Position Paper

Genetics Education for the Physical Therapy Profession

Allon Goldberg, PT, PhD

Background and Purpose. *Advances in our understanding of human genetics holds out the promise of significant diagnostic and therapeutic benefits in many fields of medicine. A number of basic questions and issues with respect to genetics and physical therapy practice and education need to be addressed. The purpose of this position paper is to highlight and explore some of those questions and issues, with the objective of advocating for increased education in relevant genetics-related topics and issues for both practicing physical therapists and students enrolled in physical therapist professional (entry-level) education programs.* ***Position and Rationale.*** *The position adopted in this paper is that increased education in relevant genetics-related topics and issues should be a priority for practicing physical therapists and students enrolled in physical therapist professional education programs. The rationale for this position is that in order to practice in the genomics era, health care clinicians should possess certain genetics-related competencies to more effectively manage and care for their patients. Some of the patient-related benefits that will result from an increased level of genetics education and awareness from within the physical therapy profession are the positive shaping of patients' attitudes towards genetic testing and counseling, the provision of accurate genetics information to patients, the generation of appropriate and timely referrals to genetics professionals, and effective advocacy on behalf of patients being discriminated against due to their genetic profiles.* ***Recommendations.*** *The implications of advances in genetics on physical therapist practice and education needs to be considered in a substantive manner. Academicians, clinicians, the American Physical Therapy Association (APTA), and the National Coalition for Health Professional Education in Genetics (NCHPEG) should initiate dialogue to decide on appropriate genetics competencies for the profession. Genetics education should be considered a priority in order for physical therapists to function as effective direct access practitioners and members of the health care team in the genomics era.*

Key Words: *Human Genome Project, Genetics education and physical therapy, Genetics Core Competencies.*

Allon Goldberg is a research fellow at the University of Michigan, Institute of Gerontology, 300 North Ingalls Bldg, 7B10-29, 0405, Ann Arbor, MI 48109-2007 (allong@umich.edu). Please address all correspondence to Allon Goldberg.

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INTRODUCTION

Unprecedented growth in our understanding of human genetics and its role in disease, coupled with recent technological advances such as the advent of powerful gene sequencing and gene mapping techniques, are expected to yield significant diagnostic and therapeutic benefits in many fields of medicine.[1-3] Because physical therapists are integral members of the health care team, physical therapist clinicians and educators alike need to consider the impact of genetics on contemporary clinical practice and education, both professional and beyond. In considering the implications of advances in human genetics on physical therapist practice and education, several basic questions need to be addressed. Should physical therapists in clinical practice concern themselves with a patient's genetic information? Are there minimum genetics competencies that clinicians should possess? Should physical therapists be educated in the ethical, legal, and social implications (ELSI) of genomics? In short, should issues relating to clinical genetics remain solely within the domain of the medical geneticist, genetic counselor, and nurse, or do they also need to be considered by physical therapists? The answers to these questions are important because they will ultimately determine the level of genetics education required by members of the physical therapy profession.

Leaders in the genetics community have questioned whether primary care physicians are prepared for the incorporation of genetics into mainstream medicine,[4] a question that could also be asked of physical therapists. The purpose of this position paper is to highlight and explore some of the questions and issues relating to genetics and physical therapy practice and education, with the objective of advocating for increased education in relevant genetics-related topics and issues for both practicing physical therapists and students enrolled in physical therapist professional education programs. The rationale for this position is that in order to practice in the genomics era, health care clinicians should possess certain genetics-related competencies to more effectively manage and care for their patients. The need for genetics education for health care professionals is a viewpoint that has been articulated by leaders within the field of genetics.[1,5-7] Not only physicians, but also nurses and other health care providers will need to become familiar with the emerging field of genetic medicine.[5-7] It is in this vein that this position paper articulates the need for the physical therapy profession to align itself with the medical community at large and seek relevant genetics education.

THE HUMAN GENOME PROJECT

The Human Genome Project (HGP) began in 1990 as a multicenter initiative with a number of important goals, such as the sequencing and mapping of the human genome by the year 2005. The first "working draft" sequences and analyses of the human genome were in fact published in 2001,[8,9] and on April 14, 2003, the International Human Genome Sequencing Consortium, led in the USA by the National Human Genome Research Institute (NHGRI) and the Department of Energy, announced the completion of the HGP more than 2 years ahead of schedule. The HGP holds much promise for many patients suffering from conditions having genetic components. One area of medical practice that will surely benefit from the project is oncology. Sequencing and mapping of genes and identification of mutations that predispose to tumor formation will facilitate screening and earlier detection, diagnosis, and treatment of malignancies. One such example is the mapping of a gene (*BRCA1*) influencing susceptibility to breast and ovarian cancer, to chromosome 17.[10,11] Conditions, diseases, and

pathologies such as aortic aneurysm,[12] osteoporosis,[13] Huntington disease,[14] obesity,[15] and numerous others, all have genetic underpinnings.

