COMP CCPM
CANADIAN ORGANIZATION OF MEDICAL PHYSICISTS
ORGANISATION CANADIENNE DES PHYSICIENS MEDICAUX

CANADIAN COLLEGE OF PHYSICISTS IN MEDICINE
LE COLLEGE CANADIEN DES PHYSICIENS EN MEDECINE

CANADIAN MEDICAL PHYSICS NEWSLETTER / Le BULLETIN CANADIEN de PHYSIQUE MEDICALE

June / Juin 1992

From the editor:

Well, it looks like this month's newsletter will be only a week late. Most of the submissions have arrived, although some are still being transmitted over the phone lines. This issue gives you some things to think over before our general meetings in Calgary. Take a look.

The last sentence in the last paragraph is not just rhetorical, it is a real request. Quite a number of the FAXes and calls that I get indicate that the Newsletter is not being looked at. Also, the response to requests for submissions and/or information has been slow. I realize that we all have too many things to read each day and that all kinds of junk crosses our desks. However, if you take a quick look at the Newsletter when it comes out you not only see what is going on in medical physics in this country, but you also get the opportunity to make some input.

An example of the importance of replies to the Newsletter is the review of medical physics graduate work done at Canadian universities included in this issue. Personally I feel that this is a very useful document. However, I know that not all graduate work has been included and that some of the information is incomplete. This is unfortunate but three requests for submissions were made and I believe there was ample opportunity to have this work included.

It is my intention to make the Newsletter a document worth reading, but it can't be done alone. It would be nice to have some assistance from some folks other than the regulars who faithfully help fill each issue.

With that said I would like to thank all those who have submitted articles for this issue of the Newsletter. In particular, I thank Shlomo Shalev and Peter Dunscombe for reports on meetings (the Newsletter wouldn't exist if it weren't for current and ex Winnipegers), and Alan Rawlinson for his review of the new AECB dose limit proposals. Jake and Ellen's reviews of the issues facing the CCPM and COMP are also appreciated. Finally, I thank Micheline Gosselin and Clément Arsenault for the French translations.

The Newsletter mailing this month contains some additional material from Raymond Carrier. I know you'll be looking at the Membership Directory from time to time. I hope you will look at the proposed by-law amendments before the annual general meeting. While you're at it, read the Newsletter, it might have something interesting in it, you never know.

John Schreiner
McGill University

TABLE OF CONTENTS

Special Feature

This issue of the Newsletter contains a review of medical physics graduate research completed in Canada in 1991. To see who really did the work in this country then, turn to page Theses 1.

SECOND ANNUAL INTERNATIONAL WORKSHOP ON ELECTRONIC PORTAL IMAGING

Newport Beach, April 3-4, 1992

This meeting was sponsored by the Southern California Chapter of the AAPM, and organized by Norman Bailey, Aaron Fenster, and Shlomo Shalev. A total of 18 papers were presented, 7 from Canada, 8 from the US, and 3 from Europe. With 30 minutes allotted to each paper, there was ample time for detailed presentations and lively discussions, and this was appreciated by both the speakers and the audience.

Three papers from three different countries discussed the clinical use of on-line portal imaging systems. Michael Herman presented the Johns Hopkins experience using a Philips SRI-100 imager to verify treatments for 58 patients. Displacement errors > 5 mm were detected in 17% of the fields. Frank Van den Heuvel described the Brussels experience using a Siemens BeamView System. In one study, 566 pelvic fields were viewed interactively and the patient position was adjusted before continuing treatment. Average displacements were 7.00 ± 6.9 mm and rotations 3.0 ± 1.3°. Heather Jory showed a wide variety of portal images from the BeamView system in Winnipeg, and discussed examples of gross errors (field sizes or shape), and beam displacement errors. She also showed a movie in which patient movement was seen, as well as intertreatment displacements in a time-lapse display.

Six papers discussed developments in system design. Jean-Pierre Bissonette from the London RCC discussed the characterization of an on-line system in terms of signal and snr transfer, NPS, LSF and MTF. He discussed the techniques, as well as some of the pitfalls and difficulties, and ended this interesting talk with a derivation of the optimal magnification (i.e. source-detector distance) which he estimates to be in the range 150-180 cm. Cedric Yu from Siemens discussed some of the new features going into BeamView Plus, in particular an automatic adjustment of digitization level and gain using histogram analysis. Larry Antonuk brought us up to date on the University of Michigan project to develop a flat panel detector using amorphous silicon arrays. He wowed everyone with his latest images acquired at 6 MV with 7.8 mu, using a detector with a 256 x 240 pixel array and a 13 x 13 cm field of view. In contrast to other video-based systems, his is not light quantum limited, and potentially could have a dynamic range of 3-4 decades. Hans Roehrig described developments in Tucson using a fibre optic scintillator, which has some advantages over the conventional metal/phosphor screen. Software development in Amsterdam, using the Quirt language, was presented by Marcel van Herk. David Jaffray eloquently analyzed the effect of scatter, using the EGS4 Monte Carlo code, as a function of beam energy, field size, and air gap. Although the scatter fraction at megavoltage energies can be as high as 0.6, he concluded that scatter will have only a small effect on image quality.

Eight papers presented a wide variety of techniques for the quantitative measurement of beam placement errors. Simulator-portal and portal-portal image pairs were compared using point, curve and Chamfer matching techniques, cross-correlation in the spatial and frequency domains, graphic overlays, and medial axes. However, at the end of the day, each group remained convinced that their own approach was the best one. Peter Munro (London RCC) described a cross-correlation approach and tested it with phantom images against human observers using graphic overlays. The humans won with an accuracy of 0.4 mm compared to 0.7 mm for the algorithm, but the computer technique is faster, cheaper and tireless. James Balter (currently U of Chicago but on his way to Chapel Hill) showed that his open-curve matching routine has a mean accuracy of less than 1.5 mm translation and 1° rotation. An alternative approach was described by Daniel Fritsch, using multiscale medial axes in scale space to register portal image pairs. Some of the audience found this pretty heavy going, and were glad that Daniel and his colleagues at Chapel Hill know how it works. Ken Giljuijs from Amsterdam described Chamfer matching, and demonstrated its use on AP pelvic images acquired with a Varian imager. Art Boyer (MD Anderson CC) managed to describe two techniques in his allotted time, using FFT correlation within a defined search area, using the first and second moments to register two images. Shlomo Shalev presented results from the Winnipeg group, in which simulator-portal image pairs are registered using fiducial points matching. Results for 200 fields over a variety of sites showed mean field displacements of 2.5 mm, and random errors of 1.5 mm. The extent of patient movement inside a cast was determined using external markers. A number of ways were proposed to interpret field placement errors in terms of their dosimetric implications, using coloured displays of target underdose area vs normal tissue overdose area. Using clinical results from 91 portal films, James Balter found a random set-up error of 2.7 ± 0.8 mm, and suggested that the planning margin be selected accordingly. Brian McParland (OCI/PMH) certainly won the prize for outstanding graphics in his slides, in which he demonstrated the dosimetric implications of enlarged margins to cover the uncertainty in determining field placement errors. Using images from 6H & N patients, he found mean displacements of 1.4 ± 0.4 mm, and field edge errors of 1.5 ± 4.6 mm.

Last, but not least, Kiaren McGee from Winnipeg presented the result of an Roc study to evaluate different processing algorithms for portal images. The

importance of experienced observers was shown to be dominant, with relatively small gains in performance due to digital processing.

In summary, the workshop was a lively, interesting, and productive meeting, and only positive comments could be heard during the excellent social functions and in the commercial exhibit area. Anyone interested in further information or copies of the abstracts, can contact the undersigned, or call Art Boyer whose laptop was in constant use recording voluminous notes (or was he catching up on other work during the presentation?).

Shlomo Shalev, Ph.D.
Manitoba Cancer Treatment and Research Foundation
Winnipeg, Manitoba April 1992

CANADIAN COUNCIL ON HEALTH FACILITIES ACCREDITATION (CCHFA) WITH NATIONAL HEALTH ORGANIZATIONS

Ottawa Congress Centre
April 15th, 1992

INTRODUCTION

I attended this meeting as a representative of the Canadian College of Physicists in Medicine with particular interest in the accreditation of Cancer Centres (which is already taking place). The N.E.O.R.C.C. most graciously covered the expenses associated with my attendance (except for a few pints of proper beer, which the reader might be interested to know, slipped down a treat).

BACKGROUND

Accreditation of Health Facilities apparently originated in the United States more than 40 years ago when Medical Schools wished to identify suitable institutions for the training for physicians. Such activities expanded and broadened in subsequent years with similar processes now taking place in Canada, Australia and the U.S.

