A Focus on Brain Tumors

2009 CANCER REPORT

2008 DATA

WESTCHESTER MEDICAL CENTER

CANCER CENTER

Dear Friend:

The last few years have been very productive for Westchester Medical Center as we have continued to follow our mission to serve as the regional healthcare referral center providing high-quality advanced health services to the residents of the Hudson Valley and the surrounding area, regardless of their ability to pay.

Our Cancer Institute has experienced positive change and progress, as well. We recently have committed significant resources to this Center of Excellence and plan to revitalize several key clinical service areas including radiation medicine, our portfolio of tumor site treatment, and the overall facility itself. We are also dedicating our efforts to meet and exceed all standards set forth by the American College of Surgeons Commission on Cancer. A new, experienced executive has joined our cancer team to lead these efforts and face the challenges and opportunities before us. We also appointed an Oncology Leadership Group, made up of key WMC stakeholders charged with working in conjunction with the service line executive to direct the future of our oncology services. They are off to a great start with the development of a new and vital strategic plan.

Finally, we want to continue to work with community healthcare organizations to improve the cancer care available to all the children and adults in the Hudson Valley. Together, we can continue to provide a comprehensive continuum of the best cancer services anywhere. I congratulate everyone on the hard work already underway and look forward to the progress that lies ahead.

Sincerely,

Michael D. Israel
President and Chief Executive Officer
Westchester Medical Center

Westchester Medical Center

877•WMC•DOCS
worldclassmedicine.com

Maria Fareri Children's Hospital • Heart Center • Cancer Institute • Transplant Center • Neuroscience Center
Joel A. Halpern Regional Trauma Center • Burn Center • Behavioral Health Center

Table of Contents

2009 CANCER COMMITTEE MEMBERS

Tauseef Ahmed, MD/Medical Oncology & Cancer Committee Chair
Andrew Ashikari, MD/Surgical Oncology
Deborah Benzil, MD/Neurosurgery
Alvin Chisholm, MD/Diagnostic Radiology
Marcelo Facciutto, MD/GI and Hepatobiliary
Zvi Lefkovitz, MD/Chairman of Radiology
Robert Madden, MD/Surgery
Myron Melamed, MD/Pathology
Chitti Moorthy, MD/Chairman Radiation Medicine
Augustine Moscatello, MD/Otolaryngology
Raj Murali, MD/Chairman Neurosurgery
John Phillips, MD/Urologic Oncology
Kathryn Spanknebel, MD/Surgical Oncology ACS CoC Liaison
Oya Tugal, MD/Pediatric Oncology

NON-PHYSICIAN MEMBERS

Andres Avila/Cancer Registry
Marsha Casey/Administration
Maureen Cooney, FNP/Pain Service
Deanna Derdelinghen, CTR/Cancer Registry
Marie DiMico/Pharmacy
Rita Donovan, RN/Oncology Nursing
Linda Glickman/Quality Clinical Resource Management
Regina Kristan, MSW, CSW/Oncology Social Services
Rev. Susan Lunning/Pastoral Care
Barry Marshall, MBA, FACHE/VP Transplant & Oncology Services
Carmel Sauerland, MSN, AOCN/Oncology Nursing
Catherine Spratt, BSN, OCN/Patient Care Services

GUEST MEMBERS/ALTERNATES

Howard Blanchette, MD/Chairman OB-GYN
Muhammad Choudhury, MD/Chairman, Urology
Isabel Dichiara/Community Relations & Outreach
Umadevi Katta, MD/Pathology
Susan Kemker, MD/Psychology
Rick Lepkowski/Regional Director, American Cancer Society
Anthony Mahler/Strategic Planning
Nisha Shah/Pharmacy

2009 SUBCOMMITTEES

CANCER CONFERENCE AND EDUCATION

Co-Coordinators:
Tauseef Ahmed, MD, FACP/Medical Oncology
Chitti Moorthy, MD/Radiation Medicine

Members:
Andres Avila/Cancer Registry
Howard Blanchette, MD/Gynecology
John Phillips, MD/ Urology Oncology
Barry Marshall, MBA, FACHE, Transplant & Oncology Services
Augustine Moscatello, MD/ ENT

CANCER DATA QUALITY

Coordinator: Kathryn Spanknebel, MD/Surgical Oncology

Members:
Andres Avila/Cancer Registry
Andrew Ashikari, MD/Surgical Oncology
Deanna Derdelinghen, CTR/Cancer Registry
Robert Madden, MD/Surgery
Barry Marshall, MBA, FACHE, Transplant & Oncology Services
Myron Melamed, MD/Pathology

QUALITY IMPROVEMENT AND RESEARCH

Coordinator: Deborah Benzil, MD/Neurosurgery

Members:
Andres Avila/Cancer Registry
Marie Dimicco/Pharmacy
Orpha Lubben, RN, MPA, CCM, CPHQ
Magdalanea Mandzielwska, MPH, CPC
Barry Marshall, MBA, FACHE, Transplant & Oncology Services
Carmel Sauerland, MSN, AOCNS/Oncology Nursing

COMMUNITY CANCER OUTREACH

Coordinator: Dr. Facciuto, MD/Liver Transplant Surgery

Members:
Isabel Dichiara/Community Relations & Outreach
Regina Kristan/Oncology Social Service
Rick Lepkowski/Regional Director ACS
Barry Marshall, MBA, FACHE, Transplant & Oncology Services
Chitti Moorthy, MD/Radiation Medicine
Carmel Sauerland, MSN, AOCNS/Oncology Nurse

CHAIRMAN'S MESSAGE

Westchester Medical Center (WMC) provides a broad spectrum of cancer care to the Hudson Valley region and beyond. In 2007, the medical center was granted a three-year Foundation for the Accreditation of Cellular Therapy (F.A.C.T.) certificate and provides cancer treatment and clinical trials in bone marrow transplant, leukemia, lymphoma, head and neck, hepatobiliary, melanoma, neurologic tumors, prostate cancer, lung cancer and other cancer sites for adults and children. Oncology programs and services provided on an inpatient and outpatient basis include infusions, transfusion, apheresis, IMRT, brachytherapy, stereotactic radiosurgery and a full scope of surgical services.

