

The Future of Precision in RT

A Tribute to
Michael B. Sharpe, Ph.D.
AAPM Memorial Session – July 31, 2017

DAVID A. JAFFRAY, Ph.D.
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HEAD, MEDICAL PHYSICS AND DIRECTOR, TECHNIA INSTITUTE
PRINCESS MARGARET CANCER CENTRE/UNIVERSITY HEALTH NETWORK

1965 - 2016

PROFESSOR, DEPARTMENTS OF RADIATION ONCOLOGY,
MEDICAL BIOPHYSICS, AND IBBME
UNIVERSITY OF TORONTO

UNIVERSITY OF TORONTO
FACULTY OF MEDICINE

TECHNA

UHN
Toronto General
Toronto Western
Princess Margaret
Toronto Rehab



Physicist Innovator Educator Mentor Cyclist Father Husband & Friend

Michael B. Sharpe, Ph.D.

Michael B. Sharpe, Ph.D.

- Associate Head of Medical Physics, Professional and Academic Affairs at the Princess Margaret Cancer Centre.
- Affiliated Faculty of the Techna Institute.
- Associate Professor in the Departments of Radiation Oncology and Mechanical and Industrial Engineering at the University of Toronto.
- Quality Leader of Cancer Care Ontario's Radiation Treatment Program.
- Fellow of the American Association of Physicists in Medicine in 2015.









Michael B. Sharpe Tribute – Toronto June 2017

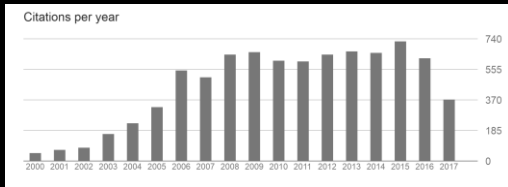


Thesis: A Unified Method of Calculating the Dose Rate and Dose Distribution for Therapeutic X-Ray Beams

Examiner: J.R. Cunningham

Mike had a deep understanding of dose calculations

Prolific, Academic, and Practical - A unique combination



<https://scholar.google.com/citations?hl=en&user=W-hJwMkAAAAAJ>

I. J. Radiation Oncology • Biology • Physics Volume 46, Number 4, 1999

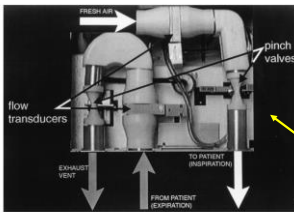


Fig. 1. The flow-transducers and valves arrangement of the modified ventilator.

ABC: Active Breathing Control

Modify a Ventilator

Control When a Patient Can Breathe

JOHN W. WONG, PH.D., MICHAEL B. SHARPE, PH.D., DAVID A. JAFFRAY, PH.D., et. al.

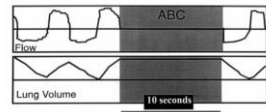


Fig. 2. The flow and volume display extracted from the ABC computer.

Suspension of Respiratory Motion based on Lung Volume



Pioneer in Accelerated Partial Breast Irradiation



Int. J. Radiation Oncology Biol. Phys., Vol. 55, No. 2, pp. 302-311, 2003
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0360-3015/03/\$ - see front matter

PII S0360-3015(02)00811-7

CLINICAL INVESTIGATION

Breast

ACCELERATED PARTIAL BREAST IRRADIATION USING 3D CONFORMAL RADIATION THERAPY (3D-CRT)

KATHY L. BAGLAN, M.D., MICHAEL B. SHARPE, Ph.D., DAVID JAFFRAY, Ph.D.,
ROBERT C. FRAZIER, M.D., JULIE FAYAD, M.S., LARRY L. KESTIN, M.D.,
VINCENT REMOUCHAMPS, M.D., ALVARO A. MARTINEZ, M.D., F.A.C.R., JOHN WONG, Ph.D., AND
FRANK A. VICINI, M.D.

