The Department of Diagnostic Imaging and Radiotherapy is a large multidisciplinary structure comprising different areas of clinical activity and research, where many disciplines work together in very close interaction. The Department is equipped with a large number of high-technology facilities and supports the implementation of biologic imaging and image-guided contouring radiotherapy at INT. The development and study of several specific radiopharmaceuticals has led to the improvement of targeted radiotherapy. These achievements are possible thanks to the tight collaboration of many experts from the fields of physics, biotechnology, biology, radiopharmacy, instrumentation, and medical sciences.

Two Radiologic Imaging Units (RD1 and RD2) are dedicated to cancer diagnosis and monitoring. RD1 carries out conventional radiologic tests (X-rays), magnetic resonance imaging (MRI), and breast cancer diagnosis (mammography, US, radioguided biopsies). RD2 provides computed tomography (CT), angiography, interventional radiology, intralesional treatments, and radiological tests for the gastrointestinal tract.

The Nuclear Medicine Unit images tumors by single photon emission tomography (SPECT) and positron emission tomography (PET/CT). Radiopharmaceuticals for diagnosis and therapy are developed in our radiochemistry lab with a 17 MeV cyclotron. A special Unit with protected beds provides radiometabolic treatments and pre-treatment dosimetry. A radioisotope laboratory for radioimmunometric tests measures tumor markers and hormone levels.

External beam radiotherapy (3D conformal radiation therapy, intensity modulated radiotherapy [IMRT], Rapid Arc, IGRT) is the main activity of the Radiation Oncology 1. The Radiation Oncology 2 Unit (RT2) also provides some applications of external beam radiotherapy, but mainly focuses on high-dose rate brachytherapy (HDR-BT) and on the combination of chemo- and radiotherapy; patients are housed in a facility with 8 beds in 4 shielded rooms.

A Medical Physics Unit supports Radiation Oncology Units in planning radiotherapy treatments and dosimetric calculations. This Unit also takes care of quality control of instruments for diagnostic imaging.
Diagnostic Radiology 1 Unit performs traditional radiology (chest and bone X-rays), breast imaging and magnetic resonance imaging (MRI). In 2012, the Unit performed about 29,000 X-ray examinations, 28,000 breast imaging examinations including 800 breast MRI, 900 interventional breast procedures, and 12,000 MRI scans.

MRI provides optimal spatial and contrast resolution between human tissues, playing an important role in cancer diagnosis in all anatomical districts, and can contribute to improving oncology treatments by assessing tumor response during and after chemo- or radiotherapy. DWI (diffusion-weighted imaging) and MRS (MR spectroscopy) have been validated as emerging functional tools to improve information about the vitality or aggressiveness of cancer tissue. The Unit is involved in several ongoing multicenter MRI studies; fields of scientific interest are: pediatric MRI focused on neuro-oncology, soft tissue sarcomas, oro-nasopharyngeal carcinoma, and colorectal cancer.

Keywords: breast imaging, MRI, radiology

MAGNETIC RESONANCE

In 2012, the Unit performed about 8000 MRI scans on adult patients. Breast MRI and pre-operative staging of cancer were performed as part of a surveillance program of high risk and BRCA mutation carriers.

MRI provides optimal spatial and contrast resolution between human tissues, playing an important role in cancer diagnosis in all anatomical sites. It also plays an increasingly prominent role in oncology treatments in assessing tumor response during and after chemo- or radiotherapy, and can be crucial in distinguishing fibrotic tissue from disease relapse.

MRI has been largely applied to evaluation of prosthetic implants where it can be the only reliable tool to detect rupture and identify the intra- or extracapsular modality of damage. Furthermore, thanks to multiplanarity and high-contrast resolution, MRI can also detect silicone migration within muscle...
fibers and lymphatic stations. The Unit also focused on the improvement of prostate cancer staging through combined analysis of endorectal MRI and magnetic resonance spectroscopy (endoMRI/MRSI). With this aim, and to improve information about the vitality or aggressiveness of cancer tissue, DWI (diffusion-weighted imaging) and MRS (MR spectroscopy) have been validated as emerging functional tools. The Unit is involved in several ongoing multicenter MRI studies; fields of scientific interest are: soft tissue sarcomas, oro-nasopharyngeal carcinoma, and prostate cancer.