Members of the Westchester Medical Center Cancer Team include physicians, nurses, allied health professionals, chaplains, social workers, dieticians, clinical researchers, and hospital administrators who work together to provide optimum care for our patients. In addition to the Multi-Specialty Oncology Conference, WMC offers eight different disease-specific tumor boards, multiple division level grand rounds, conferences and physician education symposia. These conferences allow us to provide the highest level of care, to teach, to explore treatment options, to maximize technological advances, and to encourage new ways of finding solutions. It is a privilege to provide high-quality care to our oncology patients and their families in a caring environment.

The Cancer Committee at WMC is committed to maintaining and improving the systems that support our mission, values and goals. The Cancer Committee and the WMC Cancer Registry worked diligently to review, assess and implement the latest standards of the American College of Surgeons Commission on Cancer (ACoS).

Reaching out to our local community to provide cancer education and prevention programs is an important part of Westchester Medical Center's focus. Together with other community partners such as the American Cancer Society, we are able to bring much-needed programs and services to the Hudson Valley Region.

One of the standards of the ACoS for our Cancer Program accreditation is to review and set annual goals. The Cancer Committee set forth a series of goals and objectives that tied accomplishments to the ACoS standards. Five subcommittees were established with the goal of obtaining the Pediatric Cancer Program Component accreditation along with our Teaching Hospital Cancer Program accreditation. The Cancer Program is multi-disciplinary and provides personal care that is patient-centered, research-oriented and quality driven.

Tauseef Ahmed, M.D., FACP

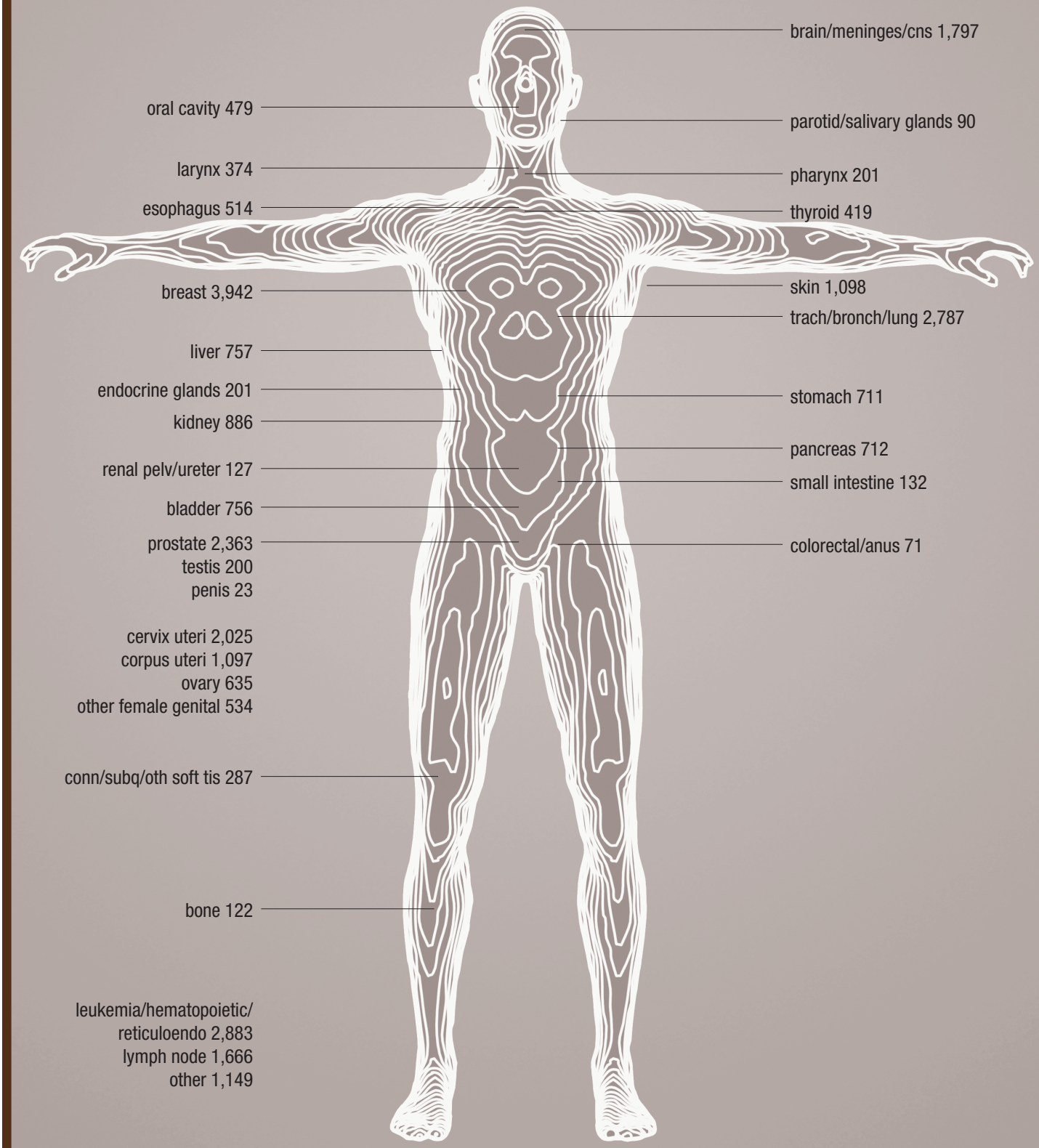
Chairman, Cancer Committee
Chief, Division of Oncology & Hematology, Westchester Medical Center
Professor, Oncology & Hematology, New York Medical College

