DANA-FARBER/BRIGHAM AND WOMEN'S
CANCER CENTER

CENTER FOR NEURO-ONCOLOGY

HARVARD MEDICAL SCHOOL
TEACHING AFFILIATE

Center for Neuro-Oncology

World-Class Cancer Care

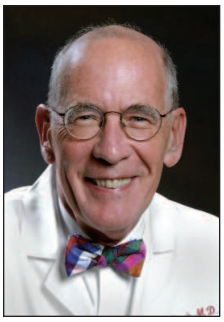
The Center for Neuro-Oncology, one of 12 treatment centers at Dana-Farber/Brigham and Women's Cancer Center, offers one of the world's most advanced treatment and research programs in adult neuro-oncology. A multidisciplinary team of specialists — including neuro-oncologists, neurosurgeons, radiation oncologists, medical oncologists, neuro-endocrinologists, neuroradiologists, neuro-pathologists, neuro-psychiatrists, neuro-psychologists, nurses, dietitians, and social workers — works together to evaluate and deliver the most effective treatment for each patient.

Front row: *Naren R. Ramakrishna, MD, PhD; Peter M. Black, MD, PhD; Patrick Y. Wen, MD*
Back row: *Elizabeth A. Maher, MD, PhD; Stephanie E. Weiss, MD; Alexandra J. Golby, MD; Mark D. Johnson, MD, PhD; Ursula B. Kaiser, MD; Santosh Kesari, MD, PhD*

The Center provides advanced care for patients with a broad range of central nervous system tumors, including:

- Acoustic neuromas (vestibular schwannomas);
- Anaplastic astrocytomas and oligodendrogliomas;
- Astrocytomas;
- Carcinomatous meningitis;
- Cavernous angiomas;
- Chordomas;
- Colloid cysts;
- Craniopharyngiomas;
- Dermoids;
- Epidermoids;
- Ependymomas and subependymomas;
- Gangliogliomas;
- Glioblastoma multiforme (GBM);
- Gliomas;
- Hemangioblastomas;
- Lymphomas;
- Leptomeningeal metastases;
- Medulloblastomas;
- Meningiomas;
- Metastatic brain tumors;
- Neuroblastomas;
- Oligodendrogliomas;
- Optic nerve gliomas;
- Pineal region tumors;
- Pituitary tumors;
- Skull base tumors;
- Skull tumors;
- Sarcomas;
- Spinal cord tumors;
- Tumors of neurofibromatosis;
- Ventricular tumors.

Brigham and Women's Hospital and Dana-Farber Cancer Institute continue to be world-class leaders in cancer treatment and research. *U.S.News & World Report*® repeatedly includes Brigham and Women's Hospital on its Honor Roll of "America's Best Hospitals" and Dana-Farber Cancer Institute among the top cancer centers in the nation.



PETER M. BLACK, MD, PHD
Chief, Neurosurgical Oncology and Director,
Center for Neuro-Oncology,
Dana-Farber/Brigham and Women's Cancer Center;
Neurosurgeon-in-Chief, Brigham and Women's Hospital;
Franc D. Ingraham Professor of Neurosurgery,
Harvard Medical School

A world-renowned expert in brain tumor treatment and research and a veteran of more than 3,000 brain tumor procedures, Dr. Black has pioneered the use of state-of-the-art surgical techniques for brain tumors, including minimally invasive image-guided neurosurgery, microneurosurgery, pituitary surgery, and skull base surgery. With particular interest in meningiomas, pituitary adenomas, low-grade gliomas, and acoustic neuromas, Dr. Black leads 15 neurosurgeons in the treatment of brain tumors and other neurosurgical diseases and co-directs the Neurosurgical Oncology Laboratory at Brigham and Women's Hospital.

ADVANCED DIAGNOSTIC SERVICES

Neuro-radiologists and neuro-pathologists at the Center for Neuro-Oncology use advanced tools to diagnose and stage central nervous system tumors, including:

STATE-OF-THE-ART DIAGNOSTIC IMAGING

- Positron Emission Tomography (PET-CT) detects areas of metabolic activity that may signal the presence of disease before any structural change becomes apparent by other imaging. Whole body scans using PET-CT can also detect systemic disease;
- 16-Channel Computed Tomography (CT) Scanner scans 32 images per second and provides detailed images in multiple planes, including 3D, to enhance planning for surgical and image-guided interventions;
- 3 Tesla MR offers twice the imaging power of the traditional 1.5 Tesla MR and enables advanced brain imaging with functional MRI (fMRI) and diffusion tensor imaging;
- Interventional biplane angiography and embolization are used to diagnose and treat tumors, especially vascular tumors.

