Final Progress Report for Research Projects Funded by Health Research Grants

Instructions: Please complete all of the items as instructed. Do not delete instructions. Do not leave any items blank; responses must be provided for all items. If your response to an item is "None", please specify "None" as your response. "Not applicable" is not an acceptable response for any of the items. There is no limit to the length of your response to any question. Responses should be single-spaced, no smaller than 12-point type. The report **must be completed using MS Word**. Submitted reports must be Word documents; they should not be converted to pdf format. Questions? Contact Health Research Program staff at 717-783-2548.

1. **Grantee Institution:** The Trustees of the University of Pennsylvania

2. **Reporting Period (start and end date of grant award period):** 1/1/2010-12/31/2013

3. **Grant Contact Person (First Name, M.I., Last Name, Degrees):** Gearline R. Robinson-Hall, BSF

4. **Grant Contact Person's Telephone Number:** 215-746-6821

5. **Grant SAP Number:** 4100050912

6. **Project Number and Title of Research Project:** 9-Infrastructure for a GMP Facility for Radiopharmaceutical Production

7. **Start and End Date of Research Project:** 07/01/2010-06/30/2011

8. **Name of Principal Investigator for the Research Project:** Chaitanya Divgi, MD

9. **Research Project Expenses**.

   9(A) Please provide the total amount of health research grant funds spent on this project for the entire duration of the grant, including indirect costs and any interest earned that was spent:

   $ 200,000

   9(B) Provide the last names (include first initial if multiple individuals with the same last name are listed) of **all** persons who worked on this research project and were supported with health research funds. Include position titles (Principal Investigator, Graduate Assistant, Post-doctoral Fellow, etc.), percent of effort on project and total health research funds expended for the position. For multiple year projects, if percent of effort varied from year to year, report in the % of Effort column the effort by year 1, 2, 3, etc. of the project (x% Yr 1; z% Yr 2-3).

Last Name, First Name	Position Title	% of Effort on Project	Cost
None			

9(C) Provide the names of **all** persons who worked on this research project, but who *were not* supported with health research funds. Include position titles (Research Assistant, Administrative Assistant, etc.) and percent of effort on project. For multiple year projects, if percent of effort varied from year to year, report in the % of Effort column the effort by year 1, 2, 3, etc. of the project (x% Yr 1; z% Yr 2-3).

Last Name, First Name	Position Title	% of Effort on Project
Divgi	PI	< 1%

9(D) Provide a list of **all** scientific equipment purchased as part of this research grant, a short description of the value (benefit) derived by the institution from this equipment, and the cost of the equipment.

Type of Scientific Equipment	Value Derived	Cost
None		

10. Co-funding of Research Project during Health Research Grant Award Period. Did this research project receive funding from any other source during the project period when it was supported by the health research grant?

Yes____X_____ No_____

If yes, please indicate the source and amount of other funds:

University of Pennsylvania institutional funds - This project cost $236,900.

11. Leveraging of Additional Funds

11(A) As a result of the health research funds provided for this research project, were you able to apply for and/or obtain funding from other sources to continue or expand the research?

Yes_____ No____X_____

If yes, please list the applications submitted (column A), the funding agency (National Institutes of Health—NIH, or other source in column B), the month and year when the application was submitted (column C), and the amount of funds requested (column D). If you have received a notice that the grant will be funded, please indicate the amount of funds to be awarded (column E). If the grant was not funded, insert “not funded” in column E.

Do not include funding from your own institution or from CURE (tobacco settlement funds). Do not include grants submitted prior to the start date of the grant as shown in Question 2. If you list grants submitted within 1-6 months of the start date of this grant, add a statement below the table indicating how the data/results from this project were used to secure that grant.

A. Title of research project on grant application	B. Funding agency (check those that apply)	C. Month and Year Submitted	D. Amount of funds requested:	E. Amount of funds to be awarded:
None	☐NIH ☐ Other federal (specify:_____) ☐ Nonfederal source (specify:_)		$	$

11(B) Are you planning to apply for additional funding in the future to continue or expand the research?