Although not obligatory in Canada, 94% of hospital beds are in accredited institutions with the remainder in small hospitals which tend to have unique organizational models. The C.C.H.F.A. is expected to, and currently does, fund itself entirely from accreditation fees which vary with the size of the institution seeking accreditation.

THE MEETING

The meeting attracted about 50 representatives of National Health Organizations, ranging from pathologists to laundry and linen people. Your correspondent was the only representative of a cancer-related organization.

The meeting was well organized with the principal speakers (generally C.C.H.F.A.) appearing knowledgeable and well prepared.

THE ACCREDITATION PROCESS

A lengthy and weighty document (3.1 kg for an acute care facility) is sent to the institution for a self assessment. Subsequently a review team comprising a physician, a nurse and (frequently) an administrator is dispatched to the institution to confirm the internal assessment. Analysis of the two assessments leads to accreditation plus identification of weaknesses in any process. The accreditation document is divided by service (such as Medical Physics) and for each service subdivided currently into seven sections such as "Physical & Human Resources", "Policies & Procedures", etc. Each service responds in these seven standard areas which are tailored to some extent to reflect the actual service functions. A satisfactory evaluation seems to result from compliance with expectations of adequate and clearly defined service goals, policies and procedures, job descriptions, continuing education plans, etc.

The evaluation document is continuously under review with the next major revision, based on a simpler organizational model, due to be available sometime next year. Although the term "standards" was used repeatedly, C.C.H.F.A. representatives were at pains to point out that accreditation does not amount to an inspection. The accreditation process has, as a major function, the provision of support to the institution in enhancing quality.

PROBLEMS WITH THE CURRENT ACCREDITATION PROCESS

1. It does not reflect some current management approaches such as Program Management which is becoming increasingly popular and Continuous Quality Improvement (if you want to increase your stature at cocktail parties say C.Q.I. - it's one of the current buzzwords).
2. The composition of survey teams (a physician, a nurse and and administrator) was seen by many participants to be frequently in appropriate. The omission of the close and routine involvement of a Physicist in Cancer Centre accreditation would also appear to be inappropriate.
3. The current document does not adequately reflect the multicultural environment of many facilities. This issue is being tackled.

However, there is flexibility within the review process so that all these issues can, to some extent, be addressed in current reviews.

OUTCOME MONITORING

An interesting discussion of the problem of Outcome Monitoring was given by the C.C.H.F.A. Director, Ambrose Hearn.

Three thousand charts from 26 Canadian Hospitals were analyzed by a team of physicians according to some protocol and also by two automated methods based on chart summaries (None of these techniques was detailed).

Seven percent of charts suggested "bad outcomes" with fourteen percent suggesting "process problems" as assessed by the physicians group. The discrepancy can apparently be explained by outcomes such as, post-op infection which is a process problem but does not affect long term outcome.

The agreement between "automated methods" and the physician group was generally poor but all approaches are apparently superior to random inspection of charts.

At this stage there was no attempt to correlate outcome or process problems with performance during accreditation. This will be an interesting area to watch.

MESSAGE FOR THE PHYSICS COMMUNITY

Accreditation is coming. We should make sure that we are recognized as key players in the operation of Cancer Centres and actively participate in the review process. This participation should be at least in the development and on-going revision of the accreditation document. We should also consider whether or not we wish to be part of the on-site survey teams. In view of the recent radiotherapy catastrophes in Europe, this level of participation may well be appropriate.

Dr. P. Dunscombe
Chief Physicist, NEORCC
Sudbury, ON

HOW MANY MEDICAL PHYSICISTS IS ENOUGH? (Continuation).

Trevor Cradduck's letter in the March Newsletter discussed the British recommendations for physics staffing in Nuclear Medicine. Using the IPSM recommendations, he calculated a need for 10 physicists in the Victoria Hospital, whereas the job is currently being done by only two. The question arises whether we here in Canada are grossly understaffed or exceptionally efficient compared to our colleagues in the UK.

I have recently reviewed our staffing levels in Winnipeg in view of the IPSM recommendations and also in accordance with AAPM Report No. 33 dated April 1991. We provide Medical Physics services to the Nuclear Medicine departments in seven hospitals with a combined total of 12 non-SPECT cameras (22,000 studies per year) and five SPECT cameras (800 studies per year). Including the appropriate factors for economies of scale and remote sites, the IPSM recommended minimum physics staffing level is 15.4 medical physicists, and the AAPM recommendation for nuclear medicine works out to be 4.4 physicists. In fact, we are funded for only two.

With regard to Diagnostic Radiology, the situation is reversed. To provide Medical Physics services to all urban and rural hospitals in Manitoba (200 x-ray tubes, including 7 CT scanners), we need only 1.2 physicists according to IPSM, and 5.4 physicists according to AAPM. Again, we are funded for two. Clearly, the British expectations from medical physicists working in this area are quite different from those in the U.S.

IPSM has also issued a statement on the recommended staffing levels for medical physics support of radiotherapy (February 1989). It uses equipment dependent factors and patient depended factors. For our situation, with three "special" and one "standard" accelerators, two cobalt units, three simulators, 2000 external beam patients, and 100 brachytherapy patients, the recommended minimum number of physicists is 7.4 whereas we are funded for only five.

It must be noted that the AAPM and IPSM recommendations do not allow for teaching, research, or administration. Many medical physicists in Canada are involved in teaching residents, technologists, and graduate students, and spend part of their time on research or developmental work. The staffing levels must be increased by about 20-25% to allow for these activities.

As mentioned by Trevor in his letter, Michael Patterson and Jake Van Dyk prepared a recommendation for minimum staffing levels in the Ontario Cancer Centres. Perhaps we should expand this document to include other Provinces, as well as medical physics support in Diagnostic Radiology, Nuclear Medicine, and Ultrasound. The only problem with this suggestion is the concern we all have that the provincial governments will not accept such recommendations as the basis for funding allocations.

Shlomo Shalev, Ph.D.
Manitoba Cancer Treatment and Research Foundation
Winnipeg, Manitoba April 1992

AECB's NEW DOSE LIMIT PROPOSALS

Last summer the AECB issued consultative document C-122, which described proposed changes to the AEC regulations, in particular the reduction of the radiation dose limits. The proposals are in response to the new recommendations on radiation protection contained in ICRP Report 60 (1990) which in turn is based on the latest risk estimates derived from reanalysis of atomic bomb survivor data and other high dose epidemiological studies.

The major proposals in C-122 are:

- For members of the general public the annual dose limit would be 1 mSv/yr (5mSv/yr at present).
- An atomic radiation worker would be defined as a worker with a reasonable probability of receiving more than 1 mSv/yr (5 mSv/yr at present).
- For atomic radiation workers the dose limit would be 20 mSv/yr (50 mSv/yr at present).
- For a pregnant worker the maximum dose for the duration of her pregnancy would be 2 mSv (10 mSv at present)

The AECB has circulated the document widely, has attempted to gauge the impact of the proposals through questionnaires and has met with different sectors of the radiation user community. There has been a vigorous response to the proposals, both for and against, from many different organizations across the country. The reaction of the hospital community has been generally critical. Typical of the issues were those raised at a recent AECB meeting held with representatives of the CCPM, COMP, CNA, CAMRT, CANM and the Canadian Association of Radiopharmacists. Some of the major concerns expressed were:

- In general the new regulations will force increased expenditure of scarce funds on radiation protection when these funds would be better spent on other far riskier work place hazards. The regulations would also exaggerate the fears of radiation in the minds of patients, staff and public.
- Radioisotope therapy patients will have to stay in hospital much longer to limit exposure of relatives and public to 1 mSv.
- The new definition of ARW will mean that many more hospital staff will have to be classified as radiation workers with added expenses for dose monitoring and training as well as problems with contract negotiations. Also it will be very difficult to measure 1 mSv/yr in the presence of a natural background of 2-3 mSv/yr.
- In many hospitals it would be impossible to guarantee that pregnant workers would not exceed the proposed 2 mSv limit, so that they would have to be reassigned to other jobs which is particularly difficult in small departments.
- For some radiopharmacutical workers it would be difficult in a given year to limit doses to 20 mSv.
- At present the AECB sets a variety of ALARA dose "constraints" in addition to the statutory dose limits. For example, medical accelerator facilities must constrain doses to 5 mSv/yr for radiation workers, 0.5 mSv/yr for non-radiation workers and 0.05 mSv/yr for members of the general public. It is not clear what the fate of these dose constraints will be in the light of C-122.