GENETICS EDUCATION

Nursing

Advances in our understanding of the relationship between human genetics and disease have prompted some health care professions, such as nursing, to recognize the importance of incorporating genetics into their clinical practice and educational programs.[16-24] Until recently, progress in this regard was slow, and successes in accomplishing these aims were limited. In the 1980s, nursing educational programs devoted little time to genetics education, and when it was provided, it was often part of a natural or basic science course.[25] Furthermore, for the years between 1983 and 1993, it is apparent that few nurses saw the utility of addressing the question of genetics, as only 22 nurses graduated from programs offering a "genetics option" or "subspecialty,"[26] and indeed, until relatively recently there were not many educational opportunities available to nurses in the field of genetics.[26,27] The situation changed in the 1990s: The rapid pace with which the HGP progressed in the latter part of the last decade and into the new century appears to have provided an impetus for the provision of more formal educational opportunities for nurses in human genetics, although the number of 1-2-day continuing education opportunities remains limited. There are currently a number of institutional-based genetics educational opportunities available to members of the nursing profession. For example, the Genetics Education Program for Nurses at Cincinnati Children's Hospital Medical Center offers genetics education opportunities and resources for nurse clinicians and faculty members (Genetics Program for Nursing Faculty)[28] alike. Some nursing schools currently offer subspecialties in clinical genetics (eg, Columbia University), master's degree programs in nursing genetics focusing on advanced practice nursing in the fields of cardiovascular, oncological, and gerontological genomics (eg, University of California, San Francisco), or individual courses in genetics within the professional curriculum. In addition, numerous genetics articles have appeared in nursing journals focusing on educating nurses on the role of the genetic counselor; on the ethical, legal, and social implications of practicing in a genomics era; on professional issues relating to their role in genetics nursing practice; and on the science and technology of genetics in clinical practice,[29-32] amongst others. These journal articles provide important ongoing educational materials for members of the nursing profession.

Medicine

The first formal genetics course offered as part of a medical school curriculum may have been taught as early as 1955.[33] A 1978 survey found that 72% of US medical schools provided a compulsory genetics course, but there was large variation in content and duration of such courses.[34] Recognizing that medical school curricula differ substantially, the Medical School Core Curriculum in Genetics was developed initially in 1995,[35] and subsequently revised in 2001. However, the extent to which these guidelines are followed is unknown. Innovative formats such as problem-based approaches supplemented by computer tutorials,[36] clinical genetics electives,[37] and clinical cases[38] have been used to teach medical genetics to medical students. The importance of genetics education for primary care providers has also been articulated.[39,40] The government-funded Genetics in Primary Care initiative[41] has the goal of enhancing the ability of primary care physician faculty in incorporating clinical application of genetic information into undergraduate and graduate primary care medical education. Continuing education courses and numerous journal articles are two of the avenues available to practicing physicians to improve genetics knowledge. For example, in 2002 and 2003, the *New England Journal of Medicine* published a series of genomic medicine review articles on topics such as genetic testing, pharmacogenomics, cardiovascular disease, breast and ovarian cancer, and the ethical, legal, and social implications of genetics,[42-46] among others. A particularly informative article is the primer on genomic medicine by the leaders of the NHGRI.[47]

Physical Therapy

Genetics education has traditionally not constituted a significant component, if any, of most professional physical therapy curricula in the USA. *A Normative Model of Physical Therapist Professional Education (Version 2004)*,[48] does however include references to genetics. An example of such a reference in the *Normative Model* is the following behavioral objective with respect to genetics and pharmacology: "List the factors that can alter normal pharmacokinetics (age, disease, drugs, genetics, nutrition, chemicals, body composition, and gender)." However, the small number of genetics references in the *Normative Model* and the exclusion of genetics from the basic foundational sciences listed in that document indicates that significant genetics content is not required in physical therapist professional education curricula. A recent survey of genetics knowledge of health professionals indicated that only 14% of physical therapist respondents reported taking one or more courses in genetics, while approximately 45% recalled having genetics content in a course.[49] Furthermore, in contrast to the nursing and medicine examples outlined, there is a paucity of information in the physical therapy professional literature related to genetics. A PubMed search using keyword "genetics" revealed eight articles in the journal *Physical Therapy*. However, only two of those are studies in genetics,[50,51] whereas another is a genetics review of a specific disease.[52] Using keywords "genetics AND physical therapy practice," or "genetics AND physical therapy education," revealed no articles in *Physical Therapy*. A special issue of the journal *Pediatric Physical Therapy* in 2001 was, however, devoted to the topic of genetics, and an article outlining aspects of the HGP and its physical therapy implications was published in a non–peer-reviewed physical therapy journal.[53] This situation may well reflect a lack of interest by physical therapists in the subject of genetics, as they presumably view such specialized knowledge as having little or no utility in clinical practice. Alternatively, the absence of genetics-related topics in the physical therapy professional literature might be due to the small number of relevant educational opportunities available to physical therapists in the area of genetics. Continuing education opportunities for physical therapists on the topic of genetics are generally limited to sessions or continuing education workshops at or preceding national meetings. These are few in number and clearly cannot meet all of the genetics educational needs of the majority of physical therapists in contemporary clinical practice.

