Cancer Education and Cancer Prevention Education for K-12 Students and Teachers

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Abstract—*Background.* A health science educational outreach program which began in 1991 and targets K-12 teachers and students has had 15,911 participants consume 60,069 hours of education as of the end of December 2003. The program is called the "Partners in Health Sciences" (PIHS) program. Many educational activities in the PIHS program contain information on both cancer biology and cancer prevention. *Methods.* All of the cancer-related education offered and consumed in the history of the PIHS program was identified and quantified. *Results.* In the PIHS program 984 K-12 teachers and 2376 grade 7-12 students consumed 4477 and 3029 hours of cancer-related education, respectively. *Conclusions* Cancer education encompasses much more than cancer prevention education and includes different aspects of cancer biology from the cell to the organism levels of biological organization. Selected topics in cancer biology can be used to motivate K-12 teachers and students to learn more about basic normal biology while simultaneously learning about cancer. In addition, the psychosocial impact of cancer on the individual, the family, and the community can be used to foster K-12 student interest in studying behavioral science. ***J Cancer Educ.*** 2004; 19:105-110.

Cancer education usually targets (1) health professionals and, at the other end of the spectrum, (2) the lay public, including cancer patients, survivors and their family members. Much of this "cancer education" is "cancer prevention education,"[1,2] that is, information on cancer screening, early diagnosis, smoking cessation, cancer-decreasing lifestyles, and so on. There are other important target groups and types of cancer education, for example, K-12 children and their teachers and cancer biology. Cancer prevention education for the K-12 student can affect lifestyle path decisions, whereas studying cancer biology provides an opportunity for students to compare and contrast normal biology with cancer biology and learn about both. This article describes a K-12 health science outreach program available free to all teachers and students in public and private schools in the state of Arkansas. The program is called "Partners in Health Sciences" (PIHS) and contains a significant amount of training in cancer biology and cancer prevention education.

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The University of Arkansas for Medical Sciences (UAMS) began a statewide, educational outreach program to K-12 teachers and their students in the health sciences in 1991.[3] The PIHS program has 7 different components. The 2 largest are (1) a series of 1-, 2-, and 3-day professional development workshops/mini courses for teachers held during the summer; and (2) a series of weekly 1.5 hour, live telecommunication or interactive television (ITV) broadcasts involving grade 7-12 students at distant sites throughout this rural state and UAMS faculty. On occasion the ITV outreach included students in California, Florida, Louisiana, Montana, New York, and West Virginia, and on one occasion, Kaoshiung, Taiwan.[3]

In the summer workshops, each teacher receives a "tool kit" which contains materials and content appropriate for replicating the same learning experience in the K-12 school classroom. Tool kits usually include a profusely illustrated course syllabus containing text and 8 × 10 laminated photographs/illustrations as well as, when appropriate, videotapes, CDs, books, microscope slides, literature from community-based health organizations, and so on. For the ITV broadcasts the teachers "field trip" their students to the ITV site nearest their school (approximately 40 active ITV sites throughout the state). The teachers participating in the ITV outreach are usually alumni of the summer workshops. Each of the teachers participating in an ITV session receives a videotape of that session which becomes a type of enduring educational material at that school.

Since summer 1991 to December 2003, a total of 1424 different K-12 teachers have consumed 38,117 hours of training in 99 different health science topics taught by 182 different UAMS faculty in 209 workshop days. Since 1994,

when the ITV outreach component of the PIHS program began, 9358 grade 7-12 students have consumed 14,037 hours of education in 39 different topics taught by 33 different UAMS faculty.