Keywords: MRI, functional imaging, diffusion imaging

RADIOLOGY AND MAGNETIC RESONANCE GI TRACT

The Unit performed about 29,000 X-ray examinations for both clinical and research activities in 2012. MRI was mainly used for rectal cancer evaluation (pre-operative staging), diagnosis of rectal cancer recurrence, and liver imaging. Suitable protocols were developed to improve the accuracy of rectal cancer diagnoses, evaluation of recurrence, and in liver imaging using liver-specific contrast medium. Clinical collaborations are active with the Colorectal Surgery Unit, the Gastrointestinal Radiotherapy, and the Liver Transplantation.

The Unit is involved in RENOREC, a study on the diagnostic accuracy of DWI in lymph node staging of rectal cancer and the prognostic value of DCE [Dynamic Contrast Enhanced] MRI (in collaboration with the Colorectal Surgery Unit, Anatomic Pathology, and the Medical Statistics, Biometry, and Bioinformatics of the INT, together with the Bioengineering Center at the University of Manchester, UK).

A project on the feasibility of liver DCE MRI with hepato-specific agents has been recently completed. X-ray examinations are required in various research protocols focused on multiple myeloma and breast cancer bone metastasis.

Keywords: rectal cancer imaging, liver imaging, X rays

PEDIATRIC MAGNETIC RESONANCE

The Unit has a crucial, long-standing collaboration with the Polytechnic Institute of Milan (Prof. Luca Mainardi and his Staff), a world-renowned center of excellence in engineering that developed multifunctional image evaluation, image “fusion”, and evaluation/re-evaluation of radiotherapy on brain white matter and tracts for this Unit. The Unit performed almost 8000 pediatric and ENT [Ear Nose and Throat] MRI imaging examinations (of the 12,000 MRI scans provided) which account each for at least one-third of this type of yearly examinations at INT. Increasing clinical needs during 2012 resulted in a steep increase in the number and quality of scans performed.

The Unit is a referral center in Italy for ENT oncologic imaging with various ongoing national clinicoradiological protocols and studies. It has also been chosen as an EORTC review center for ENT MRI protocols. The Unit is one of the most important European and World Centers of SIOP for pediatric brain tumors (we had the best results in accrual and treatment in the Herby Study on brain glioblastoma), the Central National Review Center for Ependymoma, and the second most important for Medulloblastoma.
In 2012, the Unit performed about 28,000 breast imaging examinations including 800 breast MRI, 900 interventional breast procedures, and 12,000 MRI scans. The Unit has all the diagnostic and interventional tools needed in a comprehensive cancer center, where patients from any referral come in search of reassurance to not have cancer, as well as diagnosis and proper treatment in case of lesions. Imaging consists mostly in clinical mammography and breast ultrasound studies on symptomatic or treated patients as well as on asymptomatic women with the aim of secondary prevention. We also participate in programs of MRI surveillance for high-risk patients who are BRCA mutation carriers and pre-operative staging of cancer. Intervventional examinations are directed to preoperative localization of non-palpable lesions and to the assessment of breast masses or microcalcifications by core-needle biopsies (CNB) or vacuum-assisted biopsies (VAB) with ultrasonographic or stereotactic guidance. These interventions are basic elements of a multidisciplinary approach to provide assistance for surgical planning. The Unit also implemented the breast lesion excision system (BLES), consisting in a biopsy device that, unlike VAB, acquires a unique intact specimen instead of multiple samples. New mammographic equipment performing 3D examinations (digital breast tomosynthesis) allows greater confidence in mammographic interpretation and increasing sensitivity for detection of breast cancer.