Goals and Objectives

- *Reduce morbidity and mortality of individuals at high risk for and diagnosed with cancer in the Hudson Valley Region and beyond.*
- *Obtain and disseminate descriptive data concerning the nature and extent of cancer in the communities served to promote cancer prevention and early detection.*
- *Promote accrual to cancer clinical trials and participate in continuous performance improvement through maintenance of a quality data base and regular reports to the medical staff, New York State Cancer Registry and the National Cancer Data Base.*
- *Encourage lifetime continuous medical follow-up for all Westchester Medical Center cancer patients through the annual surveillance system.*
- *Provide internal and external professional education for healthcare providers regarding all aspects of the cancer experience.*
- *Establish infrastructure competencies and oversight monitoring of subcommittee work to insure program compliance.*
- *Meet the standards set forth by the American College of Surgeons Commission on Cancer and earn their certificate of approval as a Teaching Hospital Cancer Program along with the Pediatric Cancer Program Component.*

FIGURE 1

TOTAL CANCER CASES: 1981 - 2008



WMC INCIDENCE TABLE

FIGURE 2

TOTAL CANCER CASES: 2008

PRIMARY SITE	TOTAL	PERC	SEX		CLASS OF CASE		ALIVE	EXP	AJCC-TNM STAGE/ANALYTIC ONLY							
			M	F	ANA	N-ANA			0	I	II	III	IV	UNK	N/A	BB
LIP	19	0.1	16	3	14	5	8	11	1	5	3	1	1	3	0	0
BASE OF TONGUE	117	0.4	83	34	103	14	52	65	2	8	12	15	46	20	0	0
OTH & UNSPEC PARTS OF TO	122	0.4	73	49	97	25	51	71	5	26	16	13	23	12	2	0
GUM	29	0.1	15	14	21	8	9	20	1	5	3	1	10	1	0	0
FLOOR OF MOUTH	77	0.2	47	30	62	15	30	47	0	13	9	2	30	8	0	0
PALATE	61	0.2	38	23	53	8	19	42	5	5	10	2	14	15	2	0
OTH PARTS OF MOUTH	54	0.2	34	20	48	6	20	34	0	7	3	4	26	5	3	0
PAROTID GLAND	76	0.2	38	38	61	15	41	35	0	16	14	9	16	5	0	1
OTH PARTS MAJ SALIVARY G	14	0	10	4	9	5	6	8	0	3	1	0	3	2	0	0
TONSIL	108	0.3	80	28	96	12	58	50	0	10	12	19	38	17	0	0
OROPHARYNX	43	0.1	30	13	38	5	17	26	0	1	3	3	21	10	0	0
NASOPHARYNX	57	0.2	37	20	40	17	25	32	0	3	3	6	19	8	1	0
PYRIFORM SINUS	36	0.1	30	6	30	6	6	30	1	2	4	5	16	2	0	0
HYPOPHARYNX	32	0.1	26	6	28	4	9	23	0	0	3	3	16	6	0	0
OTH LIP ,ORAL CAV & PHAR	33	0.1	25	8	26	7	11	22	0	1	3	3	10	6	3	0
ESOPHAGUS	514	1.6	363	151	417	97	106	408	11	36	70	79	71	148	2	0
STOMACH	711	2.2	500	211	576	135	217	494	11	81	55	122	166	115	24	2
SMALL INTESTINE	132	0.4	78	54	120	12	59	73	3	7	13	14	17	39	25	2
COLON	1489	4.7	816	673	998	491	519	970	122	168	171	142	166	220	6	3
RECTOSIGMOID JCT	204	0.6	123	81	143	61	64	140	12	20	30	18	21	42	0	0
RECTUM	493	1.6	285	208	387	106	225	268	41	60	62	71	52	87	14	0
ANUS AND ANAL CANAL	71	0.2	28	43	53	18	37	34	8	5	17	11	3	8	1	0
LIVER-INTRAHEP BILE DCTS	757	2.4	560	197	707	50	306	451	0	115	163	166	155	93	15	0
GALLBLADDER	96	0.3	31	65	79	17	25	71	4	7	14	9	28	16	1	0
OTH & UNSPEC PTS OF BILI	174	0.5	82	92	156	18	47	127	3	14	37	27	40	34	1	0
PANCREAS	712	2.2	374	338	648	64	160	552	4	48	122	107	250	102	11	5