ADVANCED NEURO-PATHOLOGY

A team of board-certified neuropathologists in the Center for Neuro-Oncology use all contemporary methods for diagnosing brain tumors, including immunohistochemistry, fluorescence *in situ* hybridization (FISH), molecular profiling, and electron microscopy. Neuropathologists in the Center are also actively engaged in research studies in neuro-oncology.

Neurosurgeons in the Center for Neuro-Oncology at Dana-Farber/Brigham and Women's Cancer Center provide advanced treatment for patients, including intraoperative magnetic resonance imaging therapy. Using functional brain mapping and real-time navigation during surgery, experts in the Center are able to provide the safest possible therapy, including neurosurgical treatment for tumors located in eloquent areas of the brain.

INNOVATIVE TREATMENT

The team of specialists in the Center for Neuro-Oncology delivers state-of-the-art care, including neurosurgery, radiation oncology, medical oncology, neurology, and neuro-endocrinology, neuro-psychology, and neuro-psychiatry, as well as comprehensive patient support services.

IMAGE-GUIDED NEUROSURGERY

Neurosurgeons in the Center use advanced, image-guided techniques, including navigation in the traditional operating room, brain mapping, and intraoperative imaging, to provide minimally invasive treatment and improved quality-of-life for patients. They work closely with specialists in the Brigham and Women's Hospital Surgical Planning Laboratory to perform sophisticated and comprehensive preoperative planning. Alexandra J. Golby, MD, performs brain mapping by merging high-resolution functional MRI (fMRI) with diffusion tensor imaging and intraoperative electrophysiologic testing (ECS).

Alexandra J. Golby, MD

Neurosurgeon, Dana-Farber/Brigham and Women's Cancer Center and Brigham and Women's Hospital; Principal Investigator, Golby Laboratory for Surgical Brain Mapping, Brigham and Women's Hospital and Harvard Medical School; Instructor in Surgery, Harvard Medical School

Dr. Golby has developed novel brain mapping techniques for use before and during neurosurgical procedures, including functional magnetic resonance imaging, tract mapping, and intra-operative cortical mapping specially designed for the treatment of brain tumors located in eloquent motor and language cortex. By preserving critical brain areas, Dr. Golby and her colleagues have improved outcomes and quality-of-life for patients.

Mark D. Johnson, MD, PhD

Neurosurgeon, Dana-Farber/Brigham and Women's Cancer Center and Brigham and Women's Hospital; Principal Investigator, Molecular Neuroscience Initiative of the Neurosurgical Oncology Laboratory, Brigham and Women's Hospital; Assistant Professor of Neurosurgery, Harvard Medical School

With primary clinical interest in gliomas, metastatic tumors, and radiosurgery, Dr. Johnson also conducts cellular and molecular neuroscience research in the Neurosurgical Oncology Laboratory that is aimed at unraveling the complex origins of glioma development and discovering more effective treatments for malignant brain tumors.

Functional brain mapping during surgery ensures the safest possible therapy, including neurosurgical treatment for tumors located in eloquent areas. The GE Signa® system at Brigham and Women's Hospital allows real-time navigation during surgery.

Advanced surgical techniques at the Center include:

- Microneurosurgery using the most precise and minimally invasive techniques;
- All available skull base surgical techniques;
- Pre-operative mapping to identify eloquent areas of the brain and the underlying tumor tracts;
- Segmentation of tumor and three-dimensional reconstruction;
- Craniotomy with intravenous sedation anesthesia and with other monitoring techniques as needed;
- Neuro-navigation in the traditional operating room;
- Real-time intraoperative image guidance in the Magnetic Resonance Therapy (MRT) Suite.

Neurosurgeons at the Center are also combining treatment modalities and exploring new, minimally invasive techniques, such as thermal therapies, to achieve the best results possible. These include:

- Focused ultrasound;
- Convection-enhanced delivery of chemotherapy;
- Laser hyperthermia.

Leading the Way in Intraoperative MRI

Physicians in the Brigham and Women's Hospital Department of Radiology Image Guided Therapy Program pioneered in the design and production of the intraoperative magnetic resonance imaging (MRI) scanner, featuring an open magnet for surgical application. In 1994, neurosurgeons at Brigham and Women's Hospital were the first in the world to use intraoperative MRI for brain tumor craniotomy. Today, a new, highly-sophisticated Advanced Multimodality Image-Guided Operating Room (AMIGO) system, featuring 3 Tesla high-resolution MR imaging and PET-CT with potential to use metabolic markers to guide surgery, is being developed.