Department of Radiation Oncology, William Beaumont Hospital, Royal Oak, MI

Int. J. Radiation Oncology Biol. Phys., Vol. 55, No. 2, pp. 302-311, 2003

Non-Coplanar Delivery Radiation Beams

I. J. Radiation Oncology • Biology • Physics

Volume 55, Number 2, 2003

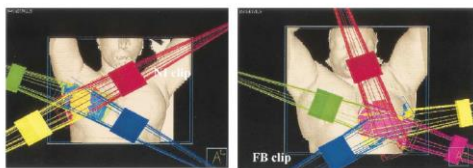


Fig. 1. Typical 4-field arrangement for right-sided lesions and 5-field arrangement for left-sided lesions.

Int. J. Radiation Oncology Biol. Phys., Vol. 55, No. 2, pp. 302-311, 2003

First Trial on Partial Breast Irradiation Delivered with External Beams

CLINICAL INVESTIGATION

Breast

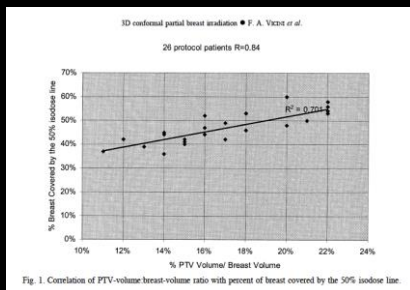
ONGOING CLINICAL EXPERIENCE UTILIZING 3D CONFORMAL EXTERNAL BEAM RADIOTHERAPY TO DELIVER PARTIAL-BREAST IRRADIATION IN PATIENTS WITH EARLY-STAGE BREAST CANCER TREATED WITH BREAST-CONSERVING THERAPY

FRANK A. VICINI, M.D.,* VINCENT REMOUCHAMPS, M.D.,* MICHELLE WALLACE, R.N.,*
MICHAEL SHARPE, Ph.D.,* JULIE FAYAD, M.S.,* LAURA TYBURSKI,* NICOLA LETTIS, B.Sc.,*
LARRY KESTIN, M.D., GREGORY EDMUNDSON, M.Sc.,* JANE PETTINGA, M.D.,†
NEAL S. GOLDSTEIN, M.D.,‡ AND JOHN WONG, Ph.D.*

Departments of *Radiation Oncology, †Surgery, and ‡Anatomic Pathology, William Beaumont Hospital, Royal Oak, Michigan

Int. J. Radiation Oncology Biol. Phys., Vol. 57, No. 5, pp. 1247-1253, 2003

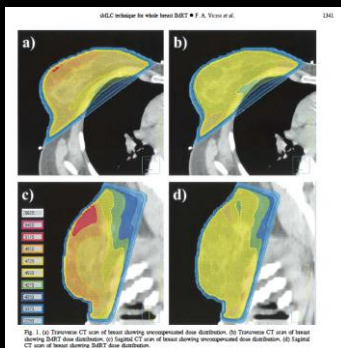
Subsequently Breast Dose Conservation Shown to Improve Cosmetic Outcome



1.6%
Decrease in
Breast
Irradiated
by > 50%
Dose Per
%PTV
Volume
Decrease

Int. J. Radiation Oncology Biol. Phys., Vol. 57, No. 5, pp. 1247-1253, 2003

IMRT to Improve Breast RT



Clinical trial that
showed that IMRT
could be used with
tangential breast
radiotherapy to
improve dose
uniformity and
lower skin dose

FRANK A. VICINI, M.D.,
MICHAEL SHARPE, PH.D.,
LARRY KESTIN, M.D., et. al.

