A planning and evaluation program for assessing telecommunications applications in community radiation oncology programs

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Management-focused scientific evaluation is a useful administrative tool especially when hospitals implement a new technology. This paper describes the components of a scientific evaluation framework and then illustrates the application and the utility of the framework in a hospital-based community oncology setting. The clinical technology, Telesynergy, is an advanced telecommunications and remote medical consultation system which has been developed by the National Cancer Institute to support community hospital-based radiation oncology programs.

Planning, implementing, refining, and evaluating any new initiative in the community hospital setting is typically an extremely daunting task. One effective methodology for providing structure to such efforts may be based on an outcomes-based planning and evaluation model that can guide the evolution of the project in a structured fashion. Previously, as we attempted to move forward with videoconferencing capabilities with a key group of stakeholders including both clinical and support staff specializing in radiation and medical oncology, surgery, laboratory medicine, radiology, nuclear medicine, administration, and budget and logistics or information science, we decided to apply evaluation science techniques to provide structure and guidance to the entire effort. The initial structure and processes of this dynamic approach have been summarized by Ricci and Nolan in a book chapter discussing biomedical applications of evaluation science driven program development.[1]

Beginning in 2002 the National Cancer Institute (NCI) initiated a 5-year program of funding for a novel demonstration of an advanced telecommunications and remote medical consultation system, Telesynergy. This system was initially deployed in 6 communities in the United States under a cooperative agreement (U56) mechanism with the Radiation Research Program based in the NCI's Division of Cancer Treatment and Diagnosis. The long-term goal of the Cancer Disparities Research Partnership (CDRP) program was to use the Telesynergy system to support reductions in cancer-related health disparities in African American, Hispanic, Native American, elderly, and low-income populations. A view of the system that was installed at the University of Pittsburgh Medical Center (UPMC) McKeesport hospital is provided (Figure 1).

The CDRP program was designed to support: planning, developing, and conducting radiation oncology clinical trials; planning, developing, and implementing nurturing partnerships between grantee institutions and academic research institutions actively involved in NCI-sponsored cancer research; establishing Telesynergy at each CDRP grantee institution and its selected academic partner; supporting a patient navigator program to facilitate access to radiation oncology services, including clinical trials, by reducing barriers (eg,

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FIGURE 1 A view of the Telesynergy videoconferencing and medical consultation workstation at UPMC McKeesport. The main workstation for initiating control and distributing information contents during conferences is in the center (the two-tier desk with the large screen on the top). To the right is the station that is used for viewing microscopic images in real time and for downloading high resolution film based images with a dicom scanner. The desk to the immediate left of the 2-tier desk is has the equipment for retrieving electronic images (computed tomography, positron-emission tomography, magnetic resonance, sonography, etc) from local and distant medical sources. The equipment on the far left desk is used to link with web sites that are not linked to the main system computer and codec but provided through other secondary videoconferencing linkage so that video can be streamed (out and in).

financial, geographic, cultural) that impact receipt of timely cancer care by patients from target populations; and conducting community outreach activities to increase knowledge and awareness of cancer and the availability of local treatment and clinical trials research.[2] Six institutions were awarded grants for the CDRP program with a total 5-year cumulative budget of about $25 million. Several of the projects have subsequently received additional funding for 2-3 years.

The CDRP based in UPMC McKeesport Hospital established a regional partnership called the Radiation Oncology Community Outreach Group (ROCOG). The latter originally consisted of community oncology centers at McKeesport Hospital, as well as partners at Jameson Health System in New Castle, Penn; Somerset Hospital in Somerset, Penn; Mercy Hospital in Pittsburgh; and The Murtha Cancer Pavilion in Johnstown, Penn.[3]

Evolving Telesynergy components

Telesynergy is a robust and flexible teleconferencing system that is designed for use with radiation oncology and medical oncology facilities for video conferencing and consultations for patient management. The components are all "off the shelf" in nature. The design allows a comprehensive type of enhanced medical communication as noted on the NIH Telesynergy website.[4] Although the system was initially designed for ISDN PRI types of linkage, it may now be used to communicate with all available types of videoconferencing systems. New codecs capable of video over internet protocols are now used, thus eliminating the need for special and costly ISDN communication lines. With a variety of selected input and output options, the Telesynergy systems can also be linked to provide streaming information to any laptop or desktop system anywhere in the world that can link to the internet, providing a wide base of versatility and capability for medical professionals and lay populations alike.