THE CONTEMPORARY PHYSICAL THERAPIST MUST BE EDUCATED IN GENETICS

Although not explicitly stating that the American Physical Therapy Association (APTA) supports increased levels of genetics education for clinicians, by inference, the language of the 2001 APTA House of Delegates document entitled "Genetics Literacy for Physical Therapists" (HOD 06-01-28-27) indicates support for genetics education for physical therapists:

> *The American Physical Therapy Association supports the concept of genetics literacy and its importance and implications for patient/client management by physical therapists. This concept encompasses the emerging importance, benefits, and risks of genetic information and gene-based therapies, as well as the associated ethical, legal, psychological, and social implications.*

The viewpoint of APTA as articulated in HOD 06-01-28-27 aside, some of the clinical reasons why education of practicing physical therapists and

student physical therapists in relevant topics and issues in genetics should be a priority are outlined below.

1. Physical therapists in clinical practice are treating patients with disorders having genetic underpinnings. In a survey of genetics knowledge of health care professionals, physical therapists treating both adults and children estimated that 12% of their patients had a genetic disorder, while 26% of their patients had conditions that were both genetic and environmental in origin.[49] Furthermore, 68% of the physical therapist respondents in that study reported that they had discussed the genetic component of their patient's problems with the patient, while 18% reported providing counseling about genetic concerns to some of their clients. It is therefore troubling that the percentage of physical therapists that were confident in providing such services was only 11% of respondents, and that only 8% of all respondents (physical therapists and other health care professionals) had received genetics content from genetics professionals. Most respondents reported obtaining information about genetics from the media.[49] If physical therapists are to discuss genetics issues with patients or to involve themselves in issues related to genetics during the normal course of a patient's physical therapy treatment, it is imperative that they seek and receive appropriate education in genetics in order to provide accurate information to patients.

2. In some cases, physical therapists may be the first to suspect that a patient may have a condition requiring referral to a medical geneticist or genetic counselor. Referral to genetics professionals encompasses referral for genetic testing and counseling. Physical therapists can potentially positively shape attitudes of patients towards genetic testing and counseling. Physical therapists may need to inform patients about the benefits of genetic testing and counseling, and the implications that these have for patients and their families' health. The genetics referral role has traditionally been reserved for the medical practitioner or nurse, but increasingly, as the physical therapy profession evolves toward a direct access mode of practice, physical therapists may also have to assume this role. Indeed, the increased emphasis on autonomous practice in many states, together with the transition to professional and postprofessional doctoral education, should provide both the impetus and opportunity to educate students and clinicians in relevant aspects of genetics, such as when and how to refer to the genetics professional. Some 8–9% of clinicians had in fact made referrals for genetic counseling or testing.[49] Genetics education for the autonomously practicing physical therapist is essential in order to understand the roles of genetics specialists in the diagnosis and treatment of patients with genetic-related disorders, to be able to educate patients in the benefits of genetic testing and counseling, and to make timely and appropriate referrals.

3. The ethical, legal, and social implications of the HGP are likely to impact many, if not most, patients seen by physical therapists in practice, and all health care providers should be aware of their ramifications for patients. The ELSI program has focused on four priority areas: privacy and fairness in the use and interpretation of genetic information, clinical integration of new genetics technologies, ethical issues surrounding research, and public and professional education.[49] Indeed, the ELSI of the HGP and the new genetics technology may well be the single most important area of genetics in which physical therapists should become educated. APTA, through the voice of the House of Delegates, has clearly mandated that physical therapists should be knowledgeable not only in the importance, benefits, and risks of genetic information and gene-based therapies, but also in the associated ethical, legal, psychological, and social implications. The ethical, legal, psychological, and social issues that have arisen as a result of the "genomic revolution" have already been problematic to some health care consumers. Reports have revealed that people believe they are being discriminated against due to a genetic disorder. This discrimination has taken the form of refusal of life or health insurance and denial or dismissal from a job.[54] There are reports of patients being fearful of genetic testing due to possible discrimination and patients failing to report genetic information to insurers or employers.[54] Physical therapists need to be aware of and be able to recognize unethical and illegal treatment of patients due to genetic discrimination, as only then can they advocate for their fair treatment. Clinicians should also be aware of the social stigma attached to having a genetic disorder, and be able to counsel patients or refer them for counseling, as appropriate and needed.