OTH & ILL-DEFINED DIGEST	17	0.1	9	8	14	3	7	10	0	0	1	0	2	1	10	0
NASAL CAV/MIDDLE EAR	25	0.1	19	6	19	6	14	11	0	1	2	1	2	2	11	0
ACCESSORY SINUSES	50	0.2	34	16	43	7	18	32	1	2	1	1	18	10	10	0
LARYNX	374	1.2	300	74	324	50	177	197	20	77	36	74	99	17	1	0
TRACHEA	5	0	4	1	4	1	1	4	0	0	0	0	0	4	0	0
BRONCHUS AND LUNG	2782	8.8	1634	1148	2289	493	599	2183	5	321	126	530	727	557	23	0
THYMUS	27	0.1	10	17	23	4	15	12	0	1	2	1	0	5	14	0
HEART, MEDIASTINUM AND P	104	0.3	73	31	82	22	31	73	0	10	10	11	13	25	13	0
OTH W/I RESP/INTRATHOR O	1	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0
BONES, JNTS, ART CART LI	53	0.2	32	21	37	16	33	20	0	9	4	2	3	15	2	2
BONES, JNTS, ART CART OT	69	0.2	42	27	52	17	38	31	0	5	1	1	4	22	16	3
HEMATOPOIETIC/RETICULOEN	3062	9.7	1822	1240	1973	1089	970	2092	0	1	1	1	5	641	1321	4
SKIN	1098	3.5	641	457	642	456	503	595	55	140	75	78	54	157	83	0
PERIPHERAL NERVES AND AN	14	0	5	9	12	2	10	4	0	0	0	1	3	3	3	2
RETROPERITONEUM AND PERI	99	0.3	24	75	84	15	52	47	0	5	1	3	9	14	50	2
CONN, SUBQ AND OTH SOFT	287	0.9	178	109	221	66	122	165	0	27	21	41	36	81	14	2
BREAST	3942	12.4	31	3911	3052	890	2326	1616	360	983	872	272	143	417	5	0
VULVA	342	1.1	0	342	312	30	215	127	130	49	47	38	18	26	4	0
VAGINA	118	0.4	0	118	105	13	84	34	57	19	10	4	6	8	1	0
CERVIX UTERI	2025	6.4	0	2025	1875	150	1540	485	1038	296	154	130	77	178	2	0
CORPUS UTERI	1097	3.5	0	1097	993	104	647	450	15	551	130	112	72	83	30	0
UTERUS, NOS	50	0.2	0	50	29	21	16	34	0	1	1	2	4	5	16	0
OVARY	635	2	0	635	474	161	290	345	0	87	26	174	93	41	4	52
OTH FEMALE GENITAL ORGS	26	0.1	0	26	22	4	15	11	2	3	0	2	2	7	6	0
PLACENTA	55	0.2	0	55	54	1	54	1	0	1	0	2	1	9	3	38
PENIS	23	0.1	23	0	19	4	17	6	3	7	2	2	1	4	0	0
PROSTATE GLAND	2363	7.5	2363	0	1954	409	1658	705	7	189	1281	137	146	194	0	0
TESTIS	200	0.6	200	0	162	38	160	40	2	87	24	11	2	34	1	1
OTHER MALE GENITAL ORGS	11	0	11	0	10	1	6	5	0	1	0	0	1	3	5	0
KIDNEY	886	2.8	565	321	732	154	486	400	0	269	111	93	132	100	27	0
RENAL PELVIS	66	0.2	47	19	61	5	40	26	12	16	6	12	8	7	0	0
URETER	61	0.2	39	22	54	7	39	22	13	14	7	9	5	6	0	0
BLADDER	756	2.4	578	178	500	256	390	366	103	96	78	55	67	100	0	2
OTHER URINARY ORGS	28	0.1	16	12	24	4	10	18	2	5	1	7	3	5	1	0
EYE AND ADNEXA	77	0.2	35	42	49	28	42	35	2	17	1	4	2	6	16	1
MENINGES	438	1.4	134	304	373	65	338	100	0	1	0	0	1	4	21	405
BRAIN	1156	3.6	630	526	989	167	495	661	0	57	39	62	163	146	362	173
OTHER CENTRAL NERVOUS SY	203	0.6	98	105	170	33	168	35	0	4	1	1	3	24	23	134
THYROID GLAND	419	1.3	115	304	342	77	357	62	1	209	40	28	27	37	0	1
ADRENAL GLAND	78	0.2	37	41	68	10	44	34	0	6	1	2	10	9	39	1
OTH ENDOCRINE GLDS/REL S	177	0.6	95	82	140	37	148	29	0	1	0	0	0	9	13	154
OTHER ILL-DEFINED SITES	21	0.1	9	12	15	6	13	8	0	0	0	0	3	7	5	0
LYMPH NODES	1666	5.3	979	687	863	803	762	904	0	133	182	123	267	117	39	2
UNKNOWN PRIMARY SITE	483	1.5	242	241	420	63	109	374	0	0	0	0	33	141	246	0
TOTAL	**31700**	**100**	**14897**	**16803**	**24691**	**7009**	**15187**	**16513**	**2062**	**4367**	**4148**	**2879**	**3523**	**4305**	**2552**	**992**