In January 1999, the Center for Information Technology (CIT) at the NIH completed development of the predecessor to the Telesynergy Medical Consultation WorkStation, a multimedia medical imaging workstation. In 2000, CIT joined forces with NCI in a pioneering Telesynergy system collaboration to reach out to distant community hospitals. The first 4 systems included hospitals in Fort Lauderdale, FL, Wheeling, WV, Belfast, Northern Ireland, and Dublin, Republic of Ireland. There are now more than 30 systems in operation globally. The newest systems (the present Version 3) provide a plasma screen, DICOM scanner, document camera, patient examination camera, microscope, and many additional options. At McKeesport, we have also added several inexpensive new input/output options to extend the communication base of the Telesynergy system to other system types and to desktop locations with Internet service access.

System usage

The main CDRP objectives for Telesynergy system video conferencing in radiation oncology are to promote the interdisciplinary participation of attending physicians, nursing staff, and oncology support staff in tumor boards and specialized tumor conferences with appropriate continuing medical education and continuing education credits; enhance quality assurance, quality control, and continuous quality improvement programs in oncology; provide special topic education sessions to reinforce understanding by involved health care personnel in resolving complex multidisciplinary diagnostic and treatment issues; provide onsite and distance learning opportunities for health care personnel of all types, community advocates, and patient groups; and interact with major health care centers and universities to promote quality in care, quality in education and equity for all socio-economic and minority groups.

Framework for scientific evaluation

Evaluation research is the application of scientific methods to improve the delivery of health programs and services by studying the way these services are designed, managed, financed, analyzing the resulting costs and outcomes, and quantifying the extent to which the needs of the various populations being served are met. Scientific evaluation of health programs uses systematic methods to assess the extent to which a health program achieves its performance goals of program-related activities (process/formative/evaluation) and the extent to which it achieves its short- and long-term outcomes. In addition, evaluation research may also include assessment of program costs and benefits.

Program evaluation is carried out to answer the following questions: Is the program being conducted as planned? To what extent is the program meeting its objectives? Are the program objectives appropriate given resources available? Are the program costs reasonable given the benefits received? How well is the program managed? Are unanticipated events occurring as a result of the program?

The conduct of scientific evaluations requires involvement of all stakeholders, clearly defined stepwise interventions, measurable program outcomes, as well as valid and reliable summary data indicators. It also requires a research design strategy and an assessment of expected barriers to the conduct of the evaluation with a strategy to overcome each barrier.[5]

Process and outcome assessment

An evaluation of the Telesynergy components of a biomedical communication and education program and other potential components of a program such as the CDRP should address both formative (process) and summative (outcome/impact) elements of these programs. The details that follow describe the general framework and approach for an evaluation plan for any program in professional development, Telesynergy, or web-based communication that might be established as a continuing part of programmatic development or enhancement in biomedical communication and remote learning efforts for health care providers and community populations alike. We have described a generalized approach for the use of outcomes based planning and assessment approaches for biomedical videoconferencing in a book chapter,[1] projecting the need for comprehensive formal assessment programs for the design and evaluation of contemplated "new works" in bioinformatics. A concise description of formative, summative, and logic model components of a scientific evaluation follows:

- *Formative* (process) evaluation is essentially descriptive in that it focuses upon the way the program is organized and functions. In conducting a formative evaluation of the ROCOG program information was collected concerning the process of creating each component within the ROCOG, implementing the resulting component and the utilization of the program. Barriers to the creation and operation of each component, facilitating processes and strategies and key activities required to create each component were documented. A chronology of events was produced showing which of the key activities were completed and when. The formative evaluation can be converted into a "replication manual" for other sites that may desire to build and implement a similar program. Also during the formative stage, evaluation data can be used to improve the management of the program if the process assessment generates suggestions for improvement. These suggestions can be communicated to the staff members who are involved in building and managing the professional development, Telesynergy, and website components.
- *Summative* (outcome/impact) evaluation focuses upon results. In summative evaluation, information is collected to measure (usually quantitatively) the impact of program activities upon clearly defined outcomes as specified in the logic model. The quality of such summative evaluation depends upon three factors: quantitatively measurable outcomes must be specified in advance of the program implementation and data must be collected relative to each, usually before and at regular intervals after program implementation; the link between program outcomes and the structure and operation of the program should be logically clear; and it should be possible to ascribe the outcomes to programmatic activities while ruling out other possible causes or explanations.