WHAT GENETICS COMPETENCIES SHOULD PHYSICAL THERAPISTS POSSESS?

In order to practice in "the genomics era," it is becoming increasingly apparent that health clinicians should possess certain competencies in the field of genetics. To address the educational needs of all health care providers, the National Coalition for Health Professional Education in Genetics (NCHPEG) was established in 1996 by the American Medical Association, the American Nurses Association, and NHGRI, as a national effort to promote genetics education for health professionals, including access to information about advances in human genetics. Membership in NCHPEG is limited to organizations that maintain a national presence and represent health professionals, consumers, private industry, managed care, genetics professionals, and government. APTA as a member of NCHPEG is responsible for promoting policies, activities, and materials to improve genetics education and access to accurate information for physical therapists, and for increasing effective and responsible use of new genetic knowledge and technologies by clinicians. On February 14, 2000, NCHPEG endorsed a set of Core Competencies in Genetics Essential for All Health Care Professionals. According to NCHPEG, the impetus for developing genetics-related competencies was to integrate genetics knowledge, skills, and attitudes into health care so that providers could deliver patient care involving awareness of genetic issues and concerns. NCHPEG recommends that each health care professional should at a minimum be able to:

1. Appreciate limitations of his or her genetic expertise.
2. Understand the social and psychological implications of genetic services.
3. Know how and when to make a referral to a genetics professional.

The Core Competency and Curriculum Working Group of NCHPEG recommends that all health care professionals should possess the Core Competencies in genetics to enable them to integrate genetics effectively and responsibly into their current practice. The recommended competencies (knowledge, skills, and attitudes) are outlined in the table. Importantly, it is recognized that this list is challenging and extensive, but can be modified for a particular discipline.

HOW SHOULD CLINICIANS AND STUDENTS RECEIVE EDUCATION IN GENETICS?

If one agrees that physical therapists should be proficient in at least some of the Core Competencies outlined in the tables, it becomes necessary to consider a number of issues relating to delivery of this information. Which genetics competencies should be taught in physical therapist professional education programs? Who would teach the genetic-related information in professional programs, and are physical therapy faculty qualified to teach such material? Lack of nursing faculty education in genetics has been identified as a significant barrier to increasing genetics content in nursing curricula.[27] If professional programs are unable to teach the material, how will student physical therapists

Table

Core Competencies in Genetics Essential for All Health Care Professionals

Note: Throughout this document, the term "clients" includes individuals and their sociological and biological families.

KNOWLEDGE

All health professionals should understand:

1.1 Basic human genetics terminology.
1.2 The basic patterns of biological inheritance and variation, both within families and within populations.
1.3 How identification of disease-associated genetic variations facilitates development of prevention, diagnosis, and treatment options.
1.4 The importance of family history (minimum three generations) in assessing predisposition to disease.
1.5 The role of genetic factors in maintaining health and preventing disease.
1.6 The difference between clinical diagnosis of disease and identification of genetic predisposition to disease (genetic variation is not strictly correlated with disease manifestation).
1.7 The role of behavioral, social, and environmental factors (lifestyle, socioeconomic factors, pollutants, etc) to modify or influence genetics in the manifestation of disease.
1.8 The influence of ethnoculture and economics in the prevalence and diagnosis of genetic disease.
1.9 The influence of ethnicity, culture, related health beliefs, and economics in the clients' ability to use genetic information and services.
1.10 The potential physical and/or psychosocial benefits, limitations, and risks of genetic information for individuals, family members, and communities.
1.11 The range of genetic approaches to treatment of disease (prevention, pharmacogenomics/prescription of drugs to match individual genetic profiles, gene-based drugs, gene therapy).
1.12 The resources available to assist clients seeking genetic information or services, including the types of genetics professionals available and their diverse responsibilities.
1.13 The components of the genetic-counseling process and the indications for referral to genetic specialists.
1.14 The indications for genetic testing and/or gene-based interventions.
1.15 The ethical, legal, and social issues related to genetic testing and recording of genetic information (eg, privacy, the potential for genetic discrimination in health insurance and employment).
1.16 The history of misuse of human genetic information (eugenics).
1.17 One's own professional role in the referral to genetics services, or provision, follow-up, and quality review of genetic services.