Keywords: breast imaging, biopsy

BREAST IMAGING UNIT

Gianfranco Scaperrotta, MD
The Staff is shared with RDI 1

Keywords: ENT imaging, pediatric imaging, MR whole body imaging

HEAD
Diagnostic oncology and interventional radiology represent the core activities of the Unit. Inpatients and outpatients undergo a diagnostic work-up that includes the different steps of patient management: primary cancer diagnosis, staging, follow-up and monitoring after surgery, chemotherapy, and radiotherapy. The lung cancer screening program (MILD) with “low dose” spiral CT continued in 2012. We performed over 2000 low-dose spiral CT, and we started testing a system involving computer-aided detection (CAD) of pulmonary nodules. Interventional radiology activities include long-term venous central catheter placement, embolization and chemoembolization for regional cancer treatment. Intrallesional radiofrequency ablation based-methods, such as chemo-interventional procedures consisting in locoregional drug delivery for malignancies of the liver, head and neck, pelvis, and limbs have been successfully performed. An international multicenter study on the treatment of inoperable hepatocellular carcinoma with intra-arterial injection of yttrium-90 radiolabeled microspheres is ongoing in collaboration with the Units of Nuclear Medicine and Gastrointestinal, Hepatopancreatobiliary Surgery and Liver Transplantation.

The Unit has also developed an original experience of percutaneous cryoblation in selected patients with small renal tumors. During 2012, over 1000 vascular diagnostic procedures, 500 vascular and non-vascular interventional procedures, over 550 long-term venous central catheters, and 600 percutaneous biopsies in various body districts were performed.

Keywords: image-guided therapies, ultrasonography, computed tomography, multifunctional fluoroscopy, digital angiography
DIAGNOSTIC AND INTERVENTIONAL GASTROENTEROLOGY

The clinical activity of the Unit is focused on diagnostic and interventional radiology of the digestive and biliary tracts and, from early 2012, diagnostic and interventional ultrasound applications were included in the Radiology and Diagnostic Imaging 2 Unit. Overall, a total of 5957 examinations were performed by the Unit: plain films of the chest decreased by 24.6% compared to 2011 due to the ongoing reorganization of the Radiological Units. Examinations of the digestive and urinary tract (total of 3754) increased by 8.4%. In the gastrointestinal diagnostic field (+7.5%), examinations of functional disorders represent a relevant part of the Unit’s activity (23.5%).

Biliary and gastroenteric interventional procedures were performed in patients with different biliopancreatic or gastrointestinal diseases. In the biliary field, definitive jaundice palliation with drainages or stents, curative dilatation of cicatricial stenoses, drainage of fistulas, transluminal biopsies, and other less common manoeuvres were routinely performed. In the gastrointestinal field, in addition to treatment of complications (transluminal drainage of fluid collections, dilatation of cicatricial stenoses), interventional procedures played a fundamental role in nutritional support (percutaneous gastrostomy, positioning of feeding tubes, stenting of inoperable stenoses). A substantial part of all these interventional procedures must be performed as promptly as possible, and therefore require exceptional organization. Overall, 727 interventional procedures were performed in the Unit, with a 12.9% increase compared to 2011.

Keywords: biliary interventional radiology, gastroenteric interventional radiology, therapeutic radiology

INTRALESIONAL TREATMENT UNIT

A Unit specifically concerned with mini-invasive intralesional treatment with percutaneous thermal ablation procedures (RF, microwave, etc.) was created in 2005. This technique, which has recently gained scientific recognition at the international level, began at INT in 1988-89 in the wake of pioneering research. Since 1990, over 1460 patients were treated mainly for liver cancer, but also kidney, lung, and bone lesions. The Unit works within the Diagnostic Imaging and Radiotherapy Department utilizing radiological interventional treatment procedures for centering and treatment follow-up.

In hepatocellular carcinomas and liver metastases of at least 3.5 cm in diameter, we evaluated the use of radiofrequency hyperthermia combined with the arterial stop flow procedure to achieve maximum effectiveness with minimal invasiveness. (Treatment in local anesthesia and one-day surgery). This procedure has been formally endorsed by the Italian Society of Interventional Radiology. We also treated liver metastases, unresectable lung cancer, supra-renal and renal cancer, and painful bone metastasis that were unresponsive to pain control with conventional therapies.

In collaboration with the Fondazione IRCCS Policlinico San Matteo (Pavia), we are studying a minimally-invasive system to destroy tumors with different tissue characteristics using very thin probes and with the possibility of single electrode insertion even in large tumors.