The first factor, the identification of quantitatively measurable outcomes requires precise specification of expected results and the implementation of valid and reliable measurement methods. The second requirement, a clear logical link between program activity and outcomes, refers to the precision and quality of the programmatic intervention. Some interventions are based on well-established behavioral or educational theory; others are based upon professional experience. In each case, before a program is implemented, there should be reasonable evidence, based either upon sound theory, or experience, or both, that any intervention or assessment program may have a potential for achieving the expected outcomes. Such planning and assessments should be agreed upon by all initial stakeholders in the program.

Although not required for management-oriented studies, it is worth mentioning that in experimental evaluations it is also necessary to compare target populations

with another group that is not within the influence of the component under evaluation (control group or comparison group) so that the attribution of any measured impact to the programmatic activities can be made accurately. Thus, other plausible explanations for the results can be evaluated and declined.

We strongly recommend that a logic model be prepared as a new health care program is being designed. *Logic models* are useful tools for scientific evaluation in that they clarify the relationship between program activities and expected outcomes. Logic models can be viewed as a series of if-then statements that serve as a theory to explain expected causal relationships between activities and outcomes. A logic model for using the Telesynergy system is summarized in Figure 2. Note that in going from top to bottom in the model one starts initially with the determination of programmatic context and identifies key stakeholders in the program, then comprehensively describes available (or needed) resources, defines activities and a work program, states what outcomes (and work products) are expected and finally delineates both short- and long-term outcomes and expectations.

The measurable outcomes we used to assess the Telesynergy system are all reflective of activities and results planned by program participants: the number of session attendees; CME and CE credits earned; hours of usage and temporal trends in usage; satisfaction of participants with technology quality and utility; quality of presentations and their educational merit; linkage details and trends with major medical centers; measures of impact components and behavioral changes in participants resulting from program activities and for community groups; acceptance of information by target community groups; increased acceptance by minority populations of clinical research participation; and use by community institutions, patient, family, and friends as a source of information.

The developmental (formative) period

We accomplished a significant number of enhancements in our main infrastructure, technical components, and programmatic goals during the initial 5-year project period including significant technical refinements of our original videoconferencing system at UPMC McKeesport Hospital. We also installed an additional newly structured Telesynergy system at our partner ROCOG facilities at Jameson Health Systems and at Somerset Hospital. We finished conversion of all systems to video over internet protocols, thus eliminating the earlier and more costly ISDN PRI communications platform that had been used previously for all systems. The replacement Tandberg Edge 95 codecs cut costs so that replacement costs delivered a breakeven point at about 1 year from purchase.

We also gained additional progress within our professional development and education components promoting regional Telesynergy-based professional and community/patient communication efforts in conjunction with Jameson and Somerset hospital facilities. Evaluation and assessment efforts have continued now for tumor boards and thoracic tumor conference components. New hospital Telesynergy-based monthly thyroid tumor conferences were initiated in September 2008. The addition of the new video over internet protocol systems to all our Telesynergy system facilities at McKeesport, Jameson, Somerset, and our mentor group at Washington University in St. Louis, in particular, have allowed us to move forward with professional and community-based efforts in distance learning. Our efforts from 2003 through 2011 have expanded to cancer-related education and promotion of clinical protocol participation in our minority communities.

Our Telesynergy system-based educational program expansions and activities are further summarized and detailed in a planning outline that which provides the basis for additional efforts to facilitate program expansion.[6] We also document added process elements to continue to provide Telesynergy system-based educational materials to those individuals or locations that do not have videoconferencing capabilities via outgoing video streams to our community partners and health care professionals at geographically dispersed locations. An economical video stream has been provided to extend the Telesynergy system operations base and capability of sharing videoconferencing programs with those that have web access but lack videoconferencing facilities.[7] We continue to focus on both ROCOG program goals and promoting clinical trial participation efforts via these educational efforts, and on promoting program sustainability for both our ROCOG partners and our urban and rural communities.

