Cancer Patient-Specific Prognostic Information

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Final Project Report

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Abstract

The goal of this project is to develop an interactive, Web-based Prognostigram program for adult patients with newly diagnosed cancer. The prognostic program creates individualized survival curves based on the Cox Proportional Hazards model of survival data from Barnes-Jewish Hospital (BJH) Oncology Data Services (ODS) and SEER*Stat (National Cancer Institute, Surveillance, Epidemiology, and End Results Software package). This program also includes important comorbid health information. Patient and physician focus groups were held to explore the utility of the program. Overall, both groups felt the program was informative and easy to use. Specific suggestions for improvement were made. Ultimately, the utility of the program needs to be assessed with

Introduction

Currently, prognostic estimates and decision-making in cancer care are primarily based on 5-year survival statistics published by the American Joint Committee on Cancer (1) and the American Cancer Society (2). These data relate mortality to site and TNM staging, but do not account for patient-specific factors such as patient age, gender, comorbidity, and cancer-related symptom severity. Since these factors are also independent predictors of survival (3-17), an index that considers these factors in addition to tumor site and TNM stage will be a better system for estimating survival.

Information resources available to patients with newly diagnosed cancers are diverse. The physician and nursing staff serve as the primary providers of meaningful, appropriate information. Patients can supplement this information with general background information about cancer and cancer therapies from printed pamphlets, articles, and textbooks. Much of this didactic material is intended for non-medical audiences and is relatively easily understood. On the other hand, prognostic information, such as life survival or five-year survival rates, is more difficult for laymen to find and meaningfully interpret. At present, patients' understanding of prognosis is generally limited to information provided to them by their physician. Physicians obtain prognostic information from the published literature and their personal experience with similarly affected patients.

Interactive teaching and decision-making programs for patient use exist in varying medical specialties (18-20) One of the most successful programs is a videodisc series from the Foundation for Informed Medical Decision-Making (Hanover, NH). This series can help patients with back pain, breast cancer, ischemic heart disease, or benign prostatic hypertrophy understand their conditions and the various treatment options available to them. Other interactive teaching and decision-making resources for patients exist on the World Wide Web. For example, the American Heart Association "What's My Risk" page (http://www.amhrt.org/risk/) uses baseline data from the Framingham study to determine the user's ten-year risk of heart disease based on age, gender, race, diastolic blood pressure, and history of smoking and diabetes. The American Urological Association "Compute Your AUA Symptom Index" page (http://www.edaptechnomed.com/auascore.htm) computes a symptom-based benign prostatic hyperplasia (BPH) severity index that may be used in deciding among the available therapies. A third example of an interactive, web-based patient prognostic and decision-making program is the Columbia Presbyterian Medical Center's "Form to Calculate Patient's Predictor Index for Health Related Facility Care" (http://cpmcnet.columbia.edu/dept/sergievsky/form.html). The page calculates the estimated time to nursing home care and death for patients with Alzheimer's disease based on a variety of clinical factors, including age, patient's current mental status, and activity level information input by the caregiver.

Interactive decision-making programs have also been developed for physicians. Once such resource, developed by Ravdin (21) for physicians of patients with breast cancer, requires a physician to input the patient's age, physician-estimated breast cancer-related mortality at five years, and physician-estimated proportional risk reduction expected from adjuvant therapy. The program then recombines this data into graphs, charts, and tables of survival displayed in context of age- and gender-matched peer mortality to aid the physician and patient in deciding whether or not to use adjuvant chemotherapy in the treatment of breast cancer.

This research report describes a new interactive multimedia patient-specific prognostic program for adult cancer patients. This program presents patient-specific survival curves, called prognostigrams, based on the experience of new cancer patients at Barnes-Jewish Hospital from 1995 to 1997 and a population-based sample from the Surveillance, Epidemiology, and End Results (SEER) program (SEER*Stat - SEER Cancer Incidence Data for the Survival Monograph 1973-1996). Age, gender, and race-matched survival curves were generated from natural mortality information obtained from the National Center for Health Statistics. These survival curves were used to compare survival for cancer patients to similar patients without cancer.

The goal of this project is to develop an interactive, Web-based prognostigram program for adult patients with newly diagnosed cancer. The prognostic program will create individualized survival curves based on the Cox Proportional Hazards model of survival data from Barnes-Jewish Hospital Oncology Data Services (ODS) and SEER. The Barnes-Jewish Hospital ODS dataset has comorbid health status information. Unfortunately, the SEER program does not contain comorbid health information. To add the impact of comorbid health information to the SEER dataset, the Investigators determined adjusted hazard ratios (i.e., adjusted for other important prognostic factors) for comorbidity from the Barnes-Jewish Hospital ODS database. Adjusted survival curves can be generated which take into account the impact of comorbid health information. The survival curve for cancer patients can then be presented on the same figure as the survival curve for age, gender, and race-matched peers. This program resides on a password-protected server at the Washington University Medical School Network Services.