*** NO. OF DIAGNOSES NOT INCLUDED IN REPORT - NOT MALE AND NOT FEMALE: 3 TYPE OF AJCC STAGING: BEST STAGE

FREQUENCY OF CANCER
TOTAL 2008 CASES: 1,111

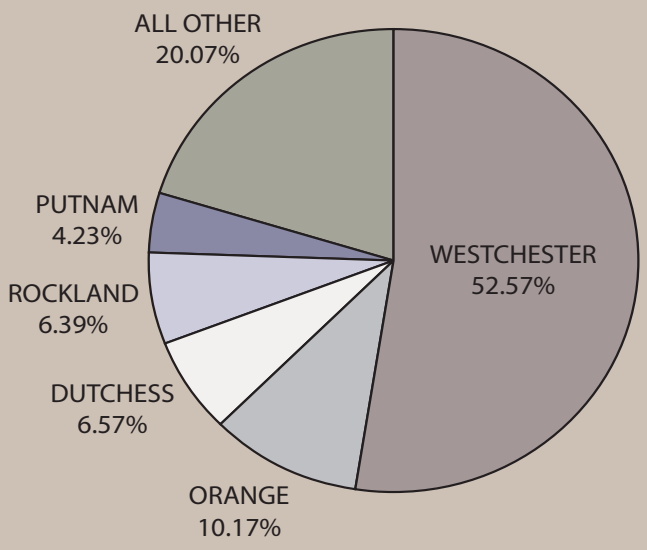


FIGURE 3

GEOGRAPHIC DISTRIBUTION
TOTAL 2008 CASES: 1,111

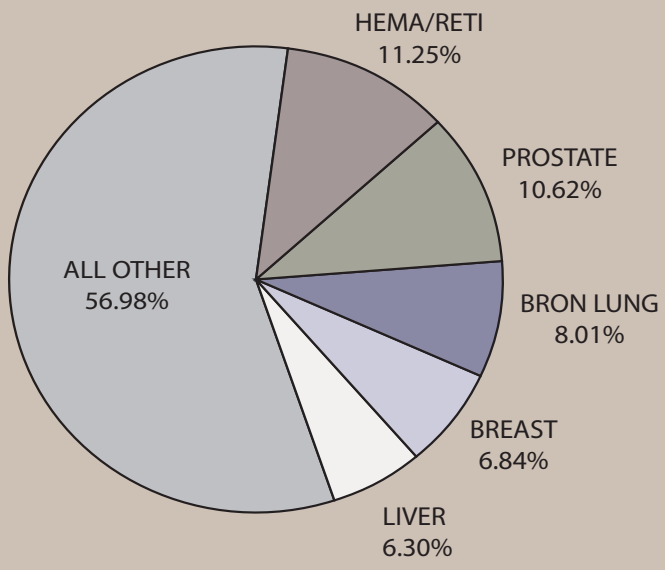


FIGURE 4

GEOGRAPHIC DISTRIBUTION
BY ZIP CODE
TOTAL 2008 CASES: 1,111

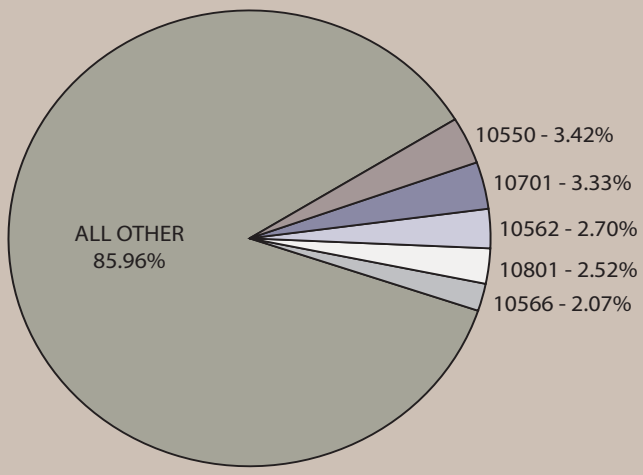


FIGURE 5

10 MOST FREQUENT
PRIMARY SITES
2008 ANALYTIC CANCER CASES

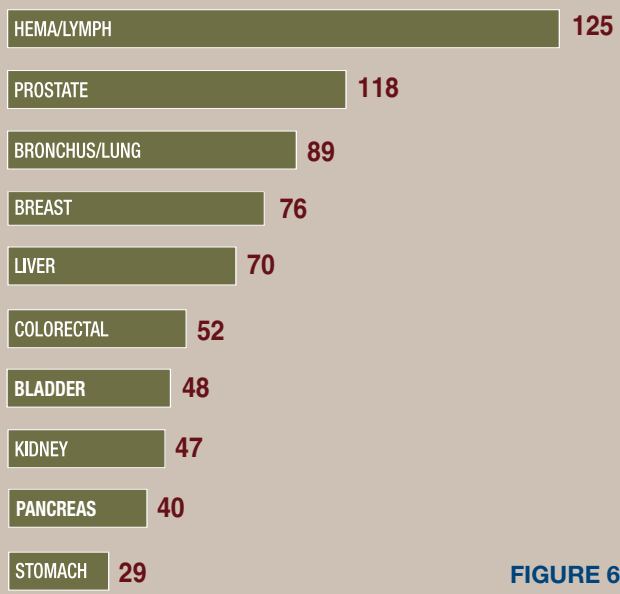


FIGURE 6

*SEER data from 2008 CANCER FACTS & FIGURES; American Cancer Society, Inc., 2008, New York.
**Excludes non-melanoma skin cancer and all carcinoma in-situ, except bladder (68 cases) for comparison.