While expressing some sympathy to these concerns the AECB at this time appears to have made concessions in two areas only. First, the AECB will likely invoke paragraph 139 of ICRP 60 which allows exposure of relatives and friends assisting radioisotope patients to be counted as "medical exposure" and therefore not to be included in the 1 mSv/yr limit. Second, the AECB is considering a 5 year averaging period for the radiation worker limit.

The AECB plans to publish its revised proposals as soon as possible in Part I of the Canada Gazette after which there will be a further opportunity to comment before they are published as Regulations in Part II of the Canada Gazette.

J. Alan Rawlinson, M.Sc., FCCPM
OCI Princess Margaret Hospital
Toronto, ON

CCPM PRESIDENT'S PODIUM

The registration package for the upcoming annual meeting of the AAPM/COMP has just arrived in the mail. This is a sign that time for this meeting is approaching fast. This is also the meeting at which the regular CCPM activities will take place. Normally, at the joint COMP/CCPM annual meeting, the College organizes a one day symposium on a specific scientific topic. However, this year, due to the joint venture with the AAPM and the AAPM summer school which follows the annual meeting, the College is not providing such a symposium. In its place, Brian McParland, the scientific program chairman of this meeting is organizing a joint AAPM/COMP/CCPM Scientific Symposium entitled the Roles of Three- Dimensions in Medical Imaging and Radiotherapy Planning. The speakers are all well known Canadians including two

medical physicists (J.J. Battista and T.M. Peters, both Fellows of the College) and one physician (W. Feindel) whose specialty is neurological imaging. This symposium will be chaired by the Honourable Sylvia O. Fedoruk, a Medical Physicist, a founding Fellow of the College, and presently the Lieutenant Governor of Saskatchewan. In addition to this joint symposium, there will also be a Harold Batho Memorial lecture which will be given by Jack Cunningham. The overall program looks interesting and exciting and all Canadian medical physicists are encouraged to attend.

The Annual General Membership Meeting of the CCPM will be held on Monday, August 24, 1992, following the COMP Annual General Membership Meeting which will start at 6:00 p.m. By holding these meetings back-to-back we hope to minimize the amount of duplication of discussion which sometimes happens for those of us who are members of both the COMP and the CCPM.

During the last few months, various members of the CCPM have participated in a variety of meetings involving organizations related to legislation or accreditation. Peter Dunscombe participated in a meeting that was organized by the Canadian Council on Health Facilities Accreditation (CCHFA). He has produced a report which is published in this Newsletter which summarizes the activities of this organization in the context of medical physics. For those of us who are involved in radiation oncology physics and who are in institutions that might undergo such accreditation, this report should be carefully noted.

Alan Rawlinson participated in a meeting to discuss the implications of Consultative Document C-122 which addresses proposed amendments to the AEC regulations for reduced radiation dose limits based on the 1991 ICRP recommendations. This meeting took place in February in Toronto and had representatives of various associations which might have a vested interest in these new limits. In this Newsletter there is also a brief report by Alan on this consultative document C-122.

Ian Cunningham participated in a workshop that was organized by the Healing Arts in Radiation Protection (HARP) Commission of the Province of Ontario to address issues related to the use of patient protective devices during radiological procedures. As a result of that workshop, the Commission has circulated a draft document which will provide guidelines on the use of protective devices. Anyone interested in discussing these guidelines should contact Ian Cunningham in London, Ontario.

At the time of writing I have not yet heard of the outcome of the college membership exams. We expect the number of applications for Fellowship exams to be fairly large if the number of the people writing the membership examination this year is any indication.

I look forward to seeing you at the AAPM/COMP/CCPM meeting this summer.

Jake Van Dyk,
President, CCPM

NOTE DU PRÉSIDENT DU CCPM

Les formulaires d'inscription pour le congrès annuel de l'AAPM/OCPM sont maintenant arrivés. Ceci nous indique que le congrès débuteras bientôt. À ce congrès, les activités régulières du CCPM auront lieu. Au congrès conjoint annuel de l'OCPM/CCPM, le Collège organise normalement un symposium d'un jour sur un sujet scientifique particulier. Cependant, le Collège ne présenteras pas ce symposium cette année en raison du congrès conjoint avec l'AAPM et de l'école d'été de l'AAPM qui se dérouleras après le congrès. À sa place, un symposium scientifique, présenté conjointement par l'AAPM, l'OCPM et le CCPM, sera organisé par Brian MacParland, le président du programme scientifique du congrès. Ce symposium portera sur les aspects tri-dimensionnels en imagerie médicale et en planification de traitements. Les conférenciers sont tous des canadiens bien connus, comme J. J. Batista (FCCPM) et T. M. Peters (FCCPM), deux physiciens médicaux, ainsi que W. Feindel, un médecin spécialisé en imagerie neurologique. Le symposium sera présidé par l'Honorable Sylvia O. Fedoruk (FCCPM), une physicienne médicale qui a participé à la fondation du Collège et qui est présentement lieutenant gouverneur de la Saskatchewan. En plus de ce symposium, une conférence à la mémoire de Harold Batho sera donnée cette année par Jack Cunningham (FCCPM). Le programme général parait très intéressant et excitant, et tous les physiciens médicaux canadiens sont encouragés d'y participer.

L'assemblée générale annuelle des membres du CCPM aura lieu le lundi, 24 août 1992, immédiatement après l'assemblée générale annuelle de l'OCPM qui débute à 18h00. En tenant ces assemblées une après l'autre, nous souhaitons que les discussions d'une assemblée à l'autre ne se répèterons pas puisque plusieurs physiciens sont membres des deux organismes.

Récemment, plusieurs membres du CCPM ont participé à des réunions d'organismes législatifs ou de certification. Entre autres, Peter Dunscombe a participé à une réunion organisée par le "Canadian Council on Health Facilities Accreditation" (CCHFA). Son rapport, qui est publié dans ce bulletin, résume les activités de cet organisme dans le

contexte de la physique médicale. Ce rapport devrait intéresser ceux parmi nous qui travaillent en radio-oncologie et dont les institutions pourraient être soumises au processus de certification.

Alan Rawlinson a assisté à une discussion sur les implications du document de consultation C-122 de la CCEA qui propose des ammendements à leurs règlements en ce qui concerne la réduction des limites de doses de rayonnement conformément aux recommandations de 1991 de la Commission internationale de protection radiologique. Des représentants de plusieurs associations ayant un intérêt particulier dans ces nouvelles limites ont assisté à cette discussion qui a eu lieu au mois de février à Toronto. Dans ce bulletin, Alan résume brièvement le document de consultation C-122.

Ian Cunningham a participé à un atelier organisé par la commission ontarienne HARP ("Healing Arts in Radiation Protection") sur les dispositifs de protection pour les patients durant des procédures radiologiques. Dans un document préliminaire sur cet atelier, la commission suggère plusieurs normes quant à l'utilisation des dispositifs de protection. Pour de plus amples renseignements sur ces normes, veuillez contacter Ian Cunningham à London, Ontario.

Je n'ai pas encore reçu les résultats des examens de Membership du Collège. Si on se fit au nombre de personne ayant écrit cet examen, nous prévoyons un nombre élevé de candidats aux examens de Fellowship.

En terminant, j'espère vous voir en grand nombre au congrès de l'AAPM/OCPM/CCPM cet été.

Jake Van Dyk,
Président, CCPM.

REPORT OF THE COMP CHAIRPERSON

COMP membership has now reached 200 in the last few weeks.

The preparations for our annual meeting jointly with the AAPM in August are well underway. Karen Breitman is coordinating local arrangements in Calgary and an exciting program has been planned.

The COMP annual general membership meeting will be held on Monday evening, August 24th at 6 pm in the Crystal Ballroom of the Palisar Hotel with the CCPM general meeting to be held directly following at ~ 7:00 or 7:30 pm in the same location.

Our newly formed Professional Affairs Committee will meet for the first time at the 1992 annual COMP meeting and will then determine their mandate and activities.

In the past few months COMP has received for review and endorsement several documents and guidelines related to radiation issues from the AECB. These have been referred to our Radiation Regulations Committee.

Ellen El-Khatib, PH.D., FCCPM
Chairperson COMP

RAPPORT DE LA PRESIDENTE DE L'OCMP

Depuis quelques semaines, l'OCPM compte maintenant 200 membres.

Les préparations pour notre congrès annuel, qui aurs lieu conjointement avec celui de l'AAPM en Août, battent leur plein. Karen Breitman assure la coordination des preparatifs à Calgary et un programme très intéressant a été planifié.