Methods

This research project had three distinct phases. In the first phase of the project, baseline demographic, clinical, and tumor information from the nation-wide population-based Surveillance, Epidemiology, and End Results (SEER) Cancer Incidence and Survival Monograph (1973-1996) dataset was used to generate unique survival curves. The second phase analyzed the relationship between baseline demographic, clinical, comorbid, and tumor information and survival for over 10,000 adult patients in the Barnes-Jewish Hospital Oncology Data Services (ODS) tumor registry. Comorbidity information is not contained within the SEER dataset. The survival estimates obtained from SEER were modified to reflect the impact of comorbidity as determined from analysis of the prognostic impact of comorbidity observed in the BJH ODS tumor registry. From this analysis, unique survival curves were generated based on the cogent predictive factors, including comorbidity. The third, and final, phase of the project was to convene focus groups of patient and physician users of the program to obtain input on the utility of the program.

The Barnes-Jewish Hospital Oncology Data Services dataset and the SEER dataset are different in the following ways. The Barnes-Jewish Hospital ODS dataset is derived from the local experience of patients from Barnes-Jewish hospital; the SEER dataset represents a sample of the US population. The SEER dataset contains information for people treated from 1973-1996, while the Barnes-Jewish Hospital dataset contains information from 1995 to present. The Barnes-Jewish Hospital dataset is therefore more contemporary while the SEER dataset has longer follow-up. Both datasets contain initial treatment information. The use of both datasets will provide complementary information and help achieve the goal of improved accuracy and precision in prognostic estimates for patients with cancer.

Phase 1**. Identification of Important Prognostic Factors in the SEER Database and Generation of Patient-Specific Prognostigrams**.

A. Identification of Important Prognostic Factors.

The SEER database contains baseline prognostic information including, age, gender, race, anatomic site (ICD-O code), and extent of disease for 2,391,000 cancer patients. With the SAS® system, bivariate and multivariable analysis was performed, for each anatomic site, to identify prognostic factors for survival. Life survival curves were generated using PROC LIFETEST.

Phase 2**. Determination of the Prognostic Impact of Comorbidity in the Barnes-Jewish ODS Tumor Registry and Adjustment of the SEER-Generated Survival Curves**

A. Identification of Important Prognostic Factors.

There are 11,791 patients in the ODS dataset with incident cancers from January 1, 1995 through December 31, 1998. The investigators used Cox Proportional Hazards analysis to identify the important prognostic factors for each anatomic site. Life survival curves were generated for each combination of significant independent predictor variables. Ninety-five per cent confidence bands were also generated around the survival curve estimates. The adjusted hazard ratios for comorbidity was determined so that the survival curves generated from the SEER database can be modified to reflect the prognostic impact of comorbidity.

The survival curves generated by the program are displayed in a most straightforward format and are intended for patients, families, health care providers, and other professionals. The format for the survival curve plots is: "Percent (of clinically-similar newly-diagnosed patients) Surviving" is on the y-axis and "Survival Duration in Months" (after initial therapy) is on the x-axis. Overlaid onto the prognostigrams are a second plot, demonstrating the natural mortality of a cohort of age-, gender-, and race-matched peers without head and neck cancer. This natural mortality data was obtained from the National Center for Health Statistics Vital Statistics Mortality Data, Multiple Cause of Death, as incorporated into a table by R.R. Monson, Ph.D. of the Department of Epidemiology, Harvard School of Public Health, Boston, MA.

Phase 3 – Convene Focus Testing

After the creation of the Prognostigram program, the investigators conducted focus group testing of patients and physicians. The purpose of the focus group testing was to gather qualitative feedback from potential users that would enable the researchers to enhance and improve future versions of the program. Each focus test was divided into three different sections:

1. Collection of personal data, including age, gender, race, educational background, computer/internet experience, and type of cancer.
2. Test of the Prognostigram's ease of use, including participant's comprehension of terminology, navigation of various features, and ability to perform basic survival analyses.
3. Gathering of feedback, including suggestions on ways to enhance the Prognostigram and assessment of whether the program would be a useful tool for the participant.

The researchers feel that the Prognostigram should be intuitive for all cancer patients to use, regardless of their experience with computers or their knowledge about cancer. Thus, this section of the focus test was an assessment of the participants' understanding of each of the program's features.

Results

Phase 1 and 2 – Identification of Prognostic Factors and Creation of Survival Curves

A program was written that reads SEER cancer mortality data in binary form and displays survival curves in a windowed environment. Life survival curves are generated for each combination of significant independent predictor variables. Confidence bands (95%) are generated around the survival curve estimates. The adjusted hazard ratios for comorbidity are determined from BJH ODS so that the survival curves generated from the SEER database can be modified to reflect the prognostic impact of comorbidity. The program is written in a modularized fashion so that, with moderate effort, it can be adapted to run on a Web server and provide output for Web site visitors.

