible need for different amounts of supplementation. Lastly, it is important that research differentiates vitamin D deficiency from osteoporosis even though they frequently co-exist. This differentiation needs to be made because there are Vitamin D receptors in many different sites, which explains why vitamin D deficiency is associated with other disorders unrelated to bone including muscle. More studies with correlations between physical therapy outcomes and vitamin D deficiency would be helpful in further investigating the impact of this issue in the rehabilitation setting.

Vitamin D deficiency has a significant impact on the function of elderly individuals. With the many changes that occur with aging, it is important to carefully screen for vitamin D deficiencies and other malnutrition concerns. As health care professionals continue to gain more knowledge on the adverse effects of this deficiency, patients will benefit and improve their functional outcomes and overall quality of life.

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