Int. J. Radiation Oncology Biol. Phys., Vol. 54, No. 5, pp. 1336-1344, 2002

Advancing Cone-beam CT for IGRT

The stability of mechanical calibration for a kV cone beam computed tomography system integrated with linear accelerator³⁾

Michael B. Sharpe³⁾
Princess Margaret Hospital and University of Toronto, Toronto, Ontario M5G 2M9, Canada

Douglas J. Moseley
Princess Margaret Hospital and Ontario Cancer Institute, Toronto, Ontario M5G 2M9, Canada

Thomas G. Purdie
Princess Margaret Hospital, Toronto, Ontario M5G 2M9, Canada

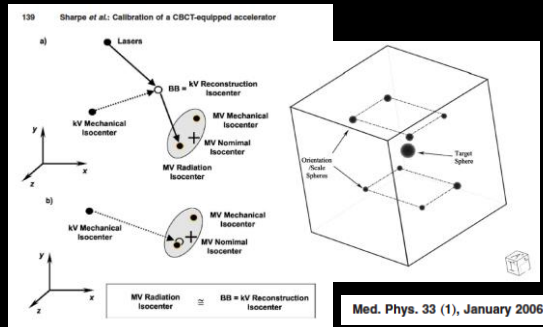
Mohammad Islam
Princess Margaret Hospital and University of Toronto, Toronto, Ontario M5G 2M9, Canada

Jeffrey H. Siewersden and David A. Jaffray
Princess Margaret Hospital, Ontario Cancer Institute, and University of Toronto, Toronto,
Ontario M5G 2M9, Canada

(Received 20 July 2005; revised 3 November 2005; accepted for publication 3 November 2005;
published 23 December 2005)

Med. Phys. 33 (1), January 2006

Calibration Methods for Cone Beam CT



Some of the earliest work in Robust Optimization for IMRT

INSTITUTE OF PHYSICS PUBLISHING
Phys. Med. Biol. 50 (2005) 5463-5477
doi:10.1088/0031-9155/50/234003

PHYSICS IN MEDICINE AND BIOLOGY

Robust optimization for intensity modulated radiation therapy treatment planning under uncertainty

Millie Chu¹, Yuriy Zinchenko¹, Shane G Henderson¹ and Michael B Sharpe²

Mike's efforts led to an outstanding and enduring collaboration between the Department of Mechanical and Industrial Engineering at the University of Toronto and the Princess Margaret Cancer Centre.



Tim Chan, Ph.D.

Inverse Optimization and Knowledge-based Treatment Planning

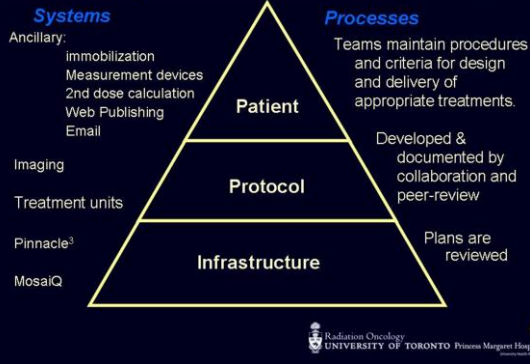
OPERATIONS RESEARCH
Vol. 62, No. 3, May-June 2014, pp. 680-695
ISSN 0030-364X (print) / ISSN 1526-5463 (online)
http://dx.doi.org/10.1287/opre.2014.1207
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Generalized Inverse Multiobjective Optimization
Predicting objective function weights from patient anatomy in prostate IMRT treatment planning
Taewoo Lee, Muhanad Hammad, Timothy C. Y. Chan, Tim Craig, and Michael B. Sharpe
Citation: *Medical Physics* 40, 121706 (2013); doi: 10.1118/1.4828841

Models for predicting objective function weights in prostate cancer IMRT
Justin J. Boutilier, Taewoo Lee, Tim Craig, Michael B. Sharpe, and Timothy C. Y. Chan
Citation: *Medical Physics* 42, 1586 (2015); doi: 10.1118/1.4914140

Sample size requirements for knowledge-based treatment planning
Justin J. Boutilier, Tim Craig, Michael B. Sharpe, and Timothy C. Y. Chan
Citation: *Medical Physics* 43, 1212 (2016); doi: 10.1118/1.4941363