Yes_____ No____X_____

If yes, please describe your plans:

12. Future of Research Project. What are the future plans for this research project?

None

13. New Investigator Training and Development. Did students participate in project supported internships or graduate or post-graduate training for at least one semester or one summer?

Yes_____ No____X_____

If yes, how many students? Please specify in the tables below:

	Undergraduate	Masters	Pre-doc	Post-doc
Male				
Female				
Unknown				
Total				

	Undergraduate	Masters	Pre-doc	Post-doc
Hispanic				
Non-Hispanic				
Unknown				
Total				

	Undergraduate	Masters	Pre-doc	Post-doc
White				
Black				
Asian				
Other				
Unknown				
Total				

14. **Recruitment of Out-of–State Researchers**. Did you bring researchers into Pennsylvania to carry out this research project?

    Yes_____ No____X_____

    If yes, please list the name and degree of each researcher and his/her previous affiliation:

15. **Impact on Research Capacity and Quality**. Did the health research project enhance the quality and/or capacity of research at your institution?

    Yes___X_____ No_____

    If yes, describe how improvements in infrastructure, the addition of new investigators, and other resources have led to more and better research.

    We increased our ability to produce radiopharmaceuticals for human use as a result of the GMP facility. This includes doubling our capacity to produce ^{18}F compounds and enabling the production of ^{11}C, which were extremely difficult to produce in the former facility. In addition, all of these compounds are produced under conditions that meet the highest regulatory standards for pharmaceutical production. As a consequence, we have been able to expand our support for human studies using molecular imaging. This is expected to lead to better techniques to detect and characterize cancer and other diseases. In addition this will accelerate the development of personalized medicine approaches by allowing the detection of specific treatment targets and the impact of targeted therapies. We have been able to produce compounds for research performed on the University of Pennsylvania campus and can now support research from academic and commercial research organizations across the Commonwealth. Given the importance of the pharmaceutical and biotechnology industry in Pennsylvania, we expect significant commercial partnerships.

In specific, we are now producing both approved radiopharmaceuticals (^{18}F-FDG) as well as a number of investigational tracers from our facility. This work supports research using standard FDG PET/CT as a response endpoint in cancer clinical trials ranging form early-phase studies of novel therapy to late phase trials. We also produce tracers used under IND to measure tumor proliferation (^{18}F-FLT), hypoxia (^{18}F-EF5) and amino acid transport (^{18}F-FDOPA), among other measures of tumor biology. The facility is also supporting the development of production for a wider range of imaging probes for cancer which can measure tumor receptor expression (^{18}F-FES), glutamine metabolism (^{11}C-glutamine and ^{18}F-fluorogutamine), and tumor dormancy (^{18}F-ISO1), which are close to being on line for human studies.

16. Collaboration, business and community involvement.

16(A) Did the health research funds lead to collaboration with research partners outside of your institution (e.g., entire university, entire hospital system)?

Yes____x_____ No_____

If yes, please describe the collaborations:

The radiopharmaceuticals produced by the new facility have spurred collaboration across the University of Pennsylvania, Children's Hospital (CHOP), and in affiliated centers (e.g., specialty clinics at Pennsylvania Hospital). There are emerging collaborations with Drexel, Temple, and Fox Chase Cancer Center related to novel PET imaging probes.

16(B) Did the research project result in commercial development of any research products?

Yes_____ No____x_____

If yes, please describe commercial development activities that resulted from the research project:

16(C) Did the research lead to new involvement with the community?

Yes_____ No____x_____

If yes, please describe involvement with community groups that resulted from the research project:

17. Progress in Achieving Research Goals, Objectives and Aims.

List the project goals, objectives and specific aims (as contained in the grant agreement). Summarize the progress made in achieving these goals, objectives and aims <u>for the period that the project was funded (i.e., from project start date through end date).</u> Indicate whether or not each goal/objective/aim was achieved; if something was not achieved, note the reasons why. Describe the methods used. If changes were made to the research

goals/objectives/aims, methods, design or timeline since the original grant application was submitted, please describe the changes. Provide detailed results of the project. Include evidence of the data that was generated and analyzed, and provide tables, graphs, and figures of the data. List published abstracts, poster presentations and scientific meeting presentations at the end of the summary of progress; peer-reviewed publications should be listed under item 20.