MATERIALS AND METHODS

This paper reports on all cancer-related education activities that have occurred in (1) the PIHS summer workshops for teachers, and (2) the ITV sessions for grade 7-12 students from 1991 through December 2003. Some workshops and ITV sessions specifically targeted a cancer topic for 100% of the training. Other topics contained cancer education content as a component of a non-cancer-related topic. In both situations the cancer content was identified and the total hours of "cancer training" consumed by participants was calculated. An example of cancer education included as part of a noncancer topic would be the workshop on "Chronobiology." In this workshop on the biological clock, 2 hours of the 7 total hours of training were focused on the topic of "biological rhythms, the cell cycle, and the chronochemotherapy of cancer: a time to treat—a time to cure." Another example would be the "Anatomy and Pathology of the Breast" workshop which began with the normal gross anatomy, histology, and embryology of the breast and included changes associated with puberty, the menstrual cycle, pregnancy, lactation, and menopause. Then a pathologist presented an overview of the benign and malignant diseases of the breast with a focus on the most common type of breast cancer. The day ended with a clinical presentation on breast cancer. In this workshop 70% of the course focused on some aspect of cancer. In the workshop on the "Integument" there was a 2-hour clinical section presented by a dermatologist which covered the dangers of unprotected sun exposure and self-screening for basal and squamous cell carcinomas and malignant melanoma. In this workshop 30% of the training was cancer related. Examples of training events, which were 100% cancer content, would be the workshops entitled "Cancer" and "A Day at the Arkansas Cancer Research Center." A preliminary report of this article has been presented.[4]

RESULTS

A large amount of the training/education offered to teachers and students in the PIHS program has focused on various aspects of cancer biology as well as on cancer prevention education. In the PIHS program 984 teachers have consumed 6888 hours of professional development training in workshops which contained cancer information totally or in part (Table 1). For all of the hours of continuing education consumed (6888 hours) by the participating teachers in the mini courses listed in Table 1, we calculated that 65% (or 4477 hours) were specifically related to cancer.

The impact of the summer workshop training for teachers for themselves, their colleagues, and their students was evaluated using a questionnaire format.[3] The results indicated that much of the information learned in the program was beneficial to the participating teacher, colleagues, and students (Table 2).

TABLE 1. Cancer Education Content Contained in 1-Day Workshops in the University of Arkansas for Medical Sciences Partners in Health Sciences Program for K-12 Teachers

A Day at the Arkansas Cancer Research Center
A Day at the Cancer Education Center
Anatomy and Pathology of the Breast
Bone Marrow Transplantation
Breast Cancer
Cancer
Cancer: Basic Biology to Prevention and Screening
Cancer Therapy: Use of Biological Time (Chronotherapy) Improves Results
Cell Division and Cancer Chemotherapy
Chronobiology
Integument
Lifestyle: Role in Health Promotion and Disease Prevention
Medical Genetics
Radiation Biology
Respiratory Anatomy and Physiology
Role of Diet in the Prevention of Cancer and Other Diseases
The ABCs of Breast Health
Tobacco in Modern Society
Women's Health Issues

Total number of participants	984
Total continuing education hours consumed	6888
Estimated number of hours of cancer education	4477

A total of 2376 grade 7-12 students have consumed 3564 hours of education in a variety of cancer-related topics in the ITV outreach component of the PIHS program (Table 3). We calculated that 85% (or 3029 hours) were cancer education hours.

DISCUSSION

Most cancer education at the K-16 level is more accurately described as cancer prevention education[1] and is focused on several main areas: tobacco use,[5,6] diet,[7,8] and sun exposure[9-13] separately or in combination.[14-16] Other areas of cancer prevention education for the K-16 student include testicular[17,18] and breast self-examination.[19] In general this type of cancer prevention education is effective as demonstrated by pretest and posttest measures. Community organizations play an important role in providing teaching materials and/or training for these activities.[16,20]

Although about 90% of the states in the United States require some health education for students, the preservice training of K-12 teachers to provide high-quality health education in schools is lacking on a national scale.[21] The same is true for preservice training of teachers in science.[3] Therefore, in-service training of teachers is necessary to fill these gaps and provide classroom teachers with the content and the confidence

TABLE 2. Evaluation/Outcomes for Teachers Attending Summer Workshops

"In regard to your personal professional development was your PIHS [Partners in Health Sciences] training a positive experience for you?"	99% yes
"In your opinion was this training experience valuable, through you, for any of your colleagues?"	97% yes
"Was this training experience valuable, through you, for your students?"	94% yes
"Did you share some of the information you learned in the course(s) and/or the course syllabus with your colleagues?"	93% yes
"Did you share some of the information you learned in the course(s) and/or the course syllabus with your students?"	83% yes
"Did you use any of the supplies or materials such as color laminated photos, videotapes, reprints, texts, charts, etc. with your students?"	76% yes
"Did you perform any new laboratory-type exercises or demonstrations with your students as a result of this training?"	54% yes

From Table 7 in ER Burns, "Anatomy of a Successful K-12 Educational Outreach Program in the Health Sciences: Eleven Years Experience at One Medical Sciences Campus," *The Anatomical Record* (*New Anat.*), 2002;269:181-193, with permission from Wiley-Liss, Inc.

to offer high-quality health and health science education to their students. This is the fundamental purpose of the professional development workshops in the PIHS program.