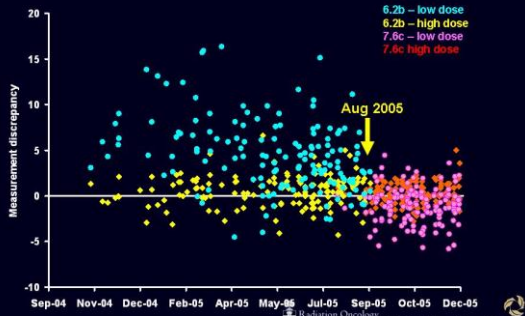
IMRT: Organizational Choices



IMRT Verification Measurements

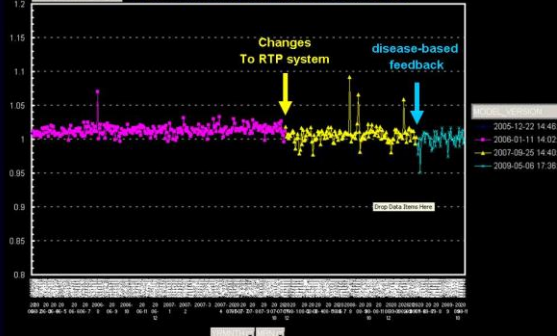
Head & Neck Cancers

Breen *et al*, Med. Phys. Oct 2008



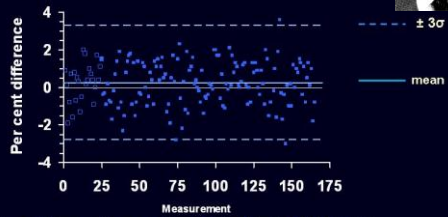
P3 vs 2nd Calculation, Synergy S Models

~950 Prostate Cancer Treatments



IMRT Process Monitoring

165 high-dose measurements
Head and neck IMRT
Pinnacle 7.6c (Sept – Dec, 2005)



Breen SL, Moseley DJ, Zhang B, Sharpe MB. Med Phys 35:4417-4425 (2008)



Automated Design of Treatment Plans

- <4 Minutes for IMRT Breast
- 1000's of cases treated
- Reduced clinical rejection rate by 50% (i.e. to 1.2%)



Automated: ~4 Minutes; >2000 Cases Completed

Pls: T. Purdie/M. Sharpe

Teacher and Societal Contributor



Medical Physics

The International Journal of Medical Physics Research and Practice

Point/Counterpoint

Within the next ten years treatment planning will become fully automated without the need for human intervention

Sharpe Michael B. Ph.D., Moore Kevin L. Ph.D., Orton Colin G. Ph.D.

First published: 10 November 2014 - full publication history

DOI: 10.1118/1.4894496 - view on scitation



Cancer Care Ontario's Innovation Award in 2007.

University Health Network's Inventor of the Year Award in 2009.

2004 Joint ASTRO-AAPM Report "Blessing" IMRT



doi:10.1016/j.ijrobp.2003.12.008

Int. J. Radiation Oncology Biol. Phys., Vol. 58, No. 5, pp. 1616–1634, 2004
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0360-3016/04/\$ - see front matter

REPORT

IMPLEMENTING IMRT IN CLINICAL PRACTICE: A JOINT DOCUMENT OF THE AMERICAN SOCIETY FOR THERAPEUTIC RADIOLOGY AND ONCOLOGY AND THE AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE

JAMES M. GALVIN D.Sc.,^{a†} GARY EZZELL, Ph.D.,[‡] AVRAHAM EISBRAUCH, M.D.,^a CEDRIC YU, D.Sc.,[‡]
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MICHAEL SHARPE, Ph.D.,[‡] LEI XING, Ph.D.,[‡] PENG XIA, Ph.D.,[‡] TONY LOMAX, Ph.D.,[‡]
DANIEL A. LOW, Ph.D.,[‡] AND JATINDER PALTA, Ph.D.[‡]

^aAmerican Society for Therapeutic Radiology and Oncology IMRT Scope Committee; [‡]American Association of Physicists in
Medicine IMRT Subcommittee of the Radiation Therapy Committee