FIGURE 9

CASES: 2008

PRIMARY SITE	TOTAL	PERC	SEX		CLASS OF CASE		ALIVE	EXP	AJCC-TNM STAGE/ANALYTIC ONLY							
			M	F	ANA	N-ANA			0	I	II	III	IV	UNK	N/A	BB
BASE OF TONGUE	4	0.4	4	0	4	0	4	0	1	0	0	1	1	1	0	0
OTH & UNSPEC PARTS OF TO	10	0.9	4	6	8	2	7	3	0	3	2	0	2	1	0	0
GUM	1	0.1	0	1	1	0	1	0	0	0	0	0	1	0	0	0
FLOOR OF MOUTH	4	0.4	3	1	3	1	3	1	0	0	0	0	3	0	0	0
OTH PARTS OF MOUTH	2	0.2	1	1	1	1	1	1	0	0	0	0	1	0	0	0
PAROTID GLAND	6	0.5	4	2	5	1	5	1	0	1	0	3	1	0	0	0
TONSIL	9	0.8	8	1	8	1	9	0	0	0	0	2	4	2	0	0
OROPHARYNX	3	0.3	1	2	3	0	3	0	0	0	0	1	1	1	0	0
NASOPHARYNX	6	0.5	5	1	4	2	4	2	0	0	0	1	2	0	1	0
ESOPHAGUS	9	0.8	7	2	9	0	8	1	1	1	3	2	1	1	0	0
STOMACH	29	2.6	20	9	25	4	24	5	1	6	2	3	6	2	5	0
SMALL INTESTINE	7	0.6	3	4	3	4	5	2	0	1	0	1	1	0	0	0
COLON	52	4.7	26	26	44	8	41	11	4	6	9	9	11	4	1	0
RECTOSIGMOID JCT	3	0.3	2	1	2	1	3	0	1	0	1	0	0	0	0	0
RECTUM	13	1.2	9	4	12	1	12	1	1	2	3	3	1	1	1	0
ANUS AND ANAL CANAL	6	0.5	4	2	6	0	5	1	0	1	1	2	0	2	0	0
LIVER-INTRAHEP BILE DCTS	70	6.3	54	16	64	6	49	21	0	24	15	13	8	4	0	0
GALLBLADDER	5	0.5	1	4	5	0	4	1	0	1	3	0	1	0	0	0
OTH & UNSPEC PTS OF BILI	4	0.4	3	1	4	0	2	2	0	1	2	0	0	1	0	0
PANCREAS	40	3.6	24	16	39	1	27	13	0	1	18	5	9	5	1	0
NASAL CAV/MIDDLE EAR	3	0.3	3	0	3	0	3	0	0	0	1	0	1	1	0	0
ACCESSORY SINUSES	1	0.1	1	0	1	0	1	0	0	0	0	1	0	0	0	0
LARYNX	15	1.4	14	1	11	4	12	3	1	1	2	5	2	0	0	0
BRONCHUS AND LUNG	89	8	51	38	69	20	57	32	0	10	3	13	38	4	1	0
THYMUS	3	0.3	3	0	3	0	2	1	0	0	0	0	0	0	3	0
HEART, MEDIASTINUM AND P	1	0.1	1	0	1	0	0	1	0	0	1	0	0	0	0	0
BONES, JNTS, ART CART LI	2	0.2	1	1	1	1	2	0	0	1	0	0	0	0	0	0
BONES, JNTS, ART CART OT	8	0.7	3	5	7	1	8	0	0	1	0	0	0	2	4	0
HEMATOPOIETIC/RETICULOEN	125	11.3	75	50	99	26	96	29	0	0	0	0	0	1	98	0
SKIN	13	1.2	6	7	8	5	13	0	0	1	1	2	0	3	1	0
RETROPERITONEUM AND PERI	3	0.3	1	2	2	1	2	1	0	0	0	0	0	0	2	0
CONN, SUBQ AND OTH SOFT	12	1.1	6	6	10	2	10	2	0	0	0	1	3	3	3	0
BREAST	75	6.8	0	75	52	23	70	5	1	18	11	9	3	10	0	0
VULVA	4	0.4	0	4	4	0	3	1	1	0	1	0	0	2	0	0
VAGINA	2	0.2	0	2	2	0	1	1	0	1	0	0	0	1	0	0
CERVIX UTERI	9	0.8	0	9	9	0	9	0	0	2	0	2	0	5	0	0
CORPUS UTERI	15	1.4	0	15	13	2	14	1	1	7	1	1	1	2	0	0
UTERUS, NOS	2	0.2	0	2	1	1	0	2	0	0	0	0	0	0	1	0
OVARY	2	0.2	0	2	1	1	1	1	0	0	0	0	1	0	0	0
PENIS	1	0.1	1	0	0	1	1	0	0	0	0	0	0	0	0	0
PROSTATE GLAND	118	10.6	118	0	97	21	115	3	0	0	88	6	2	1	0	0
TESTIS	11	1	11	0	7	4	11	0	0	6	1	0	0	0	0	0
KIDNEY	47	4.2	30	17	42	5	44	3	0	27	3	5	4	0	3	0
RENAL PELVIS	10	0.9	7	3	10	0	9	1	1	1	2	5	1	0	0	0
URETER	3	0.3	1	2	3	0	3	0	1	1	1	0	0	0	0	0
BLADDER	48	4.3	39	9	31	17	42	6	7	7	5	4	7	1	0	0
OTHER URINARY ORGS	1	0.1	1	0	1	0	1	0	0	0	0	0	0	1	0	0
EYE AND ADNEXA	4	0.4	0	4	4	0	4	0	0	2	0	0	0	0	2	0
MENINGES	24	2.2	5	19	18	6	24	0	0	0	0	0	0	0	0	24
BRAIN	37	3.3	18	19	34	3	31	6	0	2	0	0	2	0	27	5
OTHER CENTRAL NERVOUS SY	4	0.4	2	2	3	1	4	0	0	0	0	0	0	0	1	3
THYROID GLAND	29	2.6	9	20	27	2	29	0	0	17	2	3	3	2	0	0
ADRENAL GLAND	2	0.2	1	1	2	0	2	0	0	0	0	0	1	0	1	0
OTH ENDOCRINE GLDS/REL S	15	1.4	12	3	13	2	15	0	0	0	0	0	0	0	0	15
OTHER ILL-DEFINED SITES	1	0.1	1	0	1	0	1	0	0	0	0	0	0	0	1	0
LYMPH NODES	68	6.1	44	24	43	25	52	16	0	5	8	11	19	0	0	0
UNKNOWN PRIMARY SITE	21	1.9	11	10	17	4	17	4	0	0	0	0	1	0	16	0
TOTAL	**1111**	**100**	**659**	**452**	**900**		**211**	**926**	**185**	**22**	**158**	**190**	**114**	**143**	**64**	**173**

*** NO. OF DIAGNOSES NOT INCLUDED IN REPORT - NOT MALE AND NOT FEMALE: 3 TYPE OF AJCC STAGING: BEST STAGE

THE NEW 'AWAKE' BRAIN MAPPING

AN ADVANCE IN IMAGING HELPS SURGEONS FIND THE SAFEST ROUTE TO A TUMOR

Operating on a brain tumor is delicate business. Surgeons want to remove cancerous material without harming nearby tissue that controls vital functions such as vision, speech and muscle movement. One way to do that is to keep the patient conscious (though sedated) and stimulate the exposed brain during the surgical procedure.

This isn't new—it's been done for half a century. But it can now be done at Westchester Medical Center in a dramatically safer, noninvasive way, thanks to a pair of technologies: diffusion tensor imaging (DTI) and functional magnetic resonance imaging (fMRI). The technologies work together to create a map showing the surgeon's safest path to the tumor, according to P. Charles Garell, M.D., Director of Functional Neurosurgery, whose team does about 15 operations every year that involve awake brain mapping.