This response should be a DETAILED report of the methods and findings. It is not sufficient to state that the work was completed. Insufficient information may result in an unfavorable performance review, which may jeopardize future funding. If research findings are pending publication you must still include enough detail for the expert peer reviewers to evaluate the progress during the course of the project.

Health research grants funded under the Tobacco Settlement Act will be evaluated via a performance review by an expert panel of researchers and clinicians who will assess project work using this Final Progress Report, all project Annual Reports and the project's strategic plan. After the final performance review of each project is complete, approximately 12-16 months after the end of the grant, this Final Progress Report, as well as the Final Performance Review Report containing the comments of the expert review panel, and the grantee's written response to the Final Performance Review Report, will be posted on the CURE Web site.

There is no limit to the length of your response. Responses must be single-spaced below, no smaller than 12-point type. If you cut and paste text from a publication, be sure symbols print properly, e.g., the Greek symbol for alpha (α) and beta (ß) should not print as boxes (□) and include the appropriate citation(s). DO NOT DELETE THESE INSTRUCTIONS.

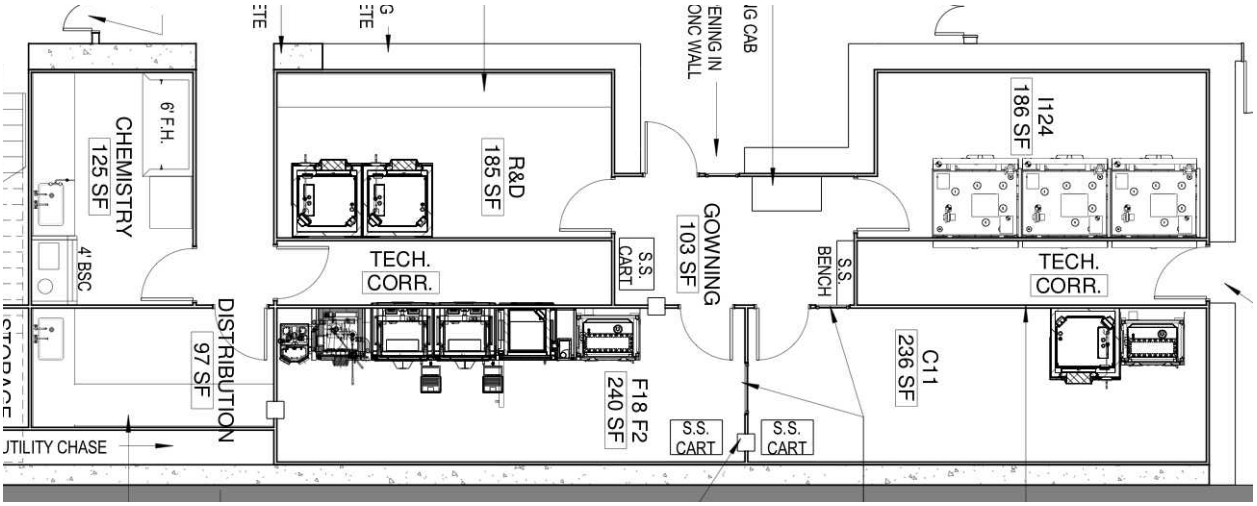
Project Objectives as Listed in the Strategic Plan:
Molecular imaging has been identified as a key enabling technology for the development and clinical implementation of targeted treatments in a number of diseases including cancer. By allowing molecular processes to be interrogated in the patient, molecular imaging can identify specific treatment targets in the patient and can confirm that treatment has effectively engaged its target. Currently, positron emission tomography (PET) is the primary molecular imaging technology with human use potential. The strength of PET rests in the development of radiolabeled compounds capable of binding to selected targets. A particular challenge associated with the development of molecular imaging radiopharmaceuticals is that the short half life of the radiopharmaceuticals (approximately 2 hours or less) requires that they be synthesized, assessed for quality and delivered to the patient in a short period of time. The lack of a robust facility on site within the University of Pennsylvania campus to perform the synthesis consistent with the requirements needed for human uses has limited the ability to translate basic discovery into clinical molecular imaging methods.