Int. J. Radiation Oncology Biol. Phys., Vol. 58, No. 5, pp. 1616–1634, 2004

AAPM TG-65: Report on Dose Calculations

Report of Task Group No. 65 of the Radiation Therapy Committee of the American Association of Physicists in Medicine

TISSUE INHOMOGENEITY CORRECTIONS FOR MEGAVOLTAGE PHOTON BEAMS

Members

Nikos Papanikolaou (Chair) University of Arkansas, Little Rock, Arkansas
Jerry J. Battista London Regional Cancer Centre, London, Ontario, Canada
Arthur L. Boyer Stanford University, Stanford, California
Constantin Kappas University of Thessaly, Medical School, Larissa, Hellas
Erie Klein Mallinckrodt Institute of Radiology, St. Louis, Missouri
T. Rock Mackie University of Wisconsin, Madison, Wisconsin
Michael Sharpe Princess Margaret Hospital, Toronto, Ontario, Canada
Jake Van Dyk London Regional Cancer Centre, London, Ontario, Canada

TG-74: The Key to Model-Based Dose Calculation

Report of AAPM Therapy Physics Committee Task Group 74: In-air output ratio, S_c , for megavoltage photon beams

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RPC, UT MD Anderson Cancer Center, Houston, Texas 77030

(Received 1 September 2008; revised 21 August 2009; accepted for publication 21 August 2009;
published 20 October 2009)



Evidence-Based Series #21-1: Section 1

Organizational Standards for the Delivery of Intensity Modulated Radiation Therapy (IMRT) in Ontario: Recommendations

A. Whitton, P. Warde, M. Sharpe, T.K. Oliver, K. Bak, K. Leszczynski, S. Etheridge, K. Fleming, E. Gutierrez, L. Favell, N. Assasi, and E. Green

A Special Project of the Radiation Treatment Program, Cancer Care Ontario and the Program in Evidence-based Care, Cancer Care Ontario

Developed by the Expert Panel on Intensity Modulated Radiation Therapy

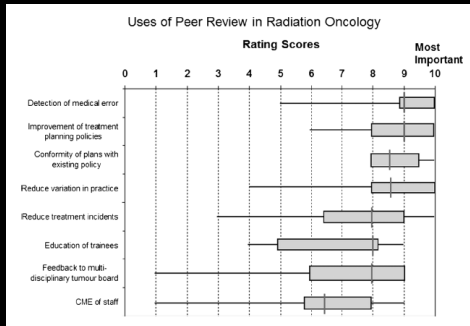
Report Date: January 30, 2008

Clinical Oncology 21(3), 192-203 (2009)

Sharpe J. *Kumt* 1 April 2011



Peer Review of Treatment Plans



Michael Brundage,^{1,2} Sophie Foxcroft,^{2,3} Tom McGowan,^{4,5} Eric Gutierrez,² Michael Sharpe,^{2,3,5} Padraig Warde^{2,3,5} *BMJ Open* 2013;3:e003241.

A True Medical Physicist

**Clinician
Academic
Educator**

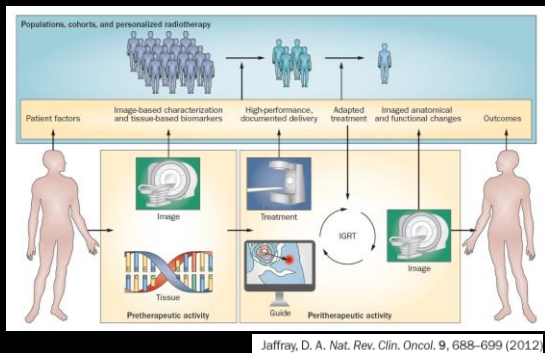


**"The Devil is in the details,
but so is salvation."**

— Admiral H.G. Rickover, USN

**Passionate
Skeptical
Committed**

Precision Medicine in RT – A Frontier of Clinical Science that needs Medical Physics





Mike personified the critical role of the Medical Physicist in the Future of Precision Medicine in RT

"I am tomorrow,
or some future day,
what I establish today.

I am today what I established
yesterday or some previous day."

James Joyce (1882-1941)