Some of the training related to cancer in the PIHS program is cancer prevention education. This content is designed to empower teachers to more effectively communicate to their students that cancer prevention lifestyles should and can be selected at an early age. In addition to cancer prevention education, the PIHS program includes the use of many examples of cancer biology to enhance the teaching and learning of biological concepts by teachers and their students. This is accomplished by demonstrating to them the interrelated importance of both (cancer cell biology and normal cell biology). Teacher-alumni of the PIHS program have informed us that students are much more interested in learning content when a disease process is involved. Some teachers refer to these as "interest hooks." Student interest in learning about a topic in biology is "enhanced" when the student realizes he or she also will be learning about a disease arising from an abnormality of normal biology. In other words, students are more motivated to learn when the topic is (1) "Hypertension" instead of "Cardiovascular Physiology," (2) "Glaucoma" instead of "Anatomy and Physiology of the Eye," (3) "Muscular Dystrophy" instead of "Anatomy and Physiology of Muscle," (4) "Chemotherapy" instead of the "Cell Cycle and Cell Division," and so on. In this way the teacher-alumni and the faculty of the PIHS program have identified some aspects of cancer biology that have served as good "hooks" for student learning about aspects of normal biology.

Cancer education is more than cancer prevention education. The definition of cancer education should include the use of specific aspects of cancer biology to enhance K-12 teacher and student interest in learning about normal and abnormal biology with each fostering the learning of the other. This concept has been recognized at the grade 13-16 level where courses and/or segments of courses dealing with various aspects of cancer as it relates to normal biology have been taught. At one point in time it was reported that there were 30 undergraduate level courses dealing with cancer in the United States.[22] A recent Internet search identified some institutions where courses for undergraduate college students present some aspect of cancer: Rosewell Memorial Park, St. Jude's Children's Hospital, Baylor University, University of Houston, University of Louisville, Ball State University, Albany University-State University of New York, Manhattanville College, University of Michigan, Long Island University, University of New Hampshire, Ohio State University, and the University of California at Davis. The most common course title was "Biology of Cancer" or "Cancer Biology." An analysis of the table of contents of the course syllabi we collected indicated that certain aspects of cancer biology are utilized in the teaching of other science content, for example, "DNA Double Helix and the Chemistry of Cancer" (Albany University), "Biochemistry of Cancer" (University of New Hampshire), "Science of Contemporary Issues" (University of Denver), "Molecular Cell Biology" (Texas A&M University), "Behavioral Medicine" (Baylor University), and "Cell Biology/Cell Biochemistry" (University of Houston).

TABLE 3. Live, Interactive Telecommunication Sessions (1.5 Hours) on Cancer and Cancer-Related Topics Involving Grade 7-12 Students

A Day in the Life of a Genetic Counselor	
Anatomy and Pathology of the Skin	
Cancer	
Cancer Biology	
Chemistry of Some Anticancer Drugs	
Clinical Chemotherapy of Cancer	
Genes and Cancer	
Inside the Dark Side of the Tobacco Industry	
Medical Biology of Skin	
Testing Anticancer Drugs in Vitro	
The Behavior of Cancer Cells—Can It Be Changed?	
The Effects of Tobacco on the Structures of the Head and Neck—A Live Demonstration	
Tumors of the Reproductive Organs: Male Compared to Female	
Uncle Joe Wants You: The Tobacco Industry and Teens	
What Students Need to Know About the Role of Diet in the Prevention of Diabetes, Cardiovascular Disease, and Certain Types of Cancer	
Total number of students	2376
Total continuing education hours consumed	3564
Estimated number of hours of cancer education	3029

Learning about cancer can be so interesting and motivational for some students that they actually change their career path selection. In a study of 105 respondents out of 235 professional school students (medicine, nursing, pharmacy, and public health) who had participated in a summer cancer education program, Huth[23] reported the following overall positive effects on a career choice toward a cancer-related field: 56 = no change, 26 = reinforced, 20 = influenced toward, and 3 = influenced away. In other words, 20 of the students participating in the training changed their career-path thinking toward a cancer-related career as a direct result of learning about cancer.