Process and outcomes evaluation

Our logic model initially provided for videoconferencing within and among our Radiation Oncology Community Outreach Group and other grant recipients of the CDRP funded by the Radiation Oncology Section of the National Cancer Institute. Specific activities were to include efforts at providing professional education for oncology-related physicians and other health care providers, and to concomitantly provide educational materials for our communities, patients, and their families. Our two-pronged approach was thus to optimize use of videoconferencing and to provide a secondary information source for the community through development of an information website. Formal education was to be accompanied by CME credits for physicians and a variety of CE credits for other health care professionals. In particular

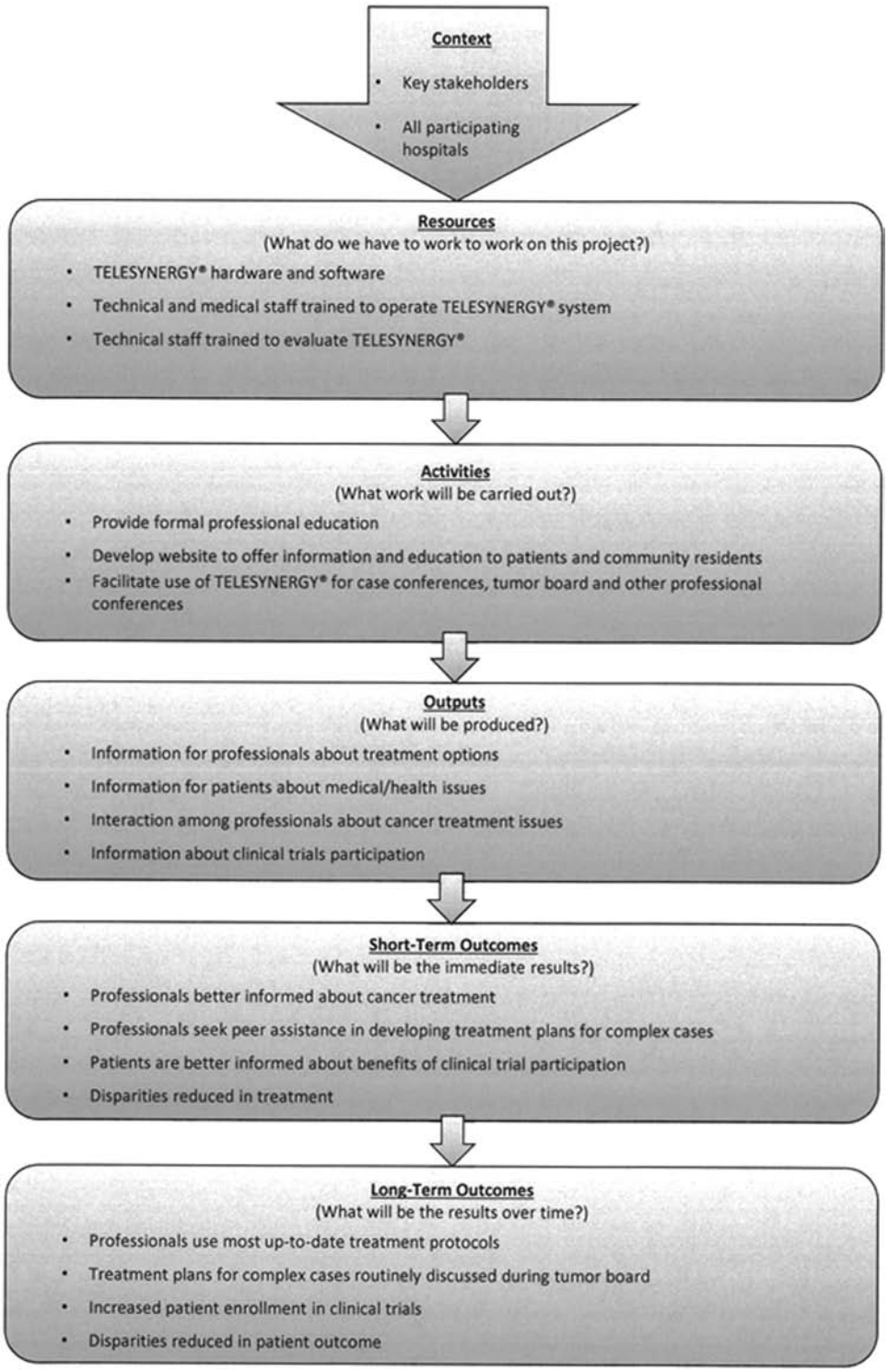

FIGURE 2 A partial logic model for the Telesynergy project evaluation.