In 2012, we started the evaluation of the efficacy of radiofrequency thermal ablation in combination with stereotaxic radiotherapy in the treatment of large hepatic metastases from colorectal cancer. Finally, in collaboration with a group of anesthesiologists, the Unit is currently evaluating paravertebral anesthesia for percutaneous radiofrequency ablation of hepatic tumors.

Keywords: radiofrequency, percutaneous thermal ablation, tumor thermal ablation

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The Staff is shared with RDI 2

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NUCLEAR MEDICINE

This Unit includes various integrated clinical sections concerned with both diagnosis and radiometabolic therapy of cancer patients. The Unit is also involved in radiochemistry and develops novel radiopharmaceuticals for the management of adult and pediatric patients with cancer in collaboration with the Department of Experimental Oncology and Molecular Medicine. The Nuclear Medicine Unit includes: 1) a diagnostic Unit based on gamma-emitting radiopharmaceuticals (SPECT Unit); 2) a diagnostic Unit based on positron-emitting radiopharmaceuticals (PET Unit); 3) a therapeutic Unit for radiometabolic therapy; 4) radiochemistry laboratories equipped with a 17 MeV cyclotron and facilities for the production of PET and SPECT tracers and radiopharmaceuticals for therapy; 5) a laboratory for pre-clinical studies equipped with a micro-PET; 6) a biochemistry laboratory for IRMA and RIA tests; 7) a clinical endocrinology section for studying patients with endocrine cancer.

Among the main achievements of the programs carried out were: a) several clinical studies on SPECT and PET diagnostic procedures and their validation as a tool for imaging and studying tumor metabolism; b) validation of some radiolabeled oncotropic tracers as a prognostic index of tumors in terms of in vivo characterization of neoplastic tissue and prediction of response; c) validation of new methodology to visualize metastatic lymph nodes in patients with gynecological cancer by lymphoscintigraphy after peritumoral injection of 99mTc-labeled microspheres; d) treatment of hepatocarcinoma by intra-arterial radioembolization with Y-90 microspheres after pre-therapeutic dosimetry to optimize tumor irradiation; e) treatment of neuroendocrine tumors by a combination of somatostatin analogues labeled with dual radioisotopes (Y-90 and Lu-177); f) optimization of radiometabolic therapy (thyroid cancer, neuroblastoma, neuroendocrine tumors, and lymphoma) by developing distinct dosimetric methods to increase the radiotherapy dose delivered to the cancer mass while sparing healthy tissue.

Keywords: nuclear medicine, nuclear oncology, radiometabolic therapy
CLINICAL PET

The multidisciplinary staff of the PET Unit (engineers, chemists, physicists, biologists, technicians, physicians) are involved in clinical activities currently focused on 18F-fluorodeoxyglucose (18F-FDG) and 11C-methionine PET/CT imaging for diagnosis, staging, therapeutic monitoring, and followup of almost all types of solid and hematological human malignancies. During 2012, about 5000 PET/CT scans were performed. Clinical research focused mainly on the following topics: 1) use of FDG PET/CT in the study of locally advanced rectal cancer patients who underwent presurgical concurrent chemoradiotherapy; 2) use of FDG PET to monitor pazopanib monotherapy in relapsed/refractory urothelial cancer and; 3) the preclinical and clinical validation of 18F-fluorothymidine (18F-FLT) for tumor characterization and treatment monitoring of breast cancer (in collaboration with the Experimental Oncology and Molecular Medicine Department, the Medical Oncology and Breast Surgery Units of INI, and the Istituto Italiano di Tecnologia Oncology Institute of the University of Milan-Bicocca, Monza). A preclinical study has been conducted on a breast cancer animal model (MDA-BB-468) implanted in mice treated with chemotherapy and in a control group of animals without treatment. Tumor metabolic response was evaluated with 2 micro-PET sequential studies (baseline and after 14 days of therapy), using 18F-FDG and 18F-FLT produced by our cyclotron-radiochemistry facility as PET tracers. Finally, a clinical study on patients with locally advanced breast cancer scheduled for primary chemotherapy has been initiated. The study will include 15 patients and their recruitment will be completed by early 2013. Chemotherapy will be monitored with three sequential FLI PET/CT studies (baseline, interim, and final) for a total of 45 scans. 18F-FLT uptake will be calculated as SUVmax and results will be compared with postsurgery histology.