Feedback from teacher-alumni of the PIHS program has identified educationally useful "hooks" to be the inclusion of some cancer cell biology information to enhance student interest in the study of normal cell division. All students learn about cell division or mitosis in biology classes in the K-12 arena. Students in the earlier grades learn the simple concept of one cell dividing into two daughter cells as an example of how animals, plant, and they themselves grow. By the time the students graduate from high school they should have learned not only the stages of the mitotic process (prophase, metaphase, anaphase, and telophase) but also that the mitotic process is a component of a much larger biological process referred to as the cell cycle, with its important S phase where the cell duplicates the chemical amount of DNA before eventually dividing that amount equally between the two daughter cells. Apparently students learn the steps in the cell cycle and the stages of the mitotic event without ever realizing or appreciating that these processes play an important role in cancer biology, diagnosis, and treatment. What follows are a few examples of how we have learned to connect some cancer cell biology with normal cell biology for grade 7-12 students and their teachers.

Teachers participating in the PIHS "Cancer" and "Cell Division and Cancer Chemotherapy" workshops first review the mitotic process using microscopes and examples of rapidly dividing biological material with which they are familiar, that is, the onion root tip and/or the whitefish embryo. Next, the teachers are introduced to the concept of the mitotic index (MI) or the number of mitotic figures/1000 cells examined. It becomes obvious that one cannot perform an MI study if one cannot recognize the various stages of the mitotic process, that is, the ability to recognize that a mitotic figure plays a fundamental role in determining the MI.

The learning session then moves to the concept of how pathologists use the MI to help them determine if a neoplasm is benign or malignant, with the MI being higher in the malignant neoplasm. Teachers then study microscope slides and/or photomicrographs (also given to them as part of their take-home tool kit) of two neoplasms, one benign and one malignant. They are asked to decide which neoplasm is benign and which is malignant on the basis of the MI only. The teachers have no trouble correctly identifying the malignant neoplasm because they can see many mitotic figures in it, that is, a high MI.

Using the same biological examples (one benign and one malignant neoplasm) the teachers are then asked to study the structure of the mitotic figures in both samples. They soon realize that in the benign neoplasm the few mitotic figures that are there are recognizably normal, but in the malignant neoplasm many of the mitotic figures have "something wrong with them," that is, obvious structural abnormalities such as a tripolar mitotic figure. The participants are then given a few pages from a pathology text in which the author discusses the use of the MI and the degree of normalcy or abnormalcy of the individual mitotic figures as some of the factors which play a role in reaching the decision "benign" or "malignant." After this exercise the usual response from the teachers is that this medically important information will make it easier to impress upon their students why they need to learn how to recognize mitotic figures and distinguish those that are normal from those that are abnormal.

Using different examples of benign and malignant neoplasms the teachers are asked to identify "benign" or "malignant" on the basis of the hyperchromaticity of the interphase nuclei. Once the teachers understand that malignant cells are commonly aneuploid, due to cell cycle and/or mitotic "mistakes," they accurately identify the malignant neoplasm on the basis of the excessive amounts of chromaticity seen in the interphase nuclei. The teachers are then asked to look for normal versus hypertrophied nucleoli in the interphase nuclei in both specimens. Although most of the teachers already know that the nucleolus is the site for the synthesis of ribosomal RNA, they have never made the connection between the excessive need for cytoplasmic ribosomes in the malignant cell and the consequently hypertrophied nucleoli in rapidly growing neoplastic cells.