L'assemblé généraleannuelle des membres de l'OCPM aura lieu lundi, le 24 août à 18:00 heures dans la Crystal Ballroom de l'hôtel Paliser. L'assemblée générale annuelle du CCPM suivra immédiatement dans la même salle vers 19:00 - 19:30 heures.

Le comité des affaires professionnelles formé récemment tiendra sa première réunion lors du congrès annuel de 1992. afin de déterminer son mandat et ses activités.

Ces derniers mois, l'OCPM a reçu de la Commission de contrôle de l'énergie atomique (CCEA), aux fins de révisions et d'approbation, plusieurs documents et recommendations relatifs à la radiation. Ces derniers ont été remis au Comité de reglementation des radiations.

Ellen El-Khatib, Ph.D., FCCPM
Presidente, OCMP

Newsletter Announcements

Addresses for Submissions:

Submissions should be sent to

L. John Schreiner
Medical Physics Department
Montréal General Hospital
1650 Avenue Cedar,
Montréal, QC.
H3G IA4

tel: (514) 934-8052
fax: (514) 934-8229

E-mail can be sent to me at McGill University at:
CXLS@MUSICA.MCGILL.CA.

Newsletter Schedule:

The newsletter schedule is :

issue	submission deadline	mailing date
Fall issue:	2nd week Nov.	1st week Dec.
Winter issue:	2nd week Feb.	1st week March.
Spring issue:	2nd week May	1st week June
Summer/Fall issue:	3rd week Sept	2nd week Oct. (new dates)

See You in Calgary

The COMP annual general membership meeting will be held on Monday evening, August 24th at 6 pm in the Crystal Ballroom of the Paliser Hotel with the CCPM general meeting to be held directly following at ~ 7:00 or 7:30 pm in the same location.

L'assemblé généraleannuelle des membres de l'OCPM aura lieu lundi, le 24 août à 18:00 heures dans la Crystal Ballroom de l'hôtel Paliser. L'assemblée générale annuelle du CCPM suivra immédiatement dans la même salle vers 19:00 - 19:30 heures.

On Se Reverra à Calgary

When making Submissions to the Newsletter, Please confirm that your submission arrives at our office by phone or FAX.

DEADLINE FOR NEXT ISSUE

FALL 1992 NEWSLETTER

TO GIVE ENOUGH TIME FOR ALL THE REPORTS ON THE GREAT SUMMER MEETINGS TO COME IN, I'VE SET THE DEADLINE TO THE LAST WEEK OF SEPTEMBER

Newsletter Submissions
Format for contributions:

Articles for the Newsletter are best submitted by E-mail (at CXLS@MUSICA.MCGILL.CA.) or on computer disk. The Newsletter is produced on a MacIntosh computer so submissions must be on Mac compatible disks or on 31/2 inch IBM disks in text or ASCI format. Please send a hard copy by mail or FAX so that any symbols or special characters can be verified.

Good quality, formatted submissions for direct use are also welcome. This reduces the work in setting-up the newsletter considerably. The final quality of the newsletter is limited by the quality of the submissions since articles are used directly. Newsletter articles should be single or double column on 8 1/2 by 11 inch paper with 1 inch margins on the sides and top and 1/2 inch on the bottom, if using two columns leave 1/2 inch between columns. Contributions should be single spaced in a clear font or type, the font size / pitch should give lower case letters that are ~2 mm high with ~6 lines of text per inch. If possible justify text on both margins. Please end your submission with your name and institution.

FAX submissions will have to be supported by original copy and will not be used directly.

The address and deadline for submissions are given on page 10 of this issue.

Calendar of Events

August 23 - 27, 1992
Calgary, Alberta
34RD ANNUAL MEETING OF AAPM AND COMP
Contact: AAPM Exec Office, 335 East 45th St,
NEW YORK, NY 10017,USA

August 30 - September 4, 1992
Banff Centre, Banff, Alberta
AAPM SUMMER SCHOOL,
THE PHYSICS OF MAGNETIC RESONANCE IMAGING
Contact: AAPM Exec Office, 335 East 45th St,
NEW YORK, NY 10017,USA

September 16 - September 19, 1992
Edgewater Hotel, Madison, Wisconsin
PREDICTION OF RESPONSE IN RADIATION THERAPY: RADIOSENSITIVITY AND REPOPULATION
Hosted by the University of Wisconsin and the AAPM
Contact: Dr. B.R.Paliwal, U. of Wisconsin Hospital
Department of Human Oncology
600 Highland Ave., K4/B 100
Madison, WI 53792

May 12 - 15, 1993,
Carleton University, Ottawa
COMP/CCPM/CMBES JOINT CONFERENCE
Contact: Dr. Ken Shortt, NRC

CONTEST

As stated last issue, the Newsletter wants to give you the opportunity to contribute to the brochure entitled *Medical Physics in Canada / La Physique Médicale au Canada*. Send in *your* captions for the various figures in the brochure. Contributions might be reviewed at our general meeting in Calgary.
Congratulations to Shlomo Shalev and John Grant, winners of the early-bird awards.

(P.S.: O.K. Walter , you can enter if you want)

MEDICAL PHYSICIST
TOM BAKER CANCER CENTRE
CALGARY, ALBERTA
CANADA

Applications are being accepted for the position of Medical Physicist or Senior Medical Physicist at the Tom Baker Cancer Centre. A Division of the Alberta Cancer Board, the Tom Baker Cancer Centre has overall responsibilities for the Southern Alberta Cancer Program. We are a comprehensive cancer centre, treating approximately 2,600 new patients a year, and have major research and education components in collaboration with the Faculty of Medicine, University of Calgary. Add the splendor of the majestic Rocky Mountains and the vitality of a rapidly growing City of 750,000 that successfully entertained the world during the 1988 Winter Olympics, and the resulting opportunities are ideal for career and family life.

The Medical Physics Department has a complement of 20, including medical physicists, physics technicians, electronics, machine shop, treatment planning and cast and mould staff. Radiation therapy equipment available includes three linear accelerators, two cobalt units, two simulators, and remote afterloading brachytherapy. The treatment planning system is based on a VAX computer.

On joining our team, you will participate in the service, research and educational activities of the Department. Qualified candidates with advanced degrees would be eligible for academic appointment with the University of Calgary.

We offer salaries that are very competitive in the Canadian market and supplement them with individual travel and professional allowances as well as a relocation package. Candidates should possess an M.Sc. or a Ph.D. Degree and have documented experience in Medical Physics. The level of the appointment will be dependent upon the qualifications and experience of the applicant.

In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada.

Be a part of our departmental growth and expand your career in a vibrant, young city. Send your Curriculum Vitae and the names of three references to:

Karen Breitman, FCCPM
Director
Department of Medical Physics
Tom Baker Cancer Centre
1331 29 Street N.W.
Calgary, Alberta
T2N 4N2

CANADIAN MEDICAL PHYSICS THESES

1991

The Canadian Medical Physics Newsletter is pleased to publish the following review of medical physics graduate work completed at Canadian Universities in 1991. Twenty-five authors have submitted their work for this report. I thank them for their submissions and congratulate them on their research efforts. I trust that this resource will be useful to other researchers in the community.

I now invite submissions for next year. The newsletter will publish a report of theses completed in 1992 in the June 1993 issue.

John Schreiner
McGill University
Montréal, QC

University of Alberta, Edmonton, AL
Departments of Physics and*
Applied Sciences in Medicine†

Edmund Ho †
Parameter Estimation in NMR Using LPSVD
M.Sc.
Supervisor: Peter S. Allen

Grace Petrikowski †
Radiographic Assessment of the Mandible as an Indicator of Skeletal Osteopenia in Rats
M.Sc.
Supervisor: T.R. Overton

Terence Riauka *
Scatter and Attenuation Correction Techniques for Single Photon Emission Computed Tomography
M.Sc.

Scatter and attenuation correction methods were evaluated for the traditional filtered backprojection method of reconstruction used in SPECT imaging. Two sets of experiments were performed. The first experiment was used to study the reduction of scatter in planar projection images, prior to reconstruction, using Compton window subtraction in conjunction with digital image filtering techniques. The second experiment was used to study attenuation correction methods applicable to the traditional filtered backprojection method of reconstruction.