The University of Pennsylvania has already initiated a project supported by federal ($2 million) and matching institutional funds ($6 million) to install a new cyclotron capable of creating the isotopes needed to synthesize PET radiopharmaceuticals. We propose here to build a facility to

allow the actual synthesis of radiopharmaceuticals for human use according to good manufacturing practices (GMP). The facility will support research at Penn and serve as a resource for commercial and academic institutions in the commonwealth. It will consist of 1000 sq. ft. of pharmacy grade, GMP/cGMP laboratory space. The new laboratory space will consist of 7 separate rooms. The four key rooms are clean, production rooms (Class 10,000 or better) for different isotopes: ^{18}F, ^{11}C, ^{124}I (and other solid target produced compounds), and a flexible R & D space. The rooms are sealed, have sealed epoxy floors, clean-room ceilings, are provided with HEPA filtration, negative pressure working areas containing hot cells and aseptic shielded cells for the distribution and fractionation of the drug doses. A changing area prior to entering the clean rooms, a wet lab with a fume hood and bio-safety laminar flow hood and workspace for preparation of necessary solutions, reagents, and drug components, supports the four production rooms.

Progress Made Toward the Achievement of the Objectives:
The construction of the GMP facility has been completed. As proposed, the facility consists of 1000 sq. ft. of pharmacy grade, GMP/cGMP laboratory space adjacent to the new cyclotron facility on Currie Blvd. on the University of Pennsylvania campus. The facility includes 4 GMP rooms, a distribution room and a wet chemistry room as illustrated in figure 1.

Figure 1: Drawing of the radiochemistry GMP facility



The 4 GMP production rooms are designated for production of ^{124}I, ^{11}C, ^{18}F and novel research and development to enable a wide range of radiopharmaceuticals to be produced. Each of the four GMP rooms has a sealed epoxy coated floor. The walls are drywall construction, sealed with epoxy paint for ease of cleaning and reduction of particulate matter in the air consistent with the original proposal. The ceilings are gasketed, clean-room ceiling tiles with sealed light fixtures, again to reduce particulate matter in the air. Each room is supplied with HEPA filtered

air to achieve a Class 10,000 or better environment consistent with GMP standards for GMP synthesis of radio pharmaceuticals.

The distribution room contains radiation counters for wipe testing and performing the final assays of the drugs before shipping them to the imaging areas. This room also has epoxy floors and walls to maintain cleanliness. Adjacent to this room is a wet chemistry area to be used for making needed chemicals and reagents. This is a clean area, epoxy walls and floor, but will not be classified nor will it have HEPA filters. There is also a gowning/changing area in the vestibule outside of the GMP production rooms to enable compliance with GMP standard.

This facility has a few unique features including distribution of radioactivity from the IBA or JSW cyclotrons, each of which has complementary capabilities. In addition, there are clean-room feed-throughs to reduce entering and exiting production space. Photographs illustrated the completed laboratory are included in figures 2 and 3 below.

Figure 2: GMP room

Figure 3: Gowning area

This facility represents the only GMP facility dedicated to the production of novel PET radiopharmaceuticals in the Commonwealth. It will provide the opportunity to pursue clinical trials and ultimate clinical production of advanced molecular diagnostics that will improve the detection and characterization of cancer. It will also provide the opportunity to partner with the region's pharmaceutical industry to develop pharmacodymanic and clinical imaging response markers that will enable personalized approaches to defining appropriate treatment targets and drug doses to optimize treatment outcomes with the minimum toxicity.

The space has been fully renovated and is now undergoing expansion to support an increasing array of studies and the recruitment of a new PET Center Director (David Mankoff, MD, PhD)

and Director of Radiochemistry (Robert H. Mach, PhD). GMP production for FDG and investigational ^{18}F- compound has been operational since 2011, and the facility is being expanded to accommodate ^{11}C- compounds and a greater array of ^{18}F- compounds.