Keywords: metabolic imaging, micro-PET, PET/CT, therapy monitoring

NUCLEAR MEDICINE THERAPY AND ENDOCRINOLOGY

The Unit is part of the Nuclear Medicine Unit and its activity covers three main areas: nuclear medicine therapy, a radioisotope laboratory, and an endocrinology outpatient clinic. Each area is involved both in routine and experimental procedures. More than 370 patients affected by different diseases including thyroid cancer, neuroendocrine tumors, and bone metastases were admitted in 2012 and treated with appropriate radiopharmaceuticals. Many other patients underwent experimental therapies with new radiopharmaceuticals in clinical trials. In particular, we are evaluating the efficacy of tandem treatment of neuroendocrine tumors refractory to conventional therapies with the somatostatin analogs 90Y-DOTA-TATE and 177Lu-DOTA-TATE. To date, 71 patients have been treated and clinical results are available for 58 patients. A complete response was observed in 45% of patients, stable disease in 42%, and progression in 13%. Mean progression free-survival is 27 months and estimated overall survival at 2 years is 78%. In addition, a protocol on the efficacy of high activities of radioiodine in metastatic thyroid cancer patients is ongoing. Seven patients have been treated with activities ranging from 7.4 to 13 GBq on the basis of individualized dosimetry. The treatment is well tolerated, resulting in minimal hematological toxicity, and preliminary clinical results are encouraging. Lastly, we are enrolling patients with castration-resistant prostate cancer and skeletal metastases to evaluate the efficacy and safety of 223Ra in a phase III study.

Keywords: nuclear medicine therapy, endocrine oncology, neuroendocrine tumors
RADIATION ONCOLOGY 1

Radiation Oncology 1 treats patients with breast, genitourinary, gastrointestinal, and lung cancers, as well as bone and soft tissue sarcomas, lymphomas, and pediatric cancers. National and international protocols and guidelines are routinely followed and patients are managed in a multidisciplinary setting to deliver the highest quality therapies available. Staff members are actively involved in multidisciplinary activities (clinics, case discussions, tumor boards, educational events, etc). In close collaboration with the Medical Physics Unit, particular efforts are devoted to the validation of new technologies, such as intensity modulated radiotherapy (IMRT), volumetric modulated arc therapy (VMAT), and three-dimensional conformal radiotherapy with image guided radiation therapy (IGRT) in each specific clinical setting.

In 2012, the Unit acquired the Calypso 4D localization system, a tool that utilizes radiofrequency waves to allow very accurate alignment of the prostate or the prostatic bed before and during each treatment session. Tracking the target motion during radiotherapy and adjusting delivery accordingly permits to study dose escalation while sparing normal tissues, to implement hypofractionated treatment schedules with possible biological advantages, and to reduce treatment duration. Radiation Oncology 1 participates in the clinical and preclinical activities of INT Prostate Cancer (PC) Program. Four radiation oncologists are in the PC multidisciplinary team and take part in clinical activities, active surveillance protocols, Monday clinical case discussions, and monthly CME events (Grand Rounds). Radiation Oncology 1 is also proactive in preclinical and translational research.

Topics of interest include the prediction of acute and late toxicity (rectal, erectile, bladder, skin toxicity) after high dose radiotherapy, correlation between plasma levels of inflammatory markers and acute and late toxicity after prostate cancer irradiation, quality of life, validation of a vaccine combination for hormone-naïve or refractory prostate cancer patients with biochemical recurrence, and new fractionation schemes and treatment modalities.

The Unit participates in the EORTC STRASS study: a phase III randomized study of preoperative radiotherapy plus surgery versus surgery alone for patients with retroperitoneal sarcoma.