SKILLS

All health professionals should be able to:

2.1 Gather genetic family-history information, including an appropriate multi-generational family history.
2.2 Identify clients who would benefit from genetic services.
2.3 Explain basic concepts of probability and disease susceptibility, and the influence of genetic factors in maintenance of health and development of disease.
2.4 Seek assistance from and refer to appropriate genetics experts and peer support resources.
2.5 Obtain credible, current information about genetics for self, clients, and colleagues.
2.6 Use effectively new information technologies to obtain current information about genetics.
2.7 Educate others about client-focused policy issues.
2.8 Participate in professional and public education about genetics.

Skills 2.9-2.17 delineate the components of the genetic-counseling process and are not expected of all health care professionals. However, health professionals should be able to facilitate the genetic-counseling process and prepare clients and families for what to expect, communicate relevant information to the genetics team, and follow up with the client after genetics services have been provided. For those health professionals who choose to provide genetic-counseling services to their clients, all components of the process, as delineated in 2.9-2.17, should be performed.

2.9 Educate clients about availability of genetic testing and/or treatment for conditions seen frequently in practice.
2.10 Provide appropriate information about the potential risks, benefits, and limitations of genetic testing.
2.11 Provide clients with an appropriate informed consent process to facilitate decision making related to genetic testing.
2.12 Provide, and encourage use of, culturally appropriate, user-friendly materials/media to convey information about genetic concepts.
2.13 Educate clients about the range of emotional effects they and/or family members may experience as a result of receiving genetic information.
2.14 Explain potential physical and psychosocial benefits and limitations of gene-based therapeutics for clients.
2.15 Discuss costs of genetic services, benefits, and potential risks of using health insurance for payment of genetic services, and potential risks of discrimination.
2.16 Safeguard privacy and confidentiality of genetic information of clients to the extent possible.
2.17 Inform clients of potential limitations to maintaining privacy and confidentiality of genetic information.

ATTITUDES

All health professionals should:

3.1 Recognize philosophical, theological, cultural, and ethical perspectives influencing use of genetic information and services.
3.2 Appreciate the sensitivity of genetic information and the need for privacy and confidentiality.
3.3 Recognize the importance of delivering genetic education and counseling fairly, accurately, and without coercion or personal bias.
3.4 Appreciate the importance of sensitivity in tailoring information and services to clients' culture, knowledge, and language level.
3.5 Seek coordination and collaboration with interdisciplinary team of health professionals.
3.6 Speak out on issues that undermine clients' rights to informed decision making and voluntary action.
3.7 Recognize the limitations of their own genetics expertise.
3.8 Demonstrate willingness to update genetics knowledge at frequent intervals.
3.9 Recognize when personal values and biases with regard to ethical, social, cultural, religious, and ethnic issues may affect or interfere with care provided to clients.
3.10 Support client-focused policies.

Source: The National Coalition for Health Professional Education in Genetics (NCHPEG), January 2001. Available online at http://www.nchpeg.org.

receive the required information? What is the role of basic scientists in teaching genetics to student physical therapists? How will physical therapists in the field be educated in genetics? These questions and others will need to be addressed by clinicians and academicians alike, in order for the profession to successfully integrate genetics into its educational programs.

Education of Practicing Physical Therapists

One avenue for educating clinicians may be to present the required genetics information at continuing education courses. In the survey of health care professionals' knowledge of genetics, 64% of physical therapists agreed that there was a need for continuing genetics education, and nearly 66% of all health care professionals said they would be interested in attending continuing education workshops at professional conferences.[49] In the case of the nursing profession however, besides taking a degree or certificate course in nursing genetics, there are still a limited number of short-term (1-2 days) continuing education courses designed to educate practicing nurses in the incorporation of genetic information into their clinical practices, a situation that is present in the physical therapy profession, as well. It has been proposed that lack of knowledgeable speakers and insufficient understanding of what is applicable are some of the reasons for few nursing genetics continuing education courses.[27] It will be necessary to identify a cadre of medical geneticists who recognize the benefits of educating non–genetics professionals, such as physical therapists, in elements of human genetics, and who are willing to conduct continuing education courses. Curricula for these 1-2-day courses would be designed by a core group of interested and knowledgeable physical therapist clinicians and faculty, in consultation with medical geneticists, and should be based on the Core Competencies outlined in the tables. Updates on genetics topics relevant to physical therapy practice should be published in physical therapy journals, because these would keep physical therapists abreast of the latest advances in the field. Seminars and presentations at national conferences would also be highly informative in this area. Other resources for genetics education for physical therapists entail less formal learning experiences, such as Web-based learning. There are many Web sites with excellent educational materials linked to them, such as those of the NHGRI (http://www.genome.gov/) and NCHPEG (http://www.nchpeg.org/). Readers should consult the article by Guttmacher for an excellent overview of human genetics on the World Wide Web.[55] Finally, a few clinicians may choose to improve their genetics knowledge by enrolling in degree programs or individual courses at universities.