Image-Guided and Conformal Radiation Therapy

Conformal radiation therapy at the Center for Neuro-Oncology provides advanced treatment, while preserving as much normal brain tissue as possible. Radiation oncology treatment approaches at the Center include:

- Intensity Modulated Radiotherapy (IMRT);
- Radiopharmaceutical therapy;
- Stereotactic radiosurgery, including frame-based and frameless image-guided stereotactic radiosurgery;
- Spine stereotactic radiosurgery;
- Proton beam radiation through the Partners Northeast Proton Therapy Center, including preclinical development and clinical trials.

Radiation oncologists in the Center use Intensity Modulated Radiotherapy (IMRT) to adjust radiation therapy between tumors and healthy tissue, reducing the risk of radiation-related injury to normal structures.

Neuro-Oncology

Patrick Y. Wen, MD

Clinical Director, Center for Neuro-Oncology, Dana Farber/Brigham and Women's Cancer Center;
Director, Division of Neuro-Oncology, Department of Neurology, Brigham and Women's Hospital;
Associate Professor of Neurology, Harvard Medical School

Dr. Wen provides advanced treatment for patients with brain tumors and neurologic complications of cancer. He conducts a large number of innovative trials focused on targeted molecular therapies, inhibitors of angiogenesis, and novel chemotherapeutic agents.

Santosh Kesari, MD, PhD

Neuro-Oncologist, Dana-Farber/Brigham and Women's Cancer Center;
Instructor in Neurology, Harvard Medical School

A board certified neurologist and neuro-oncologist, Dr. Kesari provides innovative care for neuro-oncology patients, including chemotherapy and novel molecular targeted agents for primary and metastatic brain tumors. In addition, Dr. Kesari's basic and translational research focuses on understanding developmental abnormalities leading to brain tumors and studying new drugs to effectively target these pathways.

Advanced Treatment for Meningiomas and Gliomas

Brain Science Foundation Meningioma Center

The Brain Science Foundation Meningioma Center in the Center for Neuro-Oncology, supported in part by the Brain Science Foundation, offers a highly-targeted, multi-faceted approach to care for patients with meningiomas. Peter M. Black MD, PhD, and Naren R. Ramakrishna, MD, PhD, provide innovative treatment for meningiomas, including advanced image-guided neurosurgery and fractionated stereotactic radiotherapy, used to remove and shrink meningioma tumors while sparing normal surrounding tissue. Rona S. Carroll, PhD, is working to identify agents with the potential to suppress brain tumor growth, and Elizabeth Claus, MD, PhD, is combining clinical, epidemiological, and biological data on patients with meningiomas and examining risk factors in an effort to identify patients who may benefit from specific treatments or preventative measures.

Specialized Care for Patients with Gliomas

Experts in the Center for Neuro-Oncology are applying multi-disciplinary treatment approaches and advanced research for the care of patients with gliomas. Specialized treatment techniques include local convection-enhanced delivery of drugs used to inhibit glioma growth. Research includes cellular and molecular neuroscience efforts at the Neurosurgical Oncology Laboratory, led by Peter M. Black, MD, PhD, Rona S. Carroll, PhD, and Mark D. Johnson, MD, PhD, aimed at unraveling the complex origins of glioma development and discovering more effective treatments for these disorders.

Elizabeth A. Maher, MD, PhD

Medical Oncologist, Dana-Farber/Brigham and Women's Cancer Center;
Instructor in Medicine, Harvard Medical School

Dr. Maher is a medical oncologist specializing in the care of patients with primary malignant gliomas or brain metastases. She provides state-of-the art medical care and participates in national clinical trials. A translational scientist in neuro-oncology, Dr. Maher's research focuses on the genetic analysis of gliomas and the development of preclinical glioma models with the goal of identifying new therapeutic targets and developing and testing novel therapies for gliomas.