The scatter component of the projections was reduced by using either a Metz filter or Compton window subtraction in conjunction with a Butterworth filter. The effects of attenuation on SPECT images were corrected by using either a pre-processing or an iterative post-processing attenuation correction method. For the iterative post-processing attenuation correction method, an iterative forward projection technique was investigated for different interpolation methods. The quantitative accuracy of the reconstructed transaxial slice images was evaluated by comparing them to a high count, high spatial resolution reference image using a specifically designed test which provided a quantitative measure of the similarity of an image with the reference image. It was found that the quantitative accuracy of the reconstructed transaxial images was substantially improved by the reduction of scatter in the planar projection images, and correcting for attenuation. However, both the scatter reduction and the attenuation correction techniques investigated lack robustness and, under certain circumstances, had detrimental effects on the images.

Supervisor: Richard Hooper

Carleton University, Ottawa, ON
Department of Physics

Alireza Shirazi Hosseini Dokht
Focusing Ultrasound with Zone Lenses
M.Sc.

The purpose of this study was to develop a method of designing an acoustic zone lens from plexiglass to produce a focus from the field of a plane circular ultrasonic transducer at a specific frequency. Theoretical aspects of simple and zone lenses are reviewed. To that end,the passage of ultrasound across interfaces and the focusing of ultrasound with simple and zone lenses are discussed in terms of beam patterns, FWHM, size of focal spot and step size of zone lens. The geometry of a simple plano-concave lens in terms of focal point or region is discussed and a method of calculation of focal point or region is described. The step size of zones, which is the essential feature, is discussed and calculated.
The transducer, a 32.1 mm effective diameter PZT disk, has 1.05 MHz centre frequency. Simple and zone lenses are plano-concave, each of 60 mm diameter,focal length of about 105 mm, and radius of curvature of 46.75 mm. Step sizes of the zone lens are about 3.22 mm, having three zones of equal area.
A precision apparatus to control and align a hydrophone with respect to the transducer acoustic axis is described. Experimental data (acoustic pressure fields of a series of simple and zoned lenses) were acquired, using a needle hydrophone of 0.6 mm diameter. The acquisition system and data processing were carried out by a micro-computer.
The FWHM, size of focal spot and depths of focus of simple and zone lenses are compared. The experimental results demonstrate agreement within ±4%between theoretical expectation and the measured value.
The FWHM values and size of focal spots are about equal and agree with theoretical predictions to within ±4%. The depth of focus of the zone lens agrees with simple theory and shows a decrease of 21% compared to the simple lens. The appearance of the side lobes for the zone lens resembles the Airy shape more than that of the simple lens.

Supervisors: Robert L. Clarke and Bog J. Jarosz

Julia K. Older
Beam-Hardening Correction for Standard Computed Tomography using Dual-Material Composition
M.Sc.

A nonlinear algorithm for beam-hardening correction in Computed Tomography is described. A least square matrix formulation which avoids the necessity for matrix inversion is developed to provide a framework for analysis of point spread functions and convergence of iterative algorithms. The reconstruction algorithm incorporates the scanner's energy spectrum and the material energy dependence using a mapping from the linear attenuation coefficients to the region of the dual-material plane defined by the human body. In the process a water-aluminum decomposition is also generated. Convergence to a visually acceptable monoenergetic image usually occurs within two to three iterations. Simulations of a 20 cm diameter water phantom with two symmetrically placed 5 cm diameter bone insets showed a reduction in the root mean square difference (in CT number) by a factor of 13.7 overall and 14.4 in the bone.

Supervisor: Paul C. Johns

Andrew J. Weber
Comparison of Four Methods of Blood Flow Measurement
M.Sc.

Four methods of measuring blood flow have been calibrated and compared in vivo and in vitro with respect to their ability to accurately measure perfusate flow through a vessel; transit time ultrasound, square wave electromagnetic, thermal pulse decay and radioactive tracer microspheres. Measurement artifact and accuracy as a function of perfusate temperature, type of perfusate, coupling medium, type of flow (pulsatile, constant), vessel size, vessel material and vessel orientation are considered for both cannulating and perivascular electromagnetic and ultrasonic flow probes.
For the ultrasonic flow probe, the accuracy of flow measurement was found to be independent of most of these parameters however it was found that the flow probe needed to be calibrated for each of the different perfusates, and depended on vessel orientation in the ultrasonic window. The signal strength was found to be dependent upon the type of acoustic couplant and vessel type.
The accuracy of flow measurement by the electromagnetic flow probe was independent of the perfusate temperature and type of flow, but was dependent upon the vessel diameter, orientation of the vessel, and type of perfusate.
The radioactive tracer microsphere technique and thermal pulse decay probes were studied in vivo using an isolated, autoperfused and in situ pig kidneys. The accuracy and performance of these techniques were determined in reference to the ultrasonic and electromagnetic flow probes and are described.
In our in vivo and in vitro studies, the ultrasound flow probe was found to be the most stable and accurate of these devices. Its overall performance and versatility were also superior.

Supervisor: Lee H. Gerig

Elias Zakhour
Determination of Termination of Thermal Dose and Blood Perfusion Rate from Clinical Data
M.Sc.

A method of calculating a thermal isoeffect dose by converting thermal exposure " equivalent-minutes " at 43°C has been described by Sapareto & Dewey (1984) and has been used to determine the thermal dose for the 15 patients treated by radiation followed by hyperthermia at the Ottawa Regional Cancer Center from Feb. 1988 to Jan. 1990.
For the purpose of this study, a reference temperature of 43°C and an Arrhenius break temperature of 43°C have been arbitrarily chosen to convert all thermal exposures to " equivalent-minutes " at these temperatures. A computer program written in Fortran 77 is included for performing calculations of " equivalent-minutes " (TD_{min}).
In order to calculate the blood perfusion rate during the cool-down period, the bioheat transfer equation has been solved for the temperatures following the power shut-down.

Supervisor: G. Peter Raaphorst

University of Manitoba
Department of Physics

Konstantinos Chantziantoniou
An X-ray Tube Focal Spot Size Measurement Technique Using a Digital Imaging Computer Method Physics
M.Sc.

The image quality of radiographs is continually of concern to radiologists. In the radiographic imaging chain, it is the finite size of the focal spot that is one of the major contributors to this quality. Difficulties can arise when the focal spot dimensions are large and image quality deteriorates below a level acceptable to radiologists thus making the use of the diagnostic x-ray equipment unacceptable for certain radiographic examinations. To maintain quality assurance standards, methods of measuring the manufacturers' indicated focal spot size have been established of which the pinhole camera and star resolution test pattern methods are the currently acceptable techniques. Since both of these techniques have certain drawbacks - the pinhole camera technique requires generator settings that are much higher than those generally used during diagnostic x-ray examinations and the star resolution pattern involves a subjective interpretation of the exact resolution of the test tool film image by the individual that is performing the focal spot measurement, it was decided to develop a new, more objective technique that can be used to evaluate the size of the focal spot at clinically used x-ray machine settings. For this purpose, a computer algorithm was devised to be used in conjunction with digital imaging techniques to extract the focal spot's horizontal and vertical dimensions from a digitized image of an x-ray film image of a specially designed parallel wire focal spot test tool. This new technique not only produces results that are in agreement with both the star resolution test tool pattern and pinhole camera methods, but also typically provides results to an overall accuracy of 6%, over a wide range of x-ray generator settings.

Supervisor: Dr. Allan Sourkes

Konrad Wojciech Leszczynski
Digital Imaging Techniques for Radiotherapy Treatment Verification
Ph. D.

The curative effect of ionizing radiation depends strongly upon the precision with which dose is delivered to the prescribed target volume. The requirement for high geometric accuracy in patient positioning is even more stringent where complex treatment techniques are used, such as conformal, dynamic arc or truly 3-D (non-coplanar) beams. It is expected that digital on-line portal imaging devices will play a key role in the monitoring of radiation therapy treatments.
Different approaches to on-line portal image acquisition have been compared, and the basic imaging properties of a video portal imager have been evaluated and discussed in this thesis. Analysis of the system performance indicates the most efficient ways to effect improvements in spatial resolution and signal-to-noise ratio. Digital image processing techniques for noise suppression and contrast enhancement have been developed and implemented in order to facilitate visual analysis of on-line portal images. Results obtained with phantom and clinical images indicate that improvement in image quality can be achieved using adaptive filtering and local histogram modification. A novel study of observer performance with on-line portal images showed that enhancement of contrast by selective local histogram modification significantly improves perceptibility of anatomical landmarks and assures higher accuracy in quantitative computer-assisted treatment verification.
Fully automated treatment verification is the ultimate goal of on-line portal imaging. It should include analysis of size and shape of the radiation field as well as evaluation of placement of the field with respect to the internal anatomy of the patient. A computerized technique, has been developed, for extraction of the treatment field edges and for parametrization of the field, and examples of its application to automated analysis of size and shape of the radiation field are presented.