Radiopharmaceuticals produced by the new facility will support research using PET probes for a range of cancer applications that include pharmacodynamic markers in early-phase drugs (Peter O'Dwyer, MD), head and neck cancer hypoxia (Alex Lin, MD), radiation dosimetry for proton therapy of gynecologic cancer (Lilie Lin, MD), research in alpha-emitter radionuclide therapy (Daniel Pryma, MD), and novel methods for tracking cellular therapy (Michael Farwell, MD), to name a few. This has also attracted funding, including a recent NIH R01 for Dr. Lin and DOD grant for Dr. Pryma.

18. Extent of Clinical Activities Initiated and Completed. Items 18(A) and 18(B) should be completed for all research projects. If the project was restricted to secondary analysis of clinical data or data analysis of clinical research, then responses to 18(A) and 18(B) should be "No."

18(A) Did you initiate a study that involved the testing of treatment, prevention or diagnostic procedures on human subjects?

_____Yes
___X_ No

18(B) Did you complete a study that involved the testing of treatment, prevention or diagnostic procedures on human subjects?

_____Yes
__X__ No

If "Yes" to either 18(A) or 18(B), items 18(C) – (F) must also be completed. (Do NOT complete 18(C-F) if 18(A) and 18(B) are both "No.")

18(C) How many hospital and health care professionals were involved in the research project?

_____Number of hospital and health care professionals involved in the research project

18(D) How many subjects were included in the study compared to targeted goals?

_____Number of subjects originally targeted to be included in the study
_____Number of subjects enrolled in the study

Note: Studies that fall dramatically short on recruitment are encouraged to provide the details of their recruitment efforts in Item 17, Progress in Achieving Research Goals, Objectives and Aims. For example, the number of eligible subjects approached, the number that refused to participate and the reasons for refusal. Without this information it is difficult to discern whether eligibility

criteria were too restrictive or the study simply did not appeal to subjects.

18(E) How many subjects were enrolled in the study by gender, ethnicity and race?

Gender:
_____Males
_____Females
_____Unknown

Ethnicity:
_____Latinos or Hispanics
_____Not Latinos or Hispanics
_____Unknown

Race:
_____American Indian or Alaska Native
_____Asian
_____Blacks or African American
_____Native Hawaiian or Other Pacific Islander
_____White
_____Other, specify:_____
_____Unknown

18(F) Where was the research study conducted? (List the county where the research study was conducted. If the treatment, prevention and diagnostic tests were offered in more than one county, list all of the counties where the research study was conducted.)

19. Human Embryonic Stem Cell Research. Item 19(A) should be completed for all research projects. If the research project involved human embryonic stem cells, items 19(B) and 19(C) must also be completed.

19(A) Did this project involve, in any capacity, human embryonic stem cells?
_____Yes
__X__ No

19(B) Were these stem cell lines NIH-approved lines that were derived outside of Pennsylvania?
_____Yes
_____ No

19(C) Please describe how this project involved human embryonic stem cells:

20. Articles Submitted to Peer-Reviewed Publications.

20(A) Identify all publications that resulted from the research performed during the funding period and that have been submitted to peer-reviewed publications. Do not list journal abstracts or presentations at professional meetings; abstract and meeting presentations should be listed at the end of item 17. **Include only those publications that acknowledge the Pennsylvania Department of Health as a funding source** (as required in the grant agreement). List the title of the journal article, the authors, the name of the peer-reviewed publication, the month and year when it was submitted, and the status of publication (submitted for publication, accepted for publication or published.). Submit an electronic copy of each publication or paper submitted for publication, listed in the table, in a PDF version 5.0.5 (or greater) format, 1,200 dpi. Filenames for each publication should include the number of the research project, the last name of the PI, and an abbreviated title of the publication. For example, if you submit two publications for Smith (PI for Project 01), one publication for Zhang (PI for Project 03), and one publication for Bates (PI for Project 04), the filenames would be:

Project 01 – Smith – Three cases of isolated
Project 01 – Smith – Investigation of NEB1 deletions
Project 03 – Zhang – Molecular profiling of aromatase
Project 04 – Bates – Neonatal intensive care

If the publication is not available electronically, provide 5 paper copies of the publication.