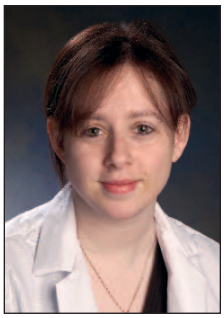
Radiation Oncology

Naren R. Ramakrishna, MD, PhD

Director, Central Nervous System Radiosurgery/Radiotherapy, Dana-Farber/Brigham and Women's Cancer Center;
Instructor in Radiation Oncology, Harvard Medical School

Dr. Ramakrishna is pioneering new techniques in image-guided radiosurgery, Intensity Modulated Radiotherapy (IMRT), radiopharmaceutical therapy, and boron-neutron capture therapy for the treatment of malignant and benign brain tumors. Dr. Ramakrishna also conducts laboratory research to develop targeted molecular drugs and radiosensitizers for brain tumors, including malignant gliomas and meningiomas.

Radiation Oncology



Stephanie E. Weiss, MD

Radiation Oncologist, Dana-Farber/Brigham and Women's Cancer Center; Instructor in Radiation Oncology, Harvard Medical School

A specialist in the treatment of central nervous system tumors, Dr. Weiss is experienced in 3D conformal radiation therapy, IMRT, stereotactic radiosurgery, and fractionated stereotactic radiotherapy. Author of a chapter on the use of fractionated stereotactic radiation for acoustic neuromas in the book *Cancer of the Nervous System*, Dr. Weiss has also published in peer-reviewed journals and presented her research at national meetings.

Neuroendocrinology

Ursula B. Kaiser, MD

Director, Neuroendocrine Program, Division of Endocrinology, Diabetes, and Metabolism, Brigham and Women's Hospital; Associate Professor of Medicine, Harvard Medical School

Dr. Kaiser provides endocrine care for patients with pituitary tumors or other types of brain tumors with endocrine involvement. She provides medical therapy for the treatment of pituitary tumors, and treats conditions of pituitary hormone excess or deficiency. Dr. Kaiser's research interests include understanding molecular mechanisms that control pituitary function and the pathogenesis of pituitary tumors.

Medical Neuro-oncology

Neuro-oncologists at the Center for Neuro-Oncology specialize in neuro-oncology and neurology and offer the latest medical oncology treatment options for brain tumors, including:

- Cutting-edge clinical trials, including targeted molecular therapies and combinations of therapies;
- Novel inhibitors of angiogenesis;
- Immunology efforts, including novel vaccine therapies and other immunotherapy for brain tumors;
- Close collaboration with laboratory research, including gene profiling research, using a bench-to-bedside approach to care;
- Local convection-enhanced delivery of drugs through catheters, and encapsulation designed to inhibit growth of gliomas;
- Innovative treatment for neurologic complications of cancer, including metastases in the nervous system.

Neuroendocrinology

Neuroendocrinology experts at the Center provide specialized treatment, including advanced medical therapy, for pituitary tumors or other tumor types with endocrine involvement, as well as care for patients with pituitary hormone excess or insufficiency and neuroendocrine complications of radiation therapy or other oncology treatment affecting pituitary hormone levels. Basic science research includes understanding mechanisms that control pituitary function and pathogenesis of pituitary tumors.

Comprehensive Patient Support Services

The Center for Neuro-Oncology provides comprehensive patient support services, including:

- Specialized support staff, including nurses, psychosocial oncologists, social workers, etc.
- Group discussion of treatment options with a multi-disciplinary team of specialists;
- Brain Tumor Support Group;
- Informational services.

Care for Patients with Pituitary Tumors

Advanced medical therapy for patients with pituitary tumors, pituitary hormone excess or insufficiency, or neuroendocrine complications of radiation therapy or other oncology treatment is provided by neuroendocrinology experts at the Center, including Ursula B. Kaiser, MD. Researchers and experts in the Center are striving to understand molecular mechanisms that control regulation of neuroendocrine function and pituitary hormone production as well as the pathogenesis of pituitary tumors.

Pituitary surgeons, including Peter M. Black, MD, PhD, and Alexandra J. Golby, MD, perform expert transsphenoidal surgery and other techniques for pituitary tumors. Naren R. Ramakrishna, MD, PhD, and Stephanie E. Weiss, MD, provide advanced radiation therapy for patients with pituitary tumors.

Pioneering Research

From Bench to Bedside

Leading the Way in Neuro-Oncology Research

Innovative translational research efforts at the Center for Neuro-Oncology include:

- Targeted molecular therapy;
- Novel inhibitors of angiogenesis;
- Local delivery of chemotherapy;
- Use of neural stem cells transfected with therapeutic drug, designed to migrate and find islets of cells from glioblastomas;
- Robotic technology in the intraoperative MRI;
- New medical therapies of pituitary disease.

