

BIOGRAPHICAL SKETCH

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NAME Elizabeth Bullitt	POSITION TITLE Van Weatherspoon Jr. Distinguished Professor of Surgery		
eRA COMMONS USER NAME bullitt			
EDUCATION/TRAINING			
INSTITUTION AND LOCATION	DEGREE (if applicable)	YEAR(s)	FIELD OF STUDY
Harvard University, Cambridge, Mass.	BA	1971	GOVERNMENT
University of Colorado, Denver, Colo	MD	1975	MEDICINE
University of Minnesota, Minn, Minn	INTERNSHIP	1976	SURGERY
Duke University, Durham, NC	RESIDENCY	1981	NEUROSURGERY
Mayfield Neurological Institute, Cincinnati, Ohio	FELLOWSHIP	1982	NEUROSURGERY

A. Positions and Activities

Employment: 1982 -1984: Assistant Professor Neurosurgery, Mayfield Neurological Institute

1984–present: Department of Neurosurgery, UNC-Chapel Hill (Clinical Assistant Professor 1984-1990; Acting Chief 1989-1990; Assistant Professor 1990-1994; Associate Professor 1994-2000; Professor 2000-present; funded chair 2005-present)

Adjunct Appointments UNC-Chapel Hill: Department of Physiology 1984-present; Department of Radiology 2000-present; Department of Computer Science 2001-present; Lineberger Cancer Center 2004-present.

Member: AANS, NSA, IEEE; Chairman Bylaws Committee NSA, Board member IBMISPS; on Advisory Board National Center for Image Guided Therapy (MIT-Harvard)

Journal Reviewer: IEEE-TMI, Medical Image Analysis, Medical Physics, NeuroImage, others

Editorships: Editor IEEE-TMI special issue 2004, Associate Editor IEEE-TMI 2005-present; Editor NeuroImage special issue 2008.

Conference reviewer or program committees (ad hoc) MICCAI, IPMI, WBIR, ISBI; moderator MICCAI 2004, program committee MICCAI 2005-7 and MICCAI workshop 2006; keynote speaker SPIE 2005, RSNA course lecturer 2005-2007

NIH/NSF: Continuous NIH funding since 1985. Speaker and/or chair NIH conferences 1999, 2002, 2004, 2005. Ad hoc NSF/NIH reviewer 1999-present. Member NIH DMG/BIMIT study section 2001-2004.

Commercial/patents: Commercial licensing of vascular software to Medtronic Corp (Minn, Minn) and to R2 Technologies (Alta Vista, CA) 2000. Medtronic consultant 2000-2003. Pre-created vessel tree sold 2004 to WL Gore and Associates (Flagstaff, AZ). Patents: Aylward S, Bullitt E, Fritsch D, Pizer S, “System and Method for Representation and Analysis of Tubular Objects,” US Patent # 6,690,816, 2/10/2004; Bullitt E, Aylward S, “Systems, Methods, and Computer Program Products for Analysis of Vessel Attributes for Diagnosis, Disease Staging, and Surgical Planning,” USSN:10/569,436, 2007 .

B. Selected Journal Articles

Bullitt E, Liu A, Aylward S, Soltys M, Boxwala A, Rosenman J, Pizer S (1997) Methods for displaying intracerebral vascular anatomy. *American Journal of Neuroradiology* 18:417-420.

Bullitt E, Liu A, Pizer SM (1997) Three dimensional reconstruction of curves from projection views. I. Algorithms. *Medical Physics* 24:1671-8.