"DTI has been studied for more than a decade," says neuroradiologist Hasit Mehta, M.D. "But it has only recently been applied to general clinical use."

The new tools were employed recently for a Yonkers woman named Taledia Hairston, who had already been through surgery, chemotherapy and radiation treatments for her lung cancer. This spring, she experienced difficulty in speaking, right arm weakness and a muscle droop on the right side of her face. A conventional MRI revealed a mass fairly deep within the left side of her brain, near centers that control speech, as well as arm and facial movement.

"We couldn't just go in and take the tumor out," says Dr. Garell, "because cutting right through might have left her with permanent deficits in speech and motor function." What he needed was a way to navigate around these critical areas to the tumor. That's where DTI came in.

As Dr. Mehta explains, DTI works by measuring the motion of water molecules, which are constantly on the move, spreading out and diffusing in different ways depending on the structures around them. Water in human tissues with a large number of fibers—such as skeletal muscle, cardiac muscle and brain tissue—diffuses fastest in the directions the fibers are pointing in, and slowest at right angles to it. In contrast, water diffuses in a spherical pattern in tissues that contain few fibers.

DTI thus can help locate fibers that carry important information, as well as more "empty" areas through which it is safer to cut. "It lets us see where the important tracks are in the brain, and where they may be infiltrated or distorted by the tumor," says Dr. Mehta. "With DTI the surgeon can see things he or she otherwise can't—the deep pathways below the surface of the brain."

The DTI scan takes just five to 10 minutes, and is followed by the fMRI, which takes another 15 to 20 minutes. This scan, not quite as new as DTI but still of relatively recent origin, maps the changes in the brain related to the patient's activity. "The machine scans the entire brain while I ask the patient to do certain things, such as speak or open and close a hand," says Dr. Mehta. "From small changes in the magnetic signal I can make a color map of the brain and show the surgeon where the hand or speech control is."

"We can follow all the important connections of the motor cortex with this map," says Dr. Garell. "We used it to map out an anatomical track to get me to the tumor."

Hairston had her head shaved and marked with incision locations. "All the while I was having a conversation with her," Dr. Garell says. "I'd seen her several times before, and we'd developed a rapport, but this was a stressful moment. It was important to reassure her."

Her head was immobilized with a clamp, and the surgeon applied a strong topical anesthetic to the scalp. He then opened the skin, talking to Hairston at all times. "I tell patients the next part is like having the dentist drill a tooth," says Dr. Garell. "You feel vibrations and hear the clanking of instruments, but that's normal."

The surgeon next removed a palm-size piece of skull, and then opened the leathery brain covering called the dura. Now the brain was exposed. Armed with his map, Dr. Garell could find the pathway to the tumor.

First, though, he confirmed what the DTI and fMRI predicted. He asked the patient to talk or open and close a hand, then placed a small electrical charge in the area that he thought controlled that function. "I was looking for areas where the stimulation made no perceptible change in activity," he says. That told him it was

safe to cut there. If the speech slurred or the hand contracted, he knew to avoid that area.

He put little 5-millimeter square tags of sterilized paper on the brain to mark the areas related to different functions. (They're peeled away when the path to the tumor has been identified.) Next, an ultrasound located the tumor several centimeters under the brain's surface. "Then it was relatively simple to find the corridor to get to the tumor," Dr. Garell says.

Once the corridor was confirmed, the anesthesiologist fully sedated the patient for the tumor removal. Dr. Garell sent an instrument into the tumor that released ultrasound waves, which broke it up. He then aspirated— sucked out—the pieces. He sewed up the dura, replaced the skull piece and sent the patient to the ICU. Hairston spent one day there, and was discharged a few days later. "I was surprised at how quickly she recovered," says Dr. Garell. "By the next morning she was wide awake and eating eggs."

And she had full movement in her right hand to do so, thanks to the DTI and fMRI scans. "Awake brain mapping told us to shift to a longer, less direct route," says the doctor, "so we were able to spare her any impairment of hand movement or other vital functions."

NEURO-ONCOLOGY, OVERVIEW OF THE PROGRAM

Primary brain tumors account for approximately 1.4% of all cancers and 2.4% of all cancer related deaths. About 35,000 new cases of primary brain tumors are diagnosed in the United States each year. The average age at diagnosis is about 57 years. No clear etiologic factors are known to cause primary brain tumors at this time, however, certain correlations are known. For example, there is a higher incidence of meningiomas in women with breast cancer. Similarly, there is also a higher incidence of meningiomas after prolonged survival in patients receiving cranial radiation for some other disease, such as leukemia. Glioblastoma multiforme (GBM) accounts for approximately half of all primary brain tumors. Secondary or metastatic tumors of the brain are also extremely common, especially from primary sources, such as lung and breast. Primary central nervous system lymphomas have become more common and currently accounts for approximately 3% of all brain neoplasms. Examples of benign brain tumors include meningiomas, acoustic neuromas, pituitary tumors, and pilocytic astrocytoma in children. Posterior fossa tumors are more common in children and examples include medulloblastoma, ependymoma, and cystic astrocytoma. The neuro-oncology program at Westchester Medical Center is a comprehensive program for both adults and children and emphasizes a multidisciplinary approach. Management decisions are made in a tumor board setting for both adults and children with malignant brain and spinal cord neoplasms. The department also has expertise in treating complex spinal tumors and peripheral nerve neoplasms.