Education of Student Physical Therapists

It will be challenging to incorporate genetics education into physical therapist professional education curricula. Nursing only encountered some success in this respect in recent years, despite having confronted the question of genetics education for at least 20 years. Success in incorporating appropriate genetics materials into physical therapist professional education curricula should come considerably quicker, however. This is so for several reasons. Due to the recent completion of the HGP, together with the media coverage afforded genetics in general, there is currently a much greater awareness of the importance and potential impact of genetics on our lives than there was even 10 years ago. This coupled with the almost daily progress being made in understanding genetics and its implications for health and disease, and the fact that the profession is currently moving to the doctoral level and direct access in all states, should hasten incorporation of appropriate genetics information into professional curricula.

Incorporation of genetics into professional physical therapist education curricula will need to encompass much more than a description of the genes and environmental conditions predisposing individuals to a particular disease. It may be that educators in physical therapist professional programs will choose to focus more on psychosocial aspects of human genetics and on professional issues such as those relating to referrals to genetics professionals than on the basic science aspect of genetics, although the latter will be important to address as well. Either way, the Core Competencies should provide the basis for genetics curriculum design. Whatever focus is chosen, it is this author's opinion that physical therapy faculty themselves should deliver as much of the genetics material as is possible, and that appropriate genetics education should be a part of the professional phase of the educational program. If physical therapy academicians are unable to teach components of the genetics curriculum, they, together with the input of basic science colleagues, should design courses containing the relevant materials and allow a basic scientist to deliver the basic science portions of the course. Physical therapy faculty, after a period of training and education, may become comfortable teaching other aspects of the genetics materials, such as the ELSI component. Timing of delivery of genetics materials is critical: the importance of relevant genetics education in the *professional* phase of the program cannot be overemphasized. Although basic genetics should be a prerequisite part of all preprofessional physical therapist education programs, it is only once students have progressed to the professional phase of their education and begun to interact with patients in clinical settings that they will be able to appreciate qualitative issues such as confidentiality and privacy of genetic information and the ethical, legal, and psychosocial aspects of genetics.

CONCLUSIONS AND RECOMMENDATIONS

The new genetic technology holds much promise for curing diseases that not long ago were thought to be incurable, and physical therapists as important providers in the contemporary health care arena must become knowledgeable in relevant aspects of genetic medicine. Genetics education for the contemporary physical therapist is important, because the autonomously practicing clinician could be the first health care professional to suspect a patient to be at risk for a treatable genetic disorder. As the profession transitions to the doctor of physical therapy degree and autonomous practice, it is incumbent upon clinicians to understand basic genetics terminology and possess relevant competencies, in order to communicate "genetically" with patients and their physicians and thereby to provide optimal care. Possession of relevant genetics-related competencies will have a positive impact on overall patient management and improve care: patients will receive accurate genetics information from physical therapists who discuss genetics issues with their patients, and referred to genetics professionals in a timely manner in order to receive appropriate care. Knowledgeable physical therapists can positively shape attitudes of patients towards genetic testing and counseling and provide highly effective advocacy on behalf of patients discriminated against due to their genetic profile. It is appropriate and expected that members of a doctoring profession fulfill these roles. The standing of the profession will consequently be enhanced in the eyes of health care professionals, patients, and the public alike, as confidence in clinical judgment skills will be increased.

The issues raised in this paper need to be addressed from two differing perspectives, as genetics education efforts will need to be implemented in professional programs and directed to the practicing physical therapist as well. If they are to be involved in the delivery of genetics materials in professional programs, physical therapy faculty will have to seek education in a field that is foreign to most current physical therapy educators. In addition, professional curricula will need revising in order to accommodate relevant genetics materials. The Core Competencies of NCHPEG should be used as the starting point for delivery of genetics materials in professional physical therapist education curricula. It is recommended that all students in physical therapist professional education programs

receive instruction in at least some of the Core Competencies. Representatives from the academic and clinical communities, as well as from APTA, should convene as a task force to begin dialogue to decide which genetics competencies should be taught in professional education programs.

The Core Competencies should also serve as the basis for designing continuing education learning experiences for practicing physical therapists. Interested parties within the profession should meet to decide which competencies are appropriate for clinicians. Creative strategies to integrate genetics into the education programs of clinicians will need to be implemented. Besides 1-2-day-long continuing education learning experiences, one envisages conference seminars and information in professional journals and appropriate genetics Web sites to be some of the avenues through which practicing physical therapists can improve their knowledge of genetics.