Phase 3 – Focus Group Testing

Twenty cancer patients and 16 cancer physicians viewed the program and participated in focus group testing. The main findings are listed below.

A. Confusing Terminology. — There were several areas of the program that were difficult for users to understand. Many of these problems arose from terms that were *misleading*. For example, most users interpreted “Age Group” to mean their current age, rather than the age at which they were diagnosed with cancer. Similarly, “Starting Year” was usually interpreted to mean the current calendar year rather than the number of years from the date of cancer diagnosis.

Other difficulties in comprehending arose due to terms that were *unfamiliar* to the participant. Only two of the patients tested understood what “Comorbidity” meant: one was a nurse and one a doctor. After defining comorbidity for the participants, however, all easily grasped the concept as well as why one would want to factor this in to their prognosis (i.e., sicker people have a poorer prognosis and healthier people have a better prognosis). The numeric comorbidity codes were also difficult to immediately understand, however the definitions of each code (None, Mild, Moderate and Severe) were easy concepts for participants to master.

B. Inconsistent Layout and Design — Other problem areas were due to inconsistent layout and design. While most participants understood what “Site” meant, many neglected to assign a value for it. Based on the tester’s observations, this seemed to be due to the fact that Site is assigned via a button option which launches a separate dialog, while the other variables were assigned via either radio buttons or pull-down menus that enabled immediate access to the various value options. The participant was thus confused by the inconsistency in how the program collected information.

C. Confusing Curves — There were several confusing aspects of the survival curves. First, by default the Prognostigram generates four different curves. This was generally viewed as excessive and overwhelming to participants. While the two main curves (General Population and Cancer) were easier to understand, most participants were not able to correctly ascertain what each curve represents. After the tester explained each curve, most participants were able to sustain this knowledge for the duration of testing. When a third curve was added (representing comorbidity), most participants had more difficulty remembering what each curve represents.

In addition to the meaning of the curves themselves being a source of confusion, many participants noticed that the program is inconsistent in whether it requires the user to click the “Display” button to regenerate a curve. At times the user was required to click “Display,” at others it regenerated the curve automatically upon changing the input data.

D. Difficult Survival Analysis — Based on the three hypothetical survival curves, 17 out of the 20 cancer patients were able to correctly determine the percentage of people with cancer who were alive five years after being diagnosed for all three curves. After the tester explained how to determine this percentage to the other three, all were able to answer the question correctly for subsequent survival curves.

Only 13 out of the 20 participants were able to correctly determine the median survival time. After the tester explained how to determine median survival time to the other seven, all were able to correctly determine it for the subsequent survival curves.
To conclude each focus testing session, the tester gathered feedback from each participant on how to enhance the Prognostigram and assessed whether the program would be a useful tool for the participant.

E. Areas of Enhancement — Based on the participant response and the opinion of the tester, the following suggestions would enhance the user experience of the Prognostigram.

1. The Prognostigram would benefit from being made more user-specific. Since the purpose of the program is to provide “patient-specific” survival information, every attempt should be made to make it a “patient-specific” program.

2. The Prognostigram would benefit by making key areas of the program easier to understand.

3.The Prognostigram would benefit from more consistent navigational design

F. Is the Prognostigram useful to patients? — Of the 20 patients who viewed the Prognostigram, 17 said they would use the program in their own situation. Of these 17, however, four said they would not want to see the program immediately. Rather, they felt that they had enough to deal with simply coming to terms with the fact that they have cancer that the program might be too overwhelming. They preferred to see the program after beginning treatment or even after completing treatment.

Discussion

The Investigators developed an interactive Prognostigram program to aid newly diagnosed cancer patients, family members, and other health care professionals. These Prognostigrams deliver unique survival information based on a patient’s age, gender, race, comorbid health status, tumor site, and extent of disease. The survival curves were generated from two separate databases – Barnes-Jewish Hospital Oncology Data Services and SEER. These survival curves demonstrate the unique prognostic impact of comorbidity to the survival of patients with cancer. This information will be important to patients, families, health care professionals, and members of the insurance industry.

Future work

The Research Team plans to apply for a grant to the National Cancer Institute. The NCI has issued a Request for Application -- Health Communications in Cancer Control in order to support research into the use of “new media” to help patents with decision-making and understanding survivorship. The research application will focus on whether the Prognostigram Program helps patients make better choices as determined by better health outcomes and reduction in health care expenditures.

The Research team is also quite interested in evaluating the impact of this Program on undergraduate and graduate medical education. The PI serves as Coursemaster for the First Year Course in Clinical Epidemiology and Medical Statistics. Therefore, he has extensive contact with medical students and believes this Program can help them better understand cancer prognostication.

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