Keywords: radiation oncology, clinical and translational research, quality assurance, toxicity prediction
GASTROINTESTINAL RADIOThERAPY

The aim of the Unit is to offer the best chance of cure to patients with locally advanced cancers of the esophagus, gastric junction, and rectum with a neoadjuvant combined radio-chemotherapy that follows international guidelines. Radiochemotherapy is administered to patients with gastric and pancreatic cancers in the pre- and post-operative setting, according to the clinical stage of disease. Best nutritional support is routinely provided. Curative radiochemotherapy is employed in patients with cancers of the anal canal, showing high rates of local control and organ preservation. Personalized treatment plans are designed for each patient and different radiation therapy techniques are used to reduce acute and late side effects. In liver metastasis, stereotactic radiotherapy is employed with high rates of disease control. Hypofractionated modality radiotherapy is used in metastatic disease in patients with poor compliance. In an optimal multidisciplinary approach, radiation oncologists, medical oncologists, and surgical oncologists participate in weekly meetings where cases are discussed and individual therapeutic strategies are designed for each patient.

Keywords: radiotherapy, multidisciplinary team

BREAST CANCER RADIOThERAPY

In 2012, about 500 patients received conventional adjuvant radiotherapy (3D conformal or IMRT) after conservative breast surgery or mastectomy, in compliance with national and international guidelines. Therapeutic programs were always discussed in a multidisciplinary setting with the Breast Surgery Unit and Medical Oncology Unit. Women over 70 years of age were administered a hypofractionated regimen (42.4 Gy, 16 fractions/3 weeks) with optimal compliance, low toxicity, and excellent/good cosmetic results in most patients. Active collaboration with the Plastic and Reconstructive Surgery Unit enables us to offer tissue expanders or prosthesis to patients undergoing breast reconstruction and schedule radiation with the best timing. The evaluation of different acute adverse skin radiotherapy-induced reactions in patients undergoing similar treatments is of particular interest. The ongoing study "Gene and microRNA expression profiles predicting radiation induced skin toxicity in breast cancer", funded by a private grant, enrolled 31 patients in 2012 who were offered reflectance spectrophotometry (RS) for objective in vivo measurements of skin erythema, in addition to conventional, objective evaluation performed by a radiation oncologist during treatment. Correlations between RS measurements and clinicians’ recording of skin toxicity and patient-to-patient variability were investigated. Selected blood samples were collected for gene expression profiling. Another study was approved by the INT Independent Ethics Committee in October 2012. In particular, the "SHARE • Cyberknife Partial Breast Irradiation for Early Stage Breast Cancer" will be conducted in conjunction with the Fondazione IRCCS Istituto Neurologico Carlo Besta, Milan.

Keywords: breast radiotherapy, hypofractionated radiotherapy, partial breast irradiation
PEDIATRIC RADIOThERAPY

Clinical research activity is focused on improving the therapeutic index of radiotherapy for childhood cancers with the aim of optimizing cure while reducing long-term iatrogenic sequelae, which are critical in the pediatric population. This goal was pursued through a rigorous multidisciplinary approach, the development and adoption of institutional, national, and international treatment programs, which represent the best up-to-date knowledge in the field of pediatric oncology, and the validation of new technologies for irradiation of children. The Unit is in charge of the radiation therapy in two national clinical trials by the Associazione Italiana Ematologia e Oncologia Pediatrica (AIEOP) on ependymoma (129 children enrolled) and Wilms’ tumor (more than 300 patients enrolled). It is also actively involved in developing new therapeutic strategies as a member of AIEOP “Central Nervous System Tumors, Bone Tumors, Renal Tumors, Neuroblastoma Working Groups” and SIOP (Société Internationale d’Oncologie Pédiatrique) “PNET and Ependymoma Working Groups”. In particular, as a member of the SIOP Ependymoma Working Group, the Unit will be the leading radiotherapy center in a forthcoming European study and is the Italian radiotherapy reference center within the SIOP PNET Working Group for new European studies on childhood medulloblastoma. At a national level, the Unit is a reference center for radiation therapy of children treated in other hospitals with limited expertise or lacking particular facilities such as anesthesiology support. In 2012, thanks to an original idea of two members of the technical staff, the Unit published a picture book entitled “The cat that lost its tail”, a fairy tale to explain radiotherapy to children. The value of the book as a therapeutic tool to improve pediatric compliance to radiotherapy procedures, and reducing requirements for general anesthesia, is under evaluation in collaboration with a team of psychologists from the Pediatric Oncology Unit.

