

BIOGRAPHICAL SKETCH

NAME: Beaulieu, Christopher F., M.D., Ph.D.

eRA COMMONS USER NAME (credential, e.g., agency login): beaulieu.christopher

POSITION TITLE: Professor of Radiology, Stanford University

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE (if applicable)	Completion Date MM/YYYY	FIELD OF STUDY
University of Washington, Seattle, WA	BS	06/1982	Chemistry
Univ. Washington School of Medicine, Seattle, WA	MD	06/1989	Medicine
University of Washington, Seattle, WA	PhD	06/1989	Biological Structure
Virginia Mason Medical Center, Seattle, WA		06/1990	Transitional Intern
Duke University Medical Center, Durham, NC		06/1994	Radiology Residency
Stanford University Medical Center, Stanford, CA		06/1995	Body Imaging Fellow

A. Personal Statement

I am a Professor of Radiology and have been on the Stanford University School of Medicine faculty for over 23 years. My primary research focus has been on advancing clinical radiology through applications of computers and in developing MRI technology, the latter focused on musculoskeletal diseases. More details on my earlier work on computer applications and MRI is given below in Section C. Over the past ~10 years I shifted my focus to bioinformatics with the primary aim of making our large repositories of clinical radiological data computationally accessible for the purposes of content based image retrieval and clinical decision support. In my clinical practice of musculoskeletal radiology, I am commonly called upon for bone tumor diagnosis, which is highly challenging, with considerable variability in radiologist accuracy. By curating a large historical collection of skeletal radiographs based on 1664 patients, my colleagues and I have established initial decision support systems for bone tumor diagnosis. This is enabled through extensive structured annotation of over 800 cases using “ePad” software we developed, and with quantitative image analysis. Working with Bao Do, MD, we recently published results on a naïve Bayesian machine for bone tumor diagnosis. Extension of that work to include data from large tumor registries and literature is a key component of the current proposal. In addition, work that we initially did on liver lesion characterization has now been adapted to bone tumors, with early results suggesting that we can automatically predict semantic labels for bone tumors. I am confident that our research team is highly qualified to accomplish the goals of the current proposal.

Napel SA, **Beaulieu CF**, Rodriguez C, et al. Automated Retrieval of CT Images of Liver Lesions Based on Image Similarity: Method and Preliminary Results. *Radiology*. 256(1):243-252, 2010.

Kurtz C, Depeursinge A, Napel S, **Beaulieu CF**, Rubin DL. On combining image-based and ontological semantic dissimilarities for medical image retrieval applications. *Med Image Anal* 18:1082-1100, 2014.

Banerjee, I., **C.F. Beaulieu**, and D.L. Rubin, Computerized prediction of radiological observations based on quantitative feature analysis: initial experience in liver lesions. *J. Digital Imaging*, 30(4):506-18, 2017.

Do, B.H., C. Langlotz, and **C.F. Beaulieu**, Bone tumor diagnosis using a naive Bayesian model of demographic and radiographic features. *J. Digital Imaging*, ePub 7/27/2017.

B. Positions and Honors

Positions, Employment, Licensure

1994 American Board of Radiology Certification
1995-present California Medical License G078532
1995-2000 Assistant Professor of Radiology, Divisions of Abdominal and Musculoskeletal Imaging
Stanford University Medical Center, Stanford, CA
2000-2006 Associate Professor of Radiology, Stanford University Medical Center
2003-present Chief of Musculoskeletal Imaging, Stanford University Medical Center
2006-present Professor of Radiology, Stanford University Medical Center
2017-present Associate Chair of Education, Department of Radiology, Stanford University

Other Experience and Professional Memberships

1986 International Society of Magnetic Resonance in Medicine (Previously SMRM)
1994 American Roentgen Ray Society
1994 Radiological Society of North America
2001 Fellow, Society of Computed Body Tomography and MRI
2016 Society of Skeletal Radiology
2017 International Skeletal Society

Honors (Selected)

1983 Medical Scientist Training Program (M.D.-Ph.D.) Scholarship
1988 Alpha Omega Alpha Medical Honor Society
1989 Doctor of Medicine with High Honors (Awarded to top 3 students)
1997 RSNA Scholars Award
1996, 1998, 1999, 2004, 2007, Cum Laude Award, Society of Computed Body Tomography and MRI
2000 Hounsfield Award, Society of Computed Body Tomography and MRI
2001, 2002, 2003 Lauterbur Award, Society of Computed Body Tomography and MRI
2009 Certificate of Merit, Educational Exhibit, "Xrayhead MSK Online: A Radiology Teaching File Based on RSNA's RadLex," RSNA 2009.

C. Contribution to Science

CT Colonography Computed tomography of the cleansed, air-distended colon evolved as a promising structural imaging test in the mid 1990's. I served as P.I. and led the research program at Stanford for nine years on R01CA72023, "Three Dimensional CT Colonography". This was a highly successful project that developed new data navigation, advanced 3D visualization, and computer aided detection algorithms. I was the point person for applying these technical developments in controlled radiologist reading trials aimed at determining optimal approaches to CTC interpretation. My group's overall work was key in the evolution of CTC, which is viewed today as a mature imaging examination that has been deployed internationally.