Supervisor: Shlomo Shalev

Keith Stewart St. Lawrence
An Analysis of the Xenon Enhanced Computed Tomography Technique for Measuring Regional Cerebral Blood Flow
M.Sc.

Xenon enhanced computed tomography (XeCT) is a non-invasive technique for measuring regional cerebral flow (rCBF). Two aspects of this technique were investigated in this thesis: (1) how does the precision of XeCT compare to that of PET, the imaging modality of choice for measuring rCBF and (2) a proposed simplification of the clinical application of the XeCT technique.
PET is generally considered the imaging modality of choice for measuring cerebral metabolism because of its ability to produce functional images of substances which occur naturally in tissue.To determine whether XeCT is a viable alternative, the precision of this CT based application was compared to that associated with the C15O2 buildup/dynamic PET rCBF measurement technique. The comparison was carried out using Monte Carlo computer simulations to model the effects of statistical noise, generally considered to be the dominant source of error in either technique. Results of the simulations indicated that XeCT is actually more precise than the C15O2 buildup technique. This finding was attributed to the better signal to noise ratio associated with the former.
The XeCT technique requires that the arterial concentration of the xenon be measured continuously during a patient study. The arterial concentration of xenon is usually measured indirectly by monitoring the concentration of xenon in end-tidal expired air with a thermoconductivity analyzer (the two concentrations are assumed in equilibrium). An alternative method is proposed, which utilizes the CT scanner to measure the expired air concentration. In this method, referred to as expired air scanning, the patient's expired air is channelled through the scan field using a flexible plastic tube and sampled by the CT scanner in conjunction with the buildup of xenon in cerebral tissue. This new method simplifies the XeCT technique by eliminating the need for a specialized instrument for measuring the expired air concentration. The viability of expired air scanning was analyzed using phantom studies and computer simulations. The results of the phantom studies demonstrated that the CT scanner does in fact have the capacity to detect changes in the xenon concentration to air. The computer simulations showed that although expired air scanning will introduce additional error in rCBF measurements, this error is quite small compared to that introduced by CT noise.

Supervisors: Peter Dunscombe & Jeff Bews

McGill University, Montréal, QC
Medical Physics Unit, Faculty of Medicine

Chantal Audet
NMR-Based Radiation Dosimetry Using Polymer Solutions
M. Sc.

The spin-spin and spin-lattice relaxation times of protons on polymers, T_{1p} and T_{2p}, respectively, have been used to probe the absorbed dose of irradiated polymer solutions in which radiation-induced changes in polymer molecular weight, M_n, occur. The M_n dependencies of T_{1p} and T_{2p}, and of the water proton T_{1w} for solutions of poly(ethylene oxide) (PEO) in D_2O and H_2O are presented. T_{1p} and T_{1w} are independent of M_n, and T_{2p} varies with M_n according to a specific inverse power dependence until low M_n when T_2 saturation occurs. The dose dependence of T_{1p} and T_{2p} measured for dilute solutions of PEO in D_2O reflects the dependence of M_n on dose. A novel semi-empirical model is proposed for the dose dependence of T_{2p} which incorporates the measured M_n power dependence of T_{2p} into a theoretical expression for the dose dependence of the M_n. This expression is based on previous bulk polymer work and has been modified to hold for polymers in solution. The model can be fitted well to the T_{2p} data measured for different doses, and the values of the fitting parameters agree with those expected from independent measurements. Practical aspects of the NMR/polymer dosimetry technique are also addressed.

Supervisor: L. John Schreiner

Jean-Pierre Bissonnette
Percent Depth Doses for Diagnostic Radiology
M. Sc.

A new model is proposed for the calculation of relative depth doses for diagnostic radiology using a direct photon transport/ray tracing technique which incorporates both primary and first scatter dose. The x-ray spectra are generated from computer algorithms based on the Birch and Marshall semi-empirical model; the spectra are established by matching calculated and measured transmission data. The algorithms for the generation of x-ray spectra and for the calculation of depth doses are described. Relative depth doses are determined for a number of radiographic techniques. The calculations are compared with measured and published depth doses; the agreement is very good for tube voltages below 90 kV_p. It is suggested that relative integral doses obtained from relative depth doses give an accurate representation of risk reductions obtained with different radiological techniques. The integral dose reductions predicted by the model are within 8.5 % of those from measured data.

Supervisor: L. John Schreiner

Brennan A. MacDonald
Surface Charge Characteristics of a Radio-Charged Electret
M. Sc.

Measurements of charge distributions across the face of isothermally, radio-charged polymer electrets are presented. The electret forming chamber is comprised of a parallel-plate ionization chamber in which the collecting electrode is covered by a dielectric (Teflon,Mylar). Charging is accomplished by the simultaneous application of electric potential and ionizing radiation to the chamber. The electret can be discharged by removing the external potential during further irradiation. For these studies the electrets are scanned with an electrostatic voltmeter probe yielding digitized maps of the surface charge as functions of time under various charging and discharge conditions. The results of numerical modelling of the charging process are compared with experimental data. Storage techniques for optimum charge retention are discussed. It is found that charge stability is comparable to that achieved through corona charging. These results allow us to design an optimum reusable, radio-charged electret-dosimeter.

Supervisor: B. Gino Fallone

Lawrence N. Ryner
An Electret Dosimeter Charged by Radiation-Induced Ionizations in Air
M. Sc.

An electret radiation dosimeter for long-term personnel monitoring is described. The design of this prototype (a modified parallel-plate ionization chamber) and the associated isothermal electret charging technique are presented. In the charging process, an external voltage causes ions created in air by the passage of radiation to move towards, and become trapped on, a dielectric (i.e. Mylar, Teflon) that covers the measuring electrode, forming an electret. Once the external voltage is removed, the field across the sensitive volume is produced by the electret charge, such that during subsequent irradiation, ions opposite in sign to those on the electret surface are attracted to the electret thus depleting the charge layer in an amount proportional to the exposure. Further irradiation releases the remaining charge on the electret which is measured with an electrometer. This technique allows the electret to be charged, used in the field, and discharged in situ, without dismantling the dosimeter as is required with other electret dosimeters relying on corona charging or other forming methods. Calibration, energy dependence, exposure range, and guard-ring effects of the dosimeter will be discussed. This electret dosimeter may prove to be a viable alternative to film dosimeters and TLDs, and is inherently superior because the measuring medium is air.

Supervisor: B. Gino Fallone

Queen's University, Kingston, ON
Department of Physics

Tanya Baldwin
Design and Construction of a Fluorescence Bronchoscope
M.Sc.

In recent years, the effectiveness of bronchoscopic examinations in locating early lung cancer has been increased by employing a fluor-escent drug, Hematoporphyrin Derivative (HpD), as an endobronchial tumour indicator. HpD is selectively retained in malignant tissue following intravenous injection. When exposed to the appropriate activation light, HpD emits a characteristic red fluorescence. Early superficial lesions can be detected with a high degree of certainty by inducing and localizing this fluorescence.
A fluorescence imaging bronchoscope was developed using a 100 W Hg arc lamp for excitation light. The system is simpler (no moving parts) and less expensive than other imaging scopes. Resolution is between 1.5 and 2.0 lp/mm. The sensitivity, measured in vitro, is 1.0 μM -this is comparable to values reported for other systems. In vivo experiments demonstrated that the available contrast and resolution are acceptable.
Preliminary results indicate that further trials involving more represent-ative animal models - and eventually human subjects - are warranted.

Supervisor: Peter Shragge

Marco Carlone
Computer Acquisition System for Use in Treatment Planning and Compensator Design
M.Sc.

An optical contour acquisition system has been developed which interfaces with a compensator design program. The contour acquisition system was designed to mount on a radiotherapy simulator so that it can be used in conjunction with other treatment planning operations. The contour acquisition system has been found to be accurate to within ±2 mm for all cases tested. The compensator program calculates dose including the effects of scatter and uses an iterative technique to produce templates from which lead compensators can be assembled. The compensator program was tested on a flat contour and a realistic human-shaped contour. The dose to a plane in the phantoms was uniform to ±3% for a minimum of 65% of the fields. The dose at the edge of the fields was found to be within 90% and 95% of the dose at the central axis.

Supervisor: Peter Shragge

University of Toronto
Department of Medical Biophysics

Peter A. Hardy

The Effects of Magnetic Particles on Magnetic Resonance Images
Ph.D.