TABLE 1 Average score summary for tumor board participant satisfaction surveys, 2007 and 2009

Question type	Average score[a] (range, 1-10)
1. Is the mixture of cases presented satisfactory?	8.6
2. Is time spent per case appropriate?	8.9
3. Is quality of specialty presentations appropriate? (Please rate)	9.1
4. Do specialists discussing cases make details understandable?	9.0
5. For special topic presentations (usually 4/year) is the number adequate?	7.4
6. Please rate the acceptability of food/beverage service for the meetings.	6.7

[a] The question response was determined by the placement of the responder's marks along a continuous line marked with values from 1 to 10, with 1 being *extremely unsatisfied;* 5, *moderately satisfied;* and 10, *extremely satisfied.* Summative outcome evaluation results from 2 satisfaction surveys presented above indicate an overall high degree of satisfaction for most elements. Only Question 6 ranked near the midline in 2007. Recognizing Napoleon's comment that "an army travels on its stomach," we immediately attempted remediation with good success.

we planned an approach to facilitate use of the Telesynergy system for case conferences, Tumor Boards, and other professional conferences. We emphasized open access and flexibility of content to support all onsite and remote educational experiences for those involved in cancer diagnosis and treatment. A similar approach of access and flexibility in content was utilized for community programs. A prime thrust of these education efforts has been to promote patient participation in clinical trials that provide the most current approaches for treatment. These general activities are linked directly to both formative and summative measures of outcomes and logic model output measures as detailed in the next section.

Overall, the videoconferencing initiative has been quite successful in providing information and influencing behaviors on several fronts. The main short-term goal we focused on included providing information for professionals about treatment options through a prospective multidisciplinary approach promoted by tumor board coordinators and supported by a broad spectrum of participating physicians. Medical oncology, radiation oncology, radiology and medical imaging, general surgery, thoracic surgery, surgical oncology, ob/gyn, head and neck surgeons, pathologists, internal medicine, family medicine, pulmonology, gastroenterology, and urology each participated in the program. Our long-term goal of assuring the use of evidence-based medicine in oncology care in the community hospital setting has been secured and supported by the dedicated participation and commitment of the oncology physicians in the weekly prospective tumor conference and their ability to bring patient outcomes for follow-up and further discussion. The extent to which this goal has been accomplished in a broader spectrum of participating physician specialties can be seen in Table 1. To date we have established a weekly prospective tumor board, thoracic tumor conference and a monthly prospective endocrine tumor conference.

Information summary for medical professionals

Both formative (process) and summative (outcomes/impact) evaluations demonstrated improvements during the 3-year program. We noted more than 40 formative observations that positively influenced program development and only 4 events with negative impacts. The most significant of those 44 total observations were improvements in facilities by the hospital in audiovisual and conferencing support, placement of support staff for patient navigation and a clinical research coordinator (CRC) to assist in clinical trial accrual and coordination. The CRC role is supported by the NIH CDRP Disparities Grant.

Summative outcomes all indicated significant improvements

Our initial 3-year summary indicated substantive progress in many outcomes measures[8,9] for both tumor board usage and for applications associated with quality assurance, quality control, and continuous quality improvement issues.[8] For physician participation (CME credit issued) in tumor boards, numbers increased with most 6-month increments reported from 2004 baseline through 2007: from a base of 120 to 156, 286, 382, 644, 628, 405 (total, 2,501). The total staff attendance at 6-month intervals was increased from a base of 178 to 300, 500, 624, 995, 732, 620 (total, 3,471). The number of cases presented ranged from a base of 34 cases per 6 months to 49 case per 6 months to 66, 66, 84, 99, 103 (total, 467; average, 78). We also detailed both longitudinal activity summaries and statistical analyses for case mix and duration of presentations as well as trending analyses and projections by quarterly intervals for all measured endpoints.

Table 1 summarizes 2 years of a participant satisfaction survey measuring 6 vital components, and Table 2 summarizes the impact assessment of behavioral changes elicited by tumor board programs during the same period. Results show not only consistently high levels of participant satisfaction but these surveys also suggest specific quality improvements achieved.