Note: The grant agreement requires that recipients acknowledge the Pennsylvania Department of Health funding in all publications. Please ensure that all publications listed acknowledge the Department of Health funding. If a publication does not acknowledge the funding from the Commonwealth, do not list the publication.

Title of Journal Article:	Authors:	Name of Peer-reviewed Publication:	Month and Year Submitted:	Publication Status (check appropriate box below):
1. None				☐Submitted ☐Accepted ☐Published

20(B) Based on this project, are you planning to submit articles to peer-reviewed publications in the future?

Yes_____ No____X_____

If yes, please describe your plans:

21. Changes in Outcome, Impact and Effectiveness Attributable to the Research Project. Describe the outcome, impact, and effectiveness of the research project by summarizing its impact on the incidence of disease, death from disease, stage of disease at time of diagnosis,

or other relevant measures of outcome, impact or effectiveness of the research project. If there were no changes, insert "None"; do not use "Not applicable." Responses must be single-spaced below, and no smaller than 12-point type. DO NOT DELETE THESE INSTRUCTIONS. There is no limit to the length of your response.

Radiopharmaceuticals produced by the new facility will support research using PET probes for a range of cancer applications that include pharmacodynamic markers in early-phase drugs (Peter O'Dwyer, MD), head and neck cancer hypoxia (Alex Lin, MD), radiation dosimetry for proton therapy of gynecologic cancer (Lilie Lin, MD), research in alpha-emitter radionuclide therapy (Daniel Pryma, MD), and novel methods for tracking cellular therapy (Michael Farwell, MD), to name a few. These cover a broad range of capabilities that enhance treatments for cancer patients including (1) better cancer detection and diagnosis, (2) earlier assessment of treatment efficacy, (3) the ability to predict therapeutic response and resistance to guided targeted therapy, and (4) biologic insights into in vivo cancer behavior leading to new treatment directions.

The facility has also attracted funding, including a recent NIH R01 for Dr. Lin and DOD grant for Dr. Pryma.

22. Major Discoveries, New Drugs, and New Approaches for Prevention Diagnosis and Treatment. Describe major discoveries, new drugs, and new approaches for prevention, diagnosis and treatment that are attributable to the completed research project. If there were no major discoveries, drugs or approaches, insert "None"; do not use "Not applicable." Responses must be single-spaced below, and no smaller than 12-point type. DO NOT DELETE THESE INSTRUCTIONS. There is no limit to the length of your response.

None

23. Inventions, Patents and Commercial Development Opportunities.

23(A) Were any inventions, which may be patentable or otherwise protectable under Title 35 of the United States Code, conceived or first actually reduced to practice in the performance of work under this health research grant? Yes_____ No___X_____

If "Yes" to 23(A), complete items a – g below for each invention. (Do NOT complete items a - g if 23(A) is "No.")

a. Title of Invention:

b. Name of Inventor(s):

c. Technical Description of Invention (describe nature, purpose, operation and physical, chemical, biological or electrical characteristics of the invention):

d. Was a patent filed for the invention conceived or first actually reduced to practice in the performance of work under this health research grant?
Yes_____ No____

If yes, indicate date patent was filed:

e. Was a patent issued for the invention conceived or first actually reduced to practice in the performance of work under this health research grant?
Yes_____ No____
If yes, indicate number of patent, title and date issued:
Patent number:
Title of patent:
Date issued:

f. Were any licenses granted for the patent obtained as a result of work performed under this health research grant? Yes_____ No____

If yes, how many licenses were granted?_____

g. Were any commercial development activities taken to develop the invention into a commercial product or service for manufacture or sale? Yes___ No____

If yes, describe the commercial development activities:

23(B) Based on the results of this project, are you planning to file for any licenses or patents, or undertake any commercial development opportunities in the future?

Yes_____ No____X_____

If yes, please describe your plans:

24. Key Investigator Qualifications. Briefly describe the education, research interests and experience and professional commitments of the Principal Investigator and all other key investigators. In place of narrative you may insert the NIH biosketch form here; however, please limit each biosketch to 1-2 pages.