The physical therapy profession has not addressed the implications of advances in genetics on clinical practice and education in a substantive manner to date. To do this comprehensively, dialogue must occur not only within the profession as described above, but should also occur between the profession and external organizations. To this end, APTA, through its permanent liaison to NCHPEG, should initiate a formal process of consultation and dialogue between that organization and the physical therapy profession. Such consultation and dialogue will facilitate genetics education for the physical therapy profession, and should be considered a priority in order for physical therapists to function as effective direct access practitioners and members of the health care team in the genomics era.

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REFERENCES

1. Collins FS. Shattuck lecture—medical and societal consequences of the Human Genome Project. *N Engl J Med.* 1999;341:28–37.
2. Boskey AL. Musculoskeletal disorders and orthopedic conditions. *JAMA.* 2001;285:619–623.
3. Collins FS, McKusick VA. Implications of the Human Genome Project for medical science. *JAMA.* 2001;285:540–544.
4. Collins FS, Guttmacher AE. Genetics moves into the medical mainstream. *JAMA.* 2001;286:2322–2324.
5. Collins F. Preparing health professionals for the genetic revolution. *JAMA.* 1997;278:1285–1286.
6. Collins FS. Genetics: an explosion of knowledge is transforming clinical practice. *Geriatrics.* 1999;54:41–47.
7. Guttmacher AE, Jenkins J, Uhlmann WR. Genomic medicine: who will practice it? A call to open arms. *Am J Med Genet.* 2001;106:216–222.
8. International Human Genome Sequencing Consortium. Initial sequencing and analysis of the human genome. *Nature.* 2001;409:860–921.
9. Venter JC, Adams MD, Myers EW, et al. The sequence of the human genome. *Science.* 2001;291:1304–1351.
10. Neuhausen SL, Swensen J, Miki Y, et al. A P1-based physical map of the region from D17S776 to D17S78 containing the breast cancer susceptibility gene *BRCA1*. *Hum Mol Genet.* 1994;3:1919–1926.
11. Miki Y, Swensen J, Shattuck-Eidens D, et al. A strong candidate for the breast and ovarian cancer susceptibility gene *BRCA1*. *Science.* 1994;266:66–71.
12. Hasham SN, Guo DC, Milewicz DM. Genetic basis of thoracic aortic aneurysms and dissections. *Curr Opin Cardiol.* 2002;17:677–683.
13. Chen HY, Chen WC, Hsu CD, Tsai FJ, Tsai CH. Relation of vitamin D receptor FokI start codon polymorphism to bone mineral density and occurrence of osteoporosis in postmenopausal women in Taiwan. *Acta Obstet Gynecol Scand.* 2002;81:93–98.
14. Squitieri F, Gellera C, Cannella M, et al. Homozygosity for CAG mutation in Huntington disease is associated with a more severe clinical course. *Brain.* 2003;126:946–955.
15. Mykytyn K, Nishimura DY, Searby CC, et al. Identification of the gene (*BBS1*) most commonly involved in Bardet-Biedl syndrome, a complex human obesity syndrome. *Nat Genet.* 2002;31:435–438.
16. Williams JK. Genetics and cystic fibrosis: a focus on carrier testing. *Pediatr Nurs.* 1995;21:444–448.
17. Rieger PT, Tinley ST. Cancer genetics and nursing practice: what every gastroenterology nurse needs to know. *Gastroenterol Nurs.* 2000;23:28–39.
18. Jenkins JF, Dimond E, Steinberg S. Preparing for the future through genetics nursing education. *J Nurs Scholarsh.* 2001;33:191–195.
19. Jenkins JF, Prows C, Dimond E, Monsen R, Williams J. Recommendations for educating nurses in genetics. *J Prof Nurs.* 2001;17:283–290.
20. Lashley FR. Genetics and nursing: the interface in education, research, and practice. *Biol Res Nurs.* 2001;3:13–23.
21. Stolzfus PK, Rust D, Ried T. Molecular cytogenetics and gene analysis: implications for oncology nurses. *Clin J Oncol Nurs.* 2001;5:201–206.
22. Tinkle MB, Cheek DJ. Human genomics: challenges and opportunities. *J Obstet Gynecol Neonatal Nurs.* 2002;31:178–187.
23. Lea DH, Monsen RB. Preparing nurses for a 21st century role in genomics-based health care. *Nurs Educ Perspect.* 2003;24:75–80.
24. Burton H, Stewart A. From Mendel to the Human Genome Project: the implications for nurse education. *Nurse Educ Today.* 2003;23:380–385.
25. Monsen RB. Genetics in basic nursing program curricula: a national survey. *Maternal Child Nurs J.* 1984;13:177–185.
26. Anderson GW. The evolution and status of genetics education in nursing in the United States 1983-1995. *Image J Nurs Sch.* 1996;28:101–106.
27. Jenkins JF. An historical perspective on genetic care. *Online J Issues Nurs.* 2000;5:1.
28. Prows CA, Hetteberg C, Johnson N, et al. Outcomes of a genetics education program for nursing faculty. *Nurs Educ Perspect.* 2003;24:81–85.
29. Dailey JV, Pagnotto MA, Fontana-Bitton S, Brewster SJ. Role of the genetic counselor: an overview. *J Perinat Neonatal Nurs.* 1995;9:32–44.
30. Williams JK, Lea DH. Applying new genetic technologies: assessment and ethical considerations. *Nurse Pract.* 1995;20:6,21–26.
31. Giarelli E, Jacobs LA. Issues related to the