Outcomes-based planning and evaluation conclusions

Although many factors, such as teamwork, planning and evidence-based case reviews contributed to the growth of

the tumor board, we suggest that multidisciplinary contributions from all involved specialty areas are central. The complexities of multimodality treatments and newer diagnostic and visualization approaches require an inclusive team willing to evaluate, learn, and evolve.[8]

The database of the McKeesport Telesynergy system indicated the following aggregate system usage in the first 5 years the system has been in place:

- Total number of system sessions, 469
- Total system "on time," 26,700 minutes (average, 55 min/session)
- Total sessions with CME credits, 335 (266 tumor boards)
- Total McKeesport tumor board session attendees, 7,760 staff (4,100 physician attendees with 4,650 CME credit hours)
- Total of active patient cases presented and discussed, 953 (average of 21 attendees per session)

The Jameson and Somerset facilities have also shown increases during their initial 2 years of experience. Somerset hospital also has a remote consultation program that has now surpassed 40 patient consult sessions per month with some extremely unique applications (eg, a live birth with OR linkage and discussion between the new mother and her husband in Iraq during and following the birth. This was possible with a local link to the Telesynergy system then to the armed forces satellite communication system and then to the father's military base camp.) Supportive parallel information for patients (and physicians) was also provided by our website, but not included in this summary.

This initial quantitative Telesynergy summary reinforces the importance of the use of a comprehensive technology system to facilitate the multidisciplinary coordination of oncological decision making in the delivery of individual patient care. Clinical trials are reviewed for each patient presented to the tumor board. This has assisted in meeting our clinical trial goals for the NCI program. The evolution of the use of this technology includes providing information and education for patients about health issues and that has helped us meet our patient participation goals during the 5-year phase of program generation and growth.

TABLE 2 Average score summary of impact (behavioral assessment) for tumor boards surveys, 2009 and 2010

Question type	Average score[a] (range, 0.0-5.0)
1. Promotion of website use (NCCN, Medline, etc.)	3.72
2. Use of a multidisciplinary approach to cancer care	4.41
3. Use of new diagnostic and therapeutic strategies	4.16
4. Use of evidence-based guidelines	4.31
5. Improve communication with your patients and their families	3.84
6. Incorporate ethical principles in clinical decision making	3.93
7. Delivering culturally sensitive and appropriate care	3.87
8. Use of performance and outcomes data to improve care	4.04
9. Understand the impact of changes in the cancer care system on future	4.22
10. Improve work within UPMC hospitals and/or other health care systems in your region?	4.66

[a] The measured scale was forced choice and ranged from 1 point (very low) through 3 points (moderate impact) to 5 points (very high impact). During both years most of the average scores for impact on participant behavior were consistently high, usually in the range of 4.0 or greater, reflecting a general level of high-impact scores resulting from participation. It appears that during the 2 years of the surveys only questions 3 and 9 showed small statistical increases in impact. There were more than 30 responders for each survey.

Short-term outcomes

Observations made over the 5-year course of this program confirm an acceptance of the educational program among the medical and ancillary staff. This has resulted in subjective changes in behavior that are presented here:

- Conference participants have become better informed about cancer treatments and the complexity of evaluation for different types of cancer.
- Participants are fully engaged with open discussion of diagnostic information and therapeutic options.
- Satisfaction surveys indicated a high degree of program acceptance. We responded to this information by integrating a greater variety of specialists (surgical subspecialties), additional ad hoc presentations and increased the variety and healthfulness of the food.
- Within UPMC McKeesport during the initial 5-year period, accrual to clinical trials increased by 34%.

Long-term outcomes

Most long-term outcomes in the ROCOG program logic model presented relate to objectives associated with behavioral changes. For professionals, including physicians and all clinical/support personnel, the behavioral observations indicate that staff would continue to use evidence-based practice for oncology care. The data in Table 2 reinforce the concept that a program can change behavior in participants. As Ricci and colleagues have reported, the concept of outcomes-based planning and evaluation may promote improved communication in oncology practices.[10] Finally, we noted the evolution of a collegial style of discourse at the tumor boards as moderated by session

leaders and how it impacted the quality of conversation, especially in complex cases. The ultimate long-term goal of this program is to identify and minimize disparities in health care noted in patients and families having socioeconomic barriers to quality health care. We have yet to accrue sufficient data on clinical outcomes in patients to evaluate our performance in achieving this goal.

Summary and recommendations

Management-focused scientific evaluation can be useful when hospitals implement a new clinical technology. The components of a scientific evaluation framework that are most useful are process and outcomes as elaborated within a detailed logic model. The recommended overall design should include a baseline assessment of all outcome variables and selected process variables before implementation of the project and a time series plot monthly or quarterly for a minimum of 12 months after implementation. Process and outcome data can then be used in discussions about the planned evolution of the project and about the continued investment of resources in the program.

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