Researchers Rona S. Carroll, PhD and Lois Lampson, PhD, from Brigham and Women's Hospital, and Charles Stiles, PhD, and Ronald Depinho, MD, from Dana-Farber Cancer Institute are collaborating with physicians in the Center for Neuro-Oncology in basic science research efforts designed to enhance the understanding of tumor behavior to develop new treatment approaches. Basic science initiatives at the Center include:

- Immunotherapy for disseminated and residual microscopic tumor foci in primary and metastatic brain tumors;
- Molecular analysis of tumors;
- Tumor profiling to discover new therapies;
- Understanding of angiogenesis and invasiveness;
- Identification of genes responsible for the regulation of normal brain function to isolate mutated genes found in brain tumors;
- Transgenic model studies of gliomas and meningiomas with focus on genes for molecular understanding of tumor type in order to evaluate novel therapeutics.

More than 2,500 brain tumor samples available in the Brain Tumor Tissue Bank, transgenic tumor models, molecular profiling, and computer-based bioinformatic techniques are combined together in a large-scale effort to identify the molecular underpinnings of brain tumors and to develop new treatment methods.

Neurosurgical Oncology Laboratory

Led by Peter M. Black, MD, PhD, Rona S. Carroll, PhD, and Mark D. Johnson, MD, PhD, in close collaboration with investigators at Dana-Farber Cancer Institute, the Neurosurgical Oncology Laboratory at Brigham and Women's Hospital conducts cellular and molecular research in brain tumors. The goal of the Laboratory is to unravel the complex origins of gliomas, meningiomas, and other tumors, with a special concentration on discovering possible control points in growth and more effective treatments for these disorders. Focused on the molecular basis of brain tumor development and resistance to treatment, as well as mechanisms of cell death occurring in neurons, astrocytes, or glioma cells after radiation, chemotherapy, or other forms of injury, the Laboratory employs multiple cutting-edge medical research techniques. These include:

- Comparative genomic hybridization and messenger RNA expression profiling of tumors;
- Mass spectrometry proteomics;
- Real-time PCR;
- SNP genome analysis;
- Development of novel delivery methods for therapeutic agents;
- Other cell and molecular biology techniques.

Connecting You to Dana-Farber/Brigham and Women's Cancer Center

If you would like more information about our physicians, or to make a referral to the Center for Neuro-Oncology at Dana-Farber/Brigham and Women's Cancer Center, please call **1-877-DFCI-BWH**.

Center for Neuro-Oncology

Neurosurgery

Peter M. Black, MD, PhD
Chief, Neurosurgical Oncology
Director, Center for Neuro-Oncology

Alexandra J. Golby, MD
Neurosurgeon

Mark D. Johnson, MD, PhD
Neurosurgeon

Neurology

Patrick Y. Wen, MD
Clinical Director, Center for Neuro-Oncology

Robert Bachoo, MD, PhD
Neurologist

Santosh Kesari, MD, PhD
Neuro-Oncologist

Medical Oncology

Elizabeth A. Maher, MD, PhD
Medical Oncologist

Endocrinology

Ursula B. Kaiser, MD
Director, Neuroendocrine Program

Gail K. Adler, MD, PhD
Endocrinologist

Robert G. Dluhy, MD
Endocrinologist

Radiation Oncology

Naren R. Ramakrishna, MD, PhD
Director, Central Nervous System Radiosurgery/Radiotherapy

Stephanie E. Weiss, MD
Radiation Oncologist

Psychiatry

Michael K. Miovic, MD
Psychosocial Oncologist

Radiology

Marcelo Di Carli, MD
Chief, Nuclear Medicine

Amir A. Zamani, MD,
Director, Neuroradiology Service

Masonari Ichise, MD,
Director, Molecular Brain Imaging Program

Ferenc A. Jolesz, MD
Director, Magnetic Resonance Imaging

Liangge Hsu, MD
Neuroradiologist

Pathology

Umberto De Girolami, MD
Chief, Neuropathology

Joseph Corbo, MD, PhD
Neuropathologist

Jennifer A. Chan, MD
Neuropathologist

Mel B. Feany, MD, PhD
Neuropathologist

Rebecca D. Folkerth, MD
Neuropathologist

Hart G. Lidov, MD, PhD
Neuropathologist

Keith L. Ligon, MD, PhD
Neuropathologist

Margaret E. McLaughlin, MD
Neuropathologist

Christopher Pierson, MD, PhD
Neuropathologist

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