Paik DS, **Beaulieu CF**, Jeffrey RB Jr, Rubin GD, Napel S. Automated flight path planning for virtual endoscopy. *Medical Physics*. 25(5):629-637, 1998.

Beaulieu CF, Jeffrey RB Jr, Karadi CA, Paik DS, Napel S. Display modes for CT colonography, part II: blinded comparison of axial CT, virtual endoscopy, and panoramic-view volume rendering. *Radiology*. 212:203-212, 1999.

Paik DS, **Beaulieu CF**, Rubin GD, Acar B, Jeffrey RB Jr, Yee J, Dey, J, Napel S. Surface Normal Overlap: a computer-aided detection algorithm with application to colonic polyps and lung nodules in helical CT. *IEEE Trans Med Imaging*. 23:661-75, 2004.

Mani A, Napel S, Paik DS, Jeffrey RB, Jr, Yee J, Olcott EW, Prokesch R, Davila M, Schraedley-Desmond P, **Beaulieu CF**. CT colongraphy: feasibility of computer-aided polyp detection in a "First Reader" paradigm. *J Comput Assist Tomogr*. 28:318-26, 2004.

Magnetic Resonance Imaging Working with my colleague Garry Gold, MD, we developed and tested a number of new MRI pulse sequences and explored new technology such as imaging at 3T. Our advances were applied to imaging of articular cartilage and other joint disorders with good success, and many of these techniques have made it into clinical practice. Other more recent aspects of my MRI research are clinical projects on topics such as variant sciatic nerve anatomy and imaging/interventions in musculotendinous disorders.

Gold GE, Suh B, Sawyer-Glover A, **Beaulieu CF**. Musculoskeletal MR imaging at 3.0 Tesla: initial clinical experience. *AJR Am J Roentgenol*. 183:1479-1486, 2004.

Gold GE, Hargreaves BA, Vasanawala SS, Webb JD, Shimakawa AS, Brittain JH, **Beaulieu CF**. Articular cartilage of the knee: evaluation with fluctuating equilibrium MR imaging--initial experience in healthy volunteers. *Radiology*. 2006; 238:712-718.

Gold GE, Pappas GP, Blemker SS, Whalen ST, Campbell G, McAdams TA, **Beaulieu CF**. Abduction and external rotation in shoulder impingement: an open MRI study on healthy volunteers, initial experience. *Radiology*. 244:815-22, 2007.

Varenika V, Lutz AM, **Beaulieu CF**, Bucknor MD. Detection and prevalence of variant sciatic nerve anatomy in relation to the piriformis muscle on MRI. *Skeletal Radiol*. 2017; 46(6):751-7.

Content Based Image Retrieval and Decision Support Working with Drs. Sandy Napel and Daniel Rubin at Stanford, we have worked to develop efficient methods for comprehensive semantic annotation and extraction of image processing features. With such tools in place and an accumulating database of annotated images, radiology is entering into the era of "large scale science, or big data", now being exploited in other biomedical disciplines. Our early work was on the clinically important task of liver lesion diagnosis, which served as a model for similar approaches to other diseases, modalities, and organ systems. Previous experience developing computer aided detection (CAD) algorithms for CT colongraphy helped inform more recent work on liver and bone. In addition, recent advances in computation in terms of machine learning and deep convolutional neural networks is being applied in our studies.

Bilello M, Gokturk SB, Desser T, Napel S, Jeffrey Jr. RB, **Beaulieu CF**. Automatic detection and classification of hypodense hepatic lesions on contrast-enhanced venous-phase CT. *Medical Physics*. 31, 2584-93, 2004.

Rubin D, Rodriguez C, Shah P, **Beaulieu CF**. iPad: Semantic Annotation and Markup of Radiological Images. *AMIA Annual Symposium Proceedings*. p.626, 2008. (Note: tool has been renamed "ePad")

Korenblum D, Rubin D, Napel S, Rodriguez C. **Beaulieu CF**. Managing Biomedical Image Metadata for Search and Retrieval of Similar Images. *J Digit Imaging*. 24:739-48, 2011.

Faruque J, **Beaulieu CF**, Rosenberg J, Rubin DL, Yao D, Napel S. Content-based image retrieval in radiology: analysis of variability in human perception of similarity. *Journal of Medical Imaging* 2015; 2:025501

A full list of my publications can be accessed at:

<https://med.stanford.edu/profiles/4200?tab=publications>

D. Additional Information: Research Support

Ongoing Research Support

PI: Brian Hargreaves, Ph.D.

Dates: 7/1/14-6/30/18

National Institutes of Health R01 EB017739

Title: Comprehensive MRI near total joint replacements

This project seeks to make routine MRI available for patients with total hip replacements and total knee replacements, including fast, high-resolution imaging and temperature mapping.

Role: Co-investigator

Salary Support: 4% during grant period

Completed Research Support (Within past 3 years)

PI: Garry E. Gold, M.D.

Dates: 6/1/10-5/31/14

National Institutes of Health R01 EB002524

Title: Rapid MRI for Evaluation of Osteoarthritis

Role: Investigator

Salary Support: 4% during grant period