Magnetic particles are comprised of a ferromagnetic material such as magnetite (Fe_3O_4) or iron (Fe) and can range in size from 10 nm to 10 µm. When placed in a strong magnetic field, magnetic particles assume a large magnetic moment around which a substantial magnetic perturbation is induced. When collections of magnetic particles are placed in a semisolid medium such as agar gel and imaged with Magnetic Resonance, the image signal intensity is greatly diminished. Magnetic particles can also arise naturally and when they do their effects on the image are similar. The thesis describes experimental and theoretical work done to determine the exact nature by which magnetic particles affect MR images. For large magnetic particles a relationship between the transverse relaxation time T_2 and the parameters of the system was derived using *Monte Carlo* computational techniques. The thesis also describes the development of a prototypical MR technique where intravenous injections of magnetic particles may be used to image tissue perfusion. An artificial capillary model was developed and imaging experiments performed on the model agreed with a theory developed to explain the effect.

Supervisor: R. Mark Henkelman

Chris H. Newcomb

The Detection and Analysis of Radiation-Induced Lung Damage
Ph.D.

Damage to lung tissue can be a major limiting factor in thoracic irradiation. The understanding of dose response relationships and fractionation effects using a variety of endpoints is important. Magnetic resonance imaging (MRI) was assessed for its sensitivity to early changes in lung tissue following irradiation. Changes in T1 and T2 were studied in vitro with a spectrometer. Although there was a detectable variation in T2, it was too small to be significant for conventional MRI.
Isoeffect formulae including the effects of time have been controversial due to experimental design and statistical techniques. An experiment was performed to test independently the effects of changes indose per fraction and overall treatment time. The results using lethality as an endpoint indicated that the linear-quadratic with time formula predicted isoeffective doses to within 7% accuracy over a wide range of times and doses per fraction. Other isoeffect formulae were also evaluated. A linear-quadratic formula with time dependent alpha parameter (TLQ) fitted the data particularly well. The TLQ model raises some fundamental questions about underlying assumptions in existent formulations and requires further investigation. A variety of statistical procedures were investigated. Multiple non-linear regression technique was the most robust procedure for dealing with the variation in data likely in these experiments.

Supervisor: Jake van Dyk

D.H. Turnbull

Two-Dimensional Transducer Arrays for Medical Ultrasound Imaging
Ph.D.

Current medical ultrasound imaging systems use linear phased array transducers to focus and steer the ultrasound beam electronically. The major limitations of the linear array are that focusing and steering can be controlled only in the array direction, resulting in degraded resolution in the perpendicular direction. Two-dimensional (2D) phased array transducers offer the potential for producing symmetrically focused ultrasound beams that can be steered throughout a three-dimensional volume.
Diced array transducer materials consisting of piezoceramic rods embedded in an epoxy matrix have been fabricated and evaluated for their suitability in 2D phased array systems. Comparisons between theoretical and measured element directivity data are used to characterize the levels of cross-coupling in the 2D array samples and diced arrays fabricated with a font acoustic matching layer on the front demonstrate pulse characteristics and radiation patterns suitable for imaging applications.
A theoretical evaluation of the focusing and steering properties of pulsed 2D arrays indicates that a 2D array with a regular arrangement of elements must have a spacing between elements of less than half the wavelength in water (tissue) for medical imaging applications. The number of elements can be reduced dramatically by using sparse set of elements,randomly distributed throughout the transducer aperture. The sidelobe structure of the sparse array is complicated, but the sidelobe amplitude increases as the number of elements decreases.
The imaging potential of 2D arrays has been investigated using simulated images of spherical lesions of varying size and contrast, embedded in a large random scattering volume. The results indicate that a dense 2D array with half wavelength spacing and a sparse array with one-eighth the number of elements (8th order) perform equivalently for all the imaging tasks investigated. A 32nd order sparse array performed at a reduced level, producing artifactual echoes within images of cysts. Comparisons of images made with linear and 2D arrays demonstrate the advantages of 2D arrays for medical ultrasound imaging.
Future areas for investigation are indicated, including possible starting points for the development of 2D phased arrays. Experiments designed to verify the image simulation studies are described. The thesis ends with a description of future imaging applications for 2D transducer arrays.

Supervisor: Stuart Foster

S.N. Urchuk
Mechanisms of Flow-Induced Signal Loss in Magnetic Resonance Angiography
M.Sc.

The inherent sensitivity of magnetic resonance (MR) imaging techniques to flowing blood has allowed the development of MR angiography, a non-invasive approach to vascular imaging. These techniques have shown promise in the cerebral and peripheral circulations. However, signal loss induced by disturbed flows has proven to be a significant limitation of MR angiography, due to its potential to mimic or exaggerate vascular disease. In this dissertation a study of flow induced signal loss is reported. Specifically, the relative contributions of mean and fluctuating fluid motions to signal loss were determined using a stenotic flow model. Our results indicate that signal loss induced by mean fluid motions is localized about the flow constriction, near the largest gradients in the mean velocity field. The fluctuating component is important over a much larger region, primarily distal to the flow constriction. For both motion components, use of gradient moment nulling (GMN) above first order was found to be an ineffective means of reducing signal loss. In contrast, shortened gradient durations were found to significantly reduce signal loss. However, though zeroth-order GMN produces the shortest gradient durations, use of a slightly longer, first-order gradient was found to be a more robust means of reducing signal loss, due to the nulling of first-order motions.

Supervisor: Donald Plewes

University of Western Ontario,
London, ON, Department of Medical Biophysics

Stephen L. Breen
Dose Estimation in Strontium-89 Radiotherapy
M.Sc.

Because of its biochemical similarity to calcium, there has been much interest in the use of strontium-89 for the palliation of bone pain from metastasised prostatic carcinoma. While the effectiveness of therapy with this beta-emitting isotope has been shown by a number of authors in recent years, there has been little work done on the determination of the absorbed dose delivered to lesions during this therapy. The dose delivered to metastatic lesions during strontium-89 radiotherapy has been estimated using the Medical Internal Radiation Dosimetry (MIRD) formalism in four patients with metastasised prostatic carcinoma.
In order to estimate the absorbed dose delivered to metastatic lesions, the amount of strontium localised in the sites was determined by scintigraphic imaging of the gamma-emitting isotope strontium-85. Five patients underwent technetium-99m methylene diphosphonate (MDP) bone scans one week prior to injection with a tracer dose of 37MBq of strontium-85 chloride. From the Tc-99m MDP scans, lesions were selected for dosimetric study. Anterior and posterior strontium-85 images of the selected lesions were obtained up to two months post-injection using a gamma camera equipped with a high-energy collimator. Using the conjugate view technique of activity quantitation, the amount of strontium in the lesion and in normal bone could be determined. During the week following injection, blood and urine samples were collected in order to observe strontium kinetics.
Observations of whole body kinetics of strontium-85 indicated that whole body retention of strontium was increased in three patients compared to the model of strontium metabolism developed by the International Commission on Radiological Protection (ICRP). Plasma strontium concentrations were lower than the normal values predicted by the ICRP model. Renal plasma clearance rates were within normal limits.
Absorbed doses to lesions in the thoracic and lumbar spine, pelvis and long bones were estimated in four patients by quantitating the uptake of strontium in lesions. Quantitive analysis of scintigrams of the lesions showed increased retention of the activity (by a factor of 4 to 20) compared with normal bone. Rates of washout of strontium from metastases were significantly lower than those predicted by the ICRP model for normal bone. These two effects resulted in absorbed doses in the range of 21+/-4 to 231+/-56cGy/MBq of strontium-89, with a median value of 68+/-14cGy/MBq. Doses to red marrow, which are thought to be overestimated, were lower by a factor of 2 to 35.
These studies with strontium-85 show that the absorbed doses delivered during strontium-89 radiotherapy can be sufficiently large to produce a therapeutic effect.

supervisor: Trevor Cradduck

Darcy Mason,
Ytterbium-169: Physical Studies of a New Radiation Source for Brachytherapy
M.Sc.