Keywords: pediatric radiotherapy, quality of life, multidisciplinary treatments
Radiation Oncology 2 (RT2) is composed of outpatient and inpatient sections. The activity of RT2 is focused on the irradiation of head and neck cancer, gynecologic cancer, and brain metastases. The outpatient section RT2 is equipped with a 6 MV Linac (Unique Varian) and an HDR brachytherapy device (Selectron Nucletron). A telecobalt unit was retired in 2012.

The outpatient section RT2 is equipped with a 6 MV Linac (Unique Varian) and an HDR brachytherapy device (Selectron Nucletron). A telecobalt unit was retired in 2012.

The inpatient section has 4 rooms with 8 beds. In 2012, 450 patients underwent 480 treatments mainly delivered with 3D-CRT or IMRT/RapidArc (91% of all cases). A total of 192 treatments were performed on patients with head and neck cancer (43%), and 92 treatments on patients with gynecologic cancer (20%). High-dose rate brachytherapy (HDR BCT) is given as endocavitary treatment in uterine cancers, as endoluminal BCT in biliary tract cancers, and as interstitial BCT in prostate cancer with HDR equipment (Selectron®). During 2012, 185 treatment plans were provided to 52 gynecologic patients. Prostate cancer HDR brachytherapy was delivered as monotherapy (28 Gy in 2 fractions) or as a boost in 27 sessions (15 patients).

Overall, 451 patients were referred to RT2 during 2012 with a mean hospital stay of 7 days. Treatments based on a combination of chemoradiotherapy are also provided in an inpatient setting, mainly to patients suffering from gynecologic, anorectal, and head and neck cancers. In 2012, 206 chemotherapy sessions were administered concomitantly with radiotherapy.

Supportive care for acute and, more infrequently, late radiotherapy-related complications is also provided. RT2 cooperates with the Radiology Diagnostic Imaging 2 for the care of patients undergoing chemomobilization, intra-arterial chemotherapy, biliary tract cancer, and other interventional oncology procedures requiring hospitalization.

Keywords: external beam brachytherapy, radiotherapy, head and neck cancer, gynecologic cancer, brain metastases

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MEDICAL PHYSICS

In cooperation with the INFN-Milan (National Institute for Nuclear Physics) and the Center for Medical Radiation Physics (Wollongong, Australia), innovative MOSFET detectors for in vivo dosimetry in prostate HDR brachytherapy were studied. With the same goal, new miniaturized scintillation detectors were developed and characterized (in collaboration with the Materials Science Department, University Milano-Bicocca).

In collaboration with Radiotherapy Oncology 1, a study was undertaken to attempt to predict radiation-induced skin toxicity in breast cancer. In particular, the Medical Physics Unit is involved in spectrophotometric analysis of skin reflectance for objective quantification of induced toxicity and the computational and instrumental evaluation of skin dose.

In the multidisciplinary Prostate Cancer Program, the Unit took part in the development of radiobiological models for the prediction of acute and late gastrointestinal and genitourinary toxicities following prostate radiotherapy. A new 4D localization system, Calypso™, was installed on the linear accelerator Varian DH-X. The system is based on electromagnetic transponders that are implanted in the patient’s prostate and permit localizing and following organ movement during radiotherapy (RT). This new localization system is now under investigation to establish the level of accuracy and reproducibility of radiation treatments.

In collaboration with the Pediatric Radiotherapy Unit, the Pediatric Oncology Unit, the Pediatric MR Unit, Politecnico di Milano, and the IRCCS E. Medea of Bosisio, the Unit is conducting a study on white and gray matter changes using magnetic resonance diffusion tensor imaging (DTI) and their correlation with RT dose and neurocognitive damages in children undergoing focal brain RT for malignant brain tumors. The first challenge was registration of CT/MR images acquired at different times that had to be deformed to take into account the growth of children. Registration was performed by a multistep framework currently under validation.

When, at the beginning of 2012, a new CT scanner was installed in Radiology and Diagnostic Imaging 2, the Medical Physics Unit estimated patient dose from CT scans and optimized the adopted protocol. Particular attention was paid to pediatric patients, and a dose reduction of up to 45% compared to the previous CT scanner was achieved.

The accrual of healthy subjects and patients with colorectal cancer for a study on the role of native fluorescence in the diagnosis of this type of tumor was completed.

Keywords: in vivo dosimetry, tumor localization, image registration