use of genetic material and information. *Oncol Nurs Forum.* 2000;27:459–467.

32. Loud JT, Peters JA, Fraser M, Jenkins J. Applications of advances in molecular biology and genomics to clinical cancer care. *Cancer Nurs.* 2002;25:110–122.

33. Waelsch SG, Nitowsky H. The genesis of teaching human genetics at medical schools. *Am J Hum Genet.* 1990;46:1222.

34. Childs B, Huether CA, Murphy EA. Human genetics teaching in U.S. medical schools. *Am J Hum Genet.* 1981;33:1–10.

35. ASHG (American Society of Human Genetics) Information and Education Committee. Report from the ASHG Information and Education Committee: medical school core curriculum in genetics. *Am J Hum Genet.* 1995;56:535–537.

36. Moore CM, Barnett DR. A problem-based learning approach to teaching medical genetics. *Am J Hum Genet.* 1992;51:930–935.

37. Bodurtha J, Spence JE, Stevens CA. Innovations in human genetics education. Medical student elective in clinical genetics. *Am J Hum Genet.* 1991;49:494–496.

38. Magee J, Gordon JI, Whelan A. Bringing the human genome and the revolution in bioinformatics to the medical school classroom: a case report from Washington University School of Medicine. *Acad Med.* 2001;76:852–855.

39. Greendale K, Pyeritz RE. Empowering primary care health professionals in medical genetics: how soon? how fast? how far? *Am J Med Genet.* 2001;106:223–232.

40. Burke W, Emery J. Genetics education for primary-care providers. *Nat Rev Genet.* 2002;3:561–566.

41. Burke W, Acheson L, Botkin J, et al. Genetics in primary care: a USA faculty development initiative. *Community Genet.* 2002;5:138–146.

42. Burke W. Genetic testing. *N Engl J Med.* 2002;347:1867–1875.

43. Evans WE, McLeod HL. Pharmacogenomics-drug disposition, drug targets, and side effects. *N Engl J Med.* 2003;348:538–549.

44. Nabel EG. Cardiovascular disease. *N Engl J Med.* 2003;349:60–72.

45. Wooster R, Weber BL. Breast and ovarian cancer. *N Engl J Med.* 2003;348:2339–2347.

46. Clayton EW. Ethical, legal, and social implications of genomic medicine. *N Engl J Med.* 2003;349:562–569.

47. Guttmacher AE, Collins FS. Genomic medicine—a primer. *N Engl J Med.* 2002;347:1512–1520.

48. *A Normative Model of Physical Therapist Professional Education (Version 2004)*. Alexandria, Va: American Physical Therapy Association; 2004.

49. Long TM, Brady R, Lapham EV. A survey of genetics knowledge of health professionals: implications for physical therapists. *Ped Phys Ther.* 2001;13:156–163.

50. Gibbons LE, Videman T, Battie MC, Kaprio J. Determinants of paraspinal muscle cross-sectional area in male monozygotic twins. *Phys Ther.* 1998;78:602–610.

51. Ropponen A, Levalahti E, Videman T, Kaprio J, Battie MC. The role of genetics and environment in lifting force and isometric trunk extensor endurance. *Phys Ther.* 2004;84:608–621.

52. Jones SH. Pulmonary emphysema and alpha1-antitrypsin deficiency. *Phys Ther.* 1974;54:579–583.

53. Lapham EV, Long T, Kozma C. New genetics: the Human Genome Project. *PT—Magazine of Physical Therapy.* 1999;7:78–83.

54. Lapham EV, Kozma C, Weiss JO. Genetic discrimination: perspectives of consumers. *Science.* 1996;274:621–624.

55. Guttmacher AE. Human genetics on the web. *Ann Rev Genomics Hum Genet.* 2001;2:213–233.