This thesis reports on physical studies of new brachytherapy sources based on the radionuclide Ytterbium-169 (^{169}Yb). ^{169}Yb sources emit photons in the energy range 50 keV to 308 keV, with an average photon energy of 93 keV. The half-life of ^{169}Yb is 32 days. These energies and half-life are intermediate compared with those of sources currently used in brachytherapy, and consequently may offer some advantages for permanent or temporary implants.
Two seed designs were selected for detailed study, based primarily on radiographic visibility in patients (for permanent implant sources) and uniformity of dose distribution.The physical data needed for clinical implementation of these sources is presented: (a) dose distributions in water, (b) source strength quantities, including the air-kerma rate constant (0.0427 $\mu Gy \cdot m^2 \cdot MBq^{-1} \cdot hr^{-1}$), exposure rate constant (1.80 $R \cdot cm^2 \cdot mCi^{-1} \cdot hr^{-1}$), and seed attenuation factors (0.74-1.01), and (c) radiation protection quantities, including the half-value layer (0.2 mm) and tenth-value layer (1.6 mm) in lead. Monte Carlo computer techniques were used

to simulate, in detail, the materials and dimensions of the ^{169}Yb seeds, and to predict the dose distribution in water. These simulations indicate that the ^{169}Yb seeds provide better dose uniformity than a commercially available ^{125}I source of lower energy (30 keV).
Source strength quantities were determined by activity and exposure rate measurements. These results and additional Monte Carlo investigations emphasize that self-absorption within the seed materials is critical in optimizing the seed design for dose uniformity. Self-absorption also complicates absolute source strength calibration and dosimetry of ^{169}Yb sources.
Estimates of public exposure from an ^{169}Yb permanent implant indicate that, without shielding, a dose equivalent of 10 mSv might be received at 1 metre, which exceeds the recommended limits. Therefore, the use of ^{169}Yb sources in permanent implants might have to be restricted, and future work should concentrate on temporary implants.

supervisor: Jerry Battista.

Daniel W. Rickey
Calibration of Doppler Ultrasound Instrumentation
M. Sc.

The problem of calibrating colour and pulsed Doppler ultrasound instrumentation is approached in two phases. In the first phase the goal is to develop a phantom capable of calibrating Doppler velocity measurements without introducing the complicating effects of fluid flowing in a tube. A device designed to evaluate the velocity measurements made with colour and pulsed Doppler instruments is described. This device uses a belt to translate a large volume of semi-rigid material through the entire Doppler sample volume. A servo-motor with feedback circuitry ensures very accurate control over the belt velocity with typical errors of 0.07 cm/s. The evaluation of four pulsed Doppler instruments has demonstrated the linearity and accuracy of these instruments over belt velocities ranging from 5 to 80 cm/s. In addition, we show the effects of the high pass (wall) filter at low belt velocities.
Two colour Doppler instruments have also been evaluated and our results show regions where the instruments are aliased and where the high pass filter dominates.In the second phase of Doppler calibration the goal is to evaluate Doppler instruments in situations that more closely mimic those in vivo. A computer-controlled pump for the calibration of Doppler ultrasound instrumentation is described. The novel design of this pump incorporates two rack-mounted pistons, driven into opposing cylinders by a micro-stepping motor. This approach allows the production of nearly uninterrupted steady flow, as well as a variety of pulsatile waveforms, including waveforms with reverse flow. The capabilities of this pump to produce steady flow from 0.1 to 60 ml/s, as well as sinusoidal flow and physiological flow, such as that found in the common femoral and common carotid arteries are demonstrated. Cycle-to-cycle reproducibility is very good, with an average variation of 0.1 ml/s over thousands of cycles.

supervisor:

Saryu Singh
Projection Presaturation: A New Approach to Producing Conformal Selective Excitation in Magnetic Resonance
Ph.D.

In recent years, several techniques of volume-selective excitation for extracting signals from a chosen region in a large sample have appeared for various applications in magnetic resonance (MR). Most of these techniques suffer from, at least, the T2-decay problem, which rules out their application for short T2 species. The remaining methods, while not suffering from the above limitations, are generally sensitive to errors in the radio frequency (RF) tip-angle and imperfections in RF profile, which cause inaccurate localization.
To overcome these problems, I have devised a new method for multi-dimensional spatial localization by accurate outer volume suppression. The method uses a series of selective RF pulses and a rotating gradient to saturate only the region outside the region(s) of interest (ROI), whose magnetization remains ideally unaffected during the localization. The magnetization within the ROI(s) is then interrogated with a readout pulse to acquire data. Suppression of the outer volume signal as well as signal loss from the ROI caused by RF imperfections are approximately estimated theoretically and compared against the measured values. The method virtually eliminates the tip-angle errors, greatly reduces the imperfections in RF profile, and thus increases the accuracy of localization.
Analytical methods are presented to design the RF pulses to localize one or more ROIs, whose shape and size can be tailored to match in-vivo targets at arbitrary positions. Experimental results from a phantom and animal study using an MR imager demonstrate that ROIs of various shapes and sizes at arbitrary positions within a 3D volume can be localized by suppressing (>99.9%) the magnetization of unwanted regions in 30-60ms. Also shown are the efficacy of the method in suppressing flow and aliasing artifacts in MRI, and in acquiring spectral/relaxometric data from a ROI.
The techique is suitable for short T2 species, as it does not suffer from the T2-decay problem. Most importantly, it can be implemented on any existing commercial MR scanner, as it does not require any special hardware. Because the method is accurate and versatile, it has many applications in MR.

supervisor: Brian Rutt.

Edward CY Tong

Towards the Quantification of Myocardial Blood Flow and Extracellular Volume via the Measurement of the Extraction Efficiency for Gd-DTPA

M.Sc.

Discrimination between different myocardial tissue states is important in the diagnosis and treatment of myocardial ischaemia.Such a discrimination is possible with the measurement of myocardial perfusion (F) and extracellular volume (~). The Modified Kety equation can be used to determine FE and ~. By means of magnetic resonance imaging and blood sampling, the tissue and blood concentrations of Gd-DTPA can be determined. In this thesis, the extraction efficiency (E) for Gd-DTPA was measured so that F could be calculated from FE.

E for the entire left ventricular myocardium (E_global) was measured in vivo for the canine heart, using the reference tracer technique. For normal blood flow, E_global was a function of capillary transit times and ranged from about 0.4 to 0.6. Under vasodilation induced by dipyridamole, E_global was independent of transit times and measured to be 0.4q10%.

E for different regions in the left ventricular myocardium (E_local) was measured in vivo using (1) and a newly-developed experimental procedure. For each dog, the relationship E_local=1- exp(-PS/F), where PS is the permeability-surface area product, was observed, suggesting that a unique PS could be used for the myocardium. Although PS was different for different dogs, the variation only slightly affected the dependence of E_local on F. The average values of E_local are approximately: 0.6 for normal tissue, 1 for acute ischaemic and >0.7 for chronic ischaemic tissue. With these values for E, F could be quantified for both normal and ischaemic tissues, but the uncertainty in F could be large (>50%) at high flows (>0.6ml/min/g).

supervisor:

COMP OCPM

CANADIAN ORGANIZATION
OF MEDICAL PHYSICISTS

ORGANISATION CANADIENNE
DES PHYSICIENS MEDICAUX

Case Postale 369, Station Postale K, Toronto, Ontario, M4P 2G7

COMP BYLAWS

13 June 1992

TO: **ALL MEMBERS / *A TOUS LES MEMBRES***
from: **Raymond Carrier, secretary**

You will find, on this page, proposals of changes, in COMP bylaws. To be adopted, such amendments have to be voted at the next annual meeting in august 1992 at Calgary. The original text of bylaws is published at the end of the 1992 directory.

Vous trouverez sur cette page des propositions de changements aux réglements de l'OCPM. L'adoption de ces amendements doit être votée en assemblée générale au mois d'août 1992 à Calgary. Le texte complet des réglements actuellement en vigueur est publié à la fin du répertoire 1992. Pas de version française encore disponible.

Art IV, B, ... item 4:

replace "...two months..." by "...**three months...**"

Art IV, B,... item 5:

first paragraph: replace last part of last sentence "... and presented at the AGM..." by "... **at least two months prior to the annual general meeting of the organization.**"

and remove second paragraph.

Art IV, B,... item 6:

completely change this item 6 by:

" Election of officers will be made by mail ballot according to article X. Ballots will be counted sequentially for positions 3) to 6) in art. IV A). The highest number of votes for each position will determine the elected officer except for the case when this would mean that 4(four) non CCPM member would then be member of the committee. In this case the CCPM member with the highest number of votes would be elected. The ballot counting will be done by the past-chairperson (also chairperson of the nominating committee) or a delegate (s)he appoints, plus one other Full member of the Association. The past-chairperson or his delegate will count the ballots and report to the Chairperson at/or prior to the annual general meeting where (s)he will announce the results."

...Art.X:

second paragraph: replace "... ordinary prepaid mail ..." by "...**ordinary mail...**"

third paragraph: change "... counted by the Secretary..." by "... **counted by the Secretary unless otherwise specified in this bylaw...**"