Methods of Diagnosis

The diagnostic procedure of choice for many patients with brain neoplasms is a MRI scan. Such a scan should be performed with and without administration of a contrast, such as gadolinium. At WMC, we also have a 3 tesla magnet. This high field strength magnet allows us to perform advanced MRI techniques, such as spectroscopy, diffusion tensor tractography, and functional MRI tensor and perfusion studies. The 3 tesla magnet also outlines a lesion with exquisite anatomical detail which helps the surgeon in choosing a safe trajectory to the tumor. MR spectroscopy often helps us differentiate tumors from other tumor like lesions, such as stroke and abscess. Functional MRI scan allows us to precisely delineate important areas, such as the motor, sensory and speech areas of the brain. Diffusion tensor tractography reveals how important tracts such as the pyramidal tract fibers are related to the tumor. This is of great importance to the surgeon while resecting these tumors without damaging such important structures. Tumors with a rich blood supply and also those related to important blood vessels such as the carotid artery can be studied by using MR angiography. In very vascular tumors or tumors where embolization is feasible, catheter cerebral angiography is carried out in a biplane neuro interventional suite. This advanced suite allows preoperative embolization of tumors to reduce vascularity and aid the surgeon during resection. A dedicated neuropathology team carefully analyzes these tumors with special stains and molecular methods to precisely define the nature of these tumors and their grading with regards to malignancy.

Treatment Strategies

A wide array of treatment strategies are offered in a customized fashion to best treat patients with these complex tumors. Depending on the nature of the tumor, it's location, and the age of the patient an appropriate sub-specialist is available to tackle the problem in the best possible manner. Surgical treatment is carried out in a state-of-the -art operating room with complex

and costly technologies that can only exist in a major tertiary care health center. We routinely employ computerized image guided navigation and interoperative ultrasound to safely resect these tumors in a as complete a fashion as possible. We have dedicated neurosurgeons and skull base neurosurgeons for dealing with tumors in these areas. Some deep tumors may need a framed stereotactic biopsy followed by adjuant radiation or chemotherapy. On the other hand, certain benign skull base tumors can undergo complete resection by a team of neurosurgeons and otolaryngologists through complex skull base approaches, lasting many hours. Intraoperative cerebral monitoring and cranial nerve monitoring is utilized to preserve function. A neurophysiologist is present in the operating room while operating on the brain to monitor motor function, sensory function, brain stem function, and cranial nerve function. Dedicated neuro-anesthesiologists provide the best possible conditions to safely operate on the brain with maximal preservation of function. Minimally invasive and endoscopic procedures are routinely performed for pituitary tumors and deep seated tumors, especially within the ventricular system. A separate team of specialists exist for dealing with children with brain tumors in a dedicated modern children's hospital with facilities rivaling any in the world.

Radiation Oncology

Many patients with malignant brain tumors will require radiation therapy following surgical treatment to prolong survival and prevent recurrence. Radiation therapy is also often necessary in patients with aggressive benign tumors, such as meningiomas and certain types of pituitary tumors. Stereotactic radiosurgery is extremely useful in controlling certain benign tumors, such as acoustic neuromas. We have a wide array of radiation tools to meet all these demands. Modern radiation methods include IMRT and stereotactic radiosurgery. After discussing the patient in a tumor board, the best radiation methodology is chosen. Single and fractionated radio surgical procedures are offered. Facilities exist to treat certain patients as an in-patient during their radiation treatment.

Medical Oncology

All patients with malignant brain tumors are discussed in an oncology tumor board and the appropriate chemotherapy choice is made. The patients are followed by the medical oncologist at regular intervals with monitoring of their response to chemotherapy. Chemotherapy protocols are changed when there is recurrence of tumor or evidence of resistance. For example, glioblastoma multiforme is initially treated with Temozolamide and in certain cases when there is a recurrence, they are treated with more aggressive chemotherapy protocols, such as Bevacizumab, a monoclonal antibody that binds vascular endothelial growth factor lygand and Irenotecan. More aggressive chemotherapy methods including bone marrow transplantation technologies are used, especially in children with tumors, such as medulloblastoma and aggressive primitive neurectodermal tumors. A dedicated floor of oncology exists both in the adult and children's hospital.

Research

The Department of Neurosurgery has a full-time research Associate Professor of Neurosurgery specializing in molecular neuro-oncology and genetics. At this time, two Ph.D. students are also working in our laboratory in addition to the neurosurgery residents. Research is being done in the signaling pathways of primary malignant tumors of the brain and metastatic tumors, such as breast cancers. Facilities exist for tissue culture and study of molecular and genetic markers. Numerous papers have been published from this laboratory and papers are being presented at national and international conferences.

In conclusion, the neuro-oncology program at Westchester Medical Center is extremely comprehensive and multi-disciplinary in its scope. The patients are managed by a competent and experienced team consisting of neurosurgeons, neurologists, medical oncologists, radiation oncologists, neuropathologists, skull base surgeons, spine surgeons, etc. A separate team of specialists exist for managing childhood central nervous system tumors. Patients are managed in a newly renovated adult oncology floor and a dedicated oncology floor in the new children's hospital. The patients benefit from being discussed at tumor boards, where the best possible therapy is customized for each patient, depending on their age, nature, and extent of disease. In addition to these clinical activities, basis research in the nature and spread of these aggressive tumors is being carried out in the Neurosurgery Department. Needless to say, patients benefit the most from this comprehensive approach.

Raj Murali, M.D.
Professor and Chairman
Department of Neurosurgery
Westchester Medical Center
New York Medical College

Acknowledgements

We gratefully acknowledge the work and support of the members of the Cancer Committee and Subcommittees and the Cancer Institute.

Special gratitude to the Cancer Registry staff for their dedication and loyalty, and to our wonderful volunteers for their invaluable assistance.

Barry Marshall, MBA, FACHE
Cancer Program Administrator, Vice President, Transplant & Oncology Services

WESTCHESTER
MEDICAL CENTER

Maria Fareri Children's Hospital • Heart Center • Cancer Institute • Transplant Center • Neuroscience Center
Joel A. Halpern Regional Trauma Center • Burn Center • Behavioral Health Center