The learning session then moves on to a review of the normal steps and the major biological events associated with each of the remaining major phases of the cell cycle: G1, S, and G2. The K-12 teacher or student only needs to understand that in G1 the cell prepares for the impending S phase, in the S phase DNA synthesis occurs, and in G2 the cell prepares for the impending mitotic event. Most of the teachers are familiar with this biological process; however, they usually have not made the connection between this normal biology and the basis for the use of cell cycle phase specific drugs in chemotherapy regimens. To connect the basic biology of the cell cycle with the chemotherapy of cancer the teachers are given the names and principle actions of several anticancer drugs which are "cell cycle phase specific." For example, they are told that cytosine arabinoside specifically targets the DNA synthetic event, vincristine specifically targets the production of microtubules during G2 preventing anaphase movement of the chromosomes, and hydroxyurea prevents movement from G1 into S.

The teachers are then asked to use this new knowledge of cell cycle phase specific drugs to design a one-time chemotherapy treatment for a patient with a rapidly growing leukemia—the goal being to kill as many of the rapidly dividing leukemia cells as possible with one treatment. At this point in the lesson the teachers are broken into small groups

("think tanks") and are asked to discuss the problem and design a therapeutic plan. Most of the teachers eventually realize that at any one point in time there will be malignant cells in each of the 4 phases of the cell cycle: M, G1, S, and G2. Therefore, to cause a maximal tumor cell kill with only a single therapeutic treatment, they should use a cocktail of different cell cycle phase specific drugs, each acting in a different phase of the cell cycle, instead of all drugs targeting the same biochemical event occurring in one phase of the cell cycle.

The session ends with a discussion of why cancer chemotherapy patients suffer major toxicity in the skin, gastrointestinal tract, blood, and bone marrow and, in males, the testis. The general concept of cell turnover as a tissue continues to maintain its integrity is presented, that is, those cells that are naturally lost must be replaced by cell cycle activity in certain subpopulations of cells in that tissue. Participants then are given specific examples. Cells lost by normal desquamation from an epithelial surface need to be replaced, as in the skin (including hair growth) and the lining of the GI tract. The same concept applies to the natural loss by cellular aging and death of leukocytes, red blood cells, and platelets from peripheral blood, and the need to replace what has been lost by cell division and differentiation in the bone marrow. Most participants are very interested to learn that because of the natural lifespan of the average red blood cell, the process of erythropoiesis in the bone marrow produces 2.4 million new red blood cells per second. The teachers are reminded of a similar fact regarding sperm production; that is, millions of sperm are produced daily by spermatogenesis, which includes cell cycle activity in the spermatogonia followed by the meiotic process from primary spermatocyte to mature sperm. Participants also learn that in many instances the cell cycle activity in these normal tissues is greater than what has been recorded in some neoplasms.

When the participants realize the tremendous amount of cell cycle activity, especially the processes of DNA synthesis and mitosis, which is required to maintain the normal status relative to the tremendous normal loss of cells, they acquire an understanding of the basis for general organ (skin, GI tract, blood and bone marrow, and testis) toxicity in chemotherapy patients receiving cell cycle phase specific drugs. Also included in this part of the lesson is that fact that because a male on chemotherapy has a significant risk of becoming infertile, cryobanking of semen is a technique whereby sperm cells can be "protected" from the toxic effects of chemotherapy.

The teachers report that by using this "cancer connection" they have a much easier time teaching the concept of cell division to their students. Many of the same cancer education concepts discussed previously are utilized when members of the faculty teach about cancer to grade 7-12 students using telecommunication technology. Other successful "cancer connections" in the PIHS program have been (1) local invasion and lymphatic spread; (2) exfoliative cytology; and (3) the cellular changes, permanent versus reversible, which occur in the respiratory system associated with smoking (epithelial metaplasia—dysplasia—anaplasia).

Obviously there are many cancer-related topics in biochemistry, immunology, virology, genetics, cell and molecular biology, molecular genetics, environmental toxicology, and so on which can be used by the K-12 teacher in the classroom to enhance student interest and learning of normal biology in relation to cancer biology and vice versa. In addition, the general topic of "cancer" can serve as an entrée to engage student interest in behavioral science content, for example, the emotional crisis for the patient and his or her family when a diagnosis of cancer occurs, coping with cancer, end-of-life issues, and depression.[24]

The use of selected topics in cancer biology to teach K-12 teachers and their students the importance of normal biology as a basis for understanding abnormal biology and vice versa is an important component of "cancer education."

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