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2.

NAME	POSITION TITLE
Divgi, Chaitanya R.	**Vice Chairman / Research, Department of Radiology, College of Physicians and Surgeons of Columbia University, NY Director, Columbia University Medical Center PET Center**
eRA COMMONS USER NAME (credential, e.g., agency login) **DivgiC**	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Bangalore University, Bangalore, India	MD	1969 - 1976	Medicine
New York University, New York, NY	MS	1986 - 1987	Health Management
Memorial-Sloan Kettering Cancer Center, New York, NY		1985 - 1987	Resident, Nuclear Med.
Memorial-Sloan Kettering Cancer Center, New York, NY		1987 - 1991	Fellow, Nuclear Immunol.

A. Personal Statement

Dr. Divgi was the Chief of the molecular imaging division and director of the PET center at the University of Pennsylvania. He is now at Columbia University. Dr. Divgi joined Penn in 2006, after more than 20 years at Memorial Sloan-Kettering Cancer Center, where he directed the radio-labeled antibody program as well as the targeted therapy program in Nuclear Medicine. He has been at the forefront of clinical PET development; he serves on the Special Emphasis Panel as well as other review boards at the National Cancer Institute, is a member of the Cancer Steering Committee of the Biomarkers Consortium at the National Institutes of Health, and is an internationally acknowledged leader in the use of novel radiopharmaceuticals in the detection and management of cancer.

B. Positions and Honors

4/81-6/82	Chief of Nuclear Medicine, Choithram Hospital and Research Centre, Indore, India
6/82-6/85	Specialist Physician and Head, Nuclear Medicine Service, Department of Medical Imaging, Al-Jazeira Hospital, Ministry of Health, Abu Dhabi, United Arab Emirates
6/91-11/96	Assistant Member and Assistant Attending Physician, Department of Radiology, Nuclear Medicine Service and Department of Medicine, Clinical Immunology Service, Memorial Sloan-Kettering Cancer Center (MSKCC), New York, NY
3/92-12/01	Head, Monoclonal Antibody Unit, Nuclear Medicine Service, MSKCC, New York, NY
4/93-3/01	Head, Nuclear Cardiology Section, Nuclear Medicine Service, MSKCC, New York, NY

6/94- 5/06	Director, Nuclear Medicine Outpatient Consultation and Therapy Clinic, Nuclear Medicine Service, MSKCC, New York, NY
11/96-8/02	Associate Attending Physician and Associate Member, Department of Radiology and Department of Medicine, MSKCC, New York, NY
1/02- 5/06	Head, Targeted Therapy Section, Nuclear Medicine Service, MSKCC, New York, NY
09/02- 5/06	Attending Physician and Member, Nuclear Medicine and Clinical Immunology Services, Department of Radiology and Department of Medicine, MSKCC, New York, NY
2006-2011	Chief of Nuclear Medicine Division, Department of Radiology, Hospital of the University of Pennsylvania
2011-current	Vice Chairman / Research, Department of Radiology, College of Physicians and Surgeons of Columbia University, NY Director, Columbia University Medical Center PET Center

Other Experience and Professional Memberships/Honors

1995, 1998, 2001, 2004	Lectureship, Institute for Molecular & Immunologic Medicine, Barcelona, Spain
1997	Lectureship, Royal College of Radiologists at the University of Hong Kong, Hong Kong
1999, 2003	Lectureship, University of Singapore, Singapore
2000, 2003	Lectureship, Tata Institute for Fundamental Research, Bombay, India
2000	Lectureship, Royal College of Physicians of Canada, Mont Tremblant, Quebec
2003	Vikram Sarabhai Memorial Oration Award, SNM (India)
2004	Keynote address, Society of Nuclear Medicine (India) annual meeting
2004	Keynote Speaker: First International Symposium on Nuclear Oncology, Brazil
2004	Nuclear Oncology update, Radiologic Society of North America Annual Meeting.
2005	Keynote Speaker: First International Symposium on Radiopharmaceutical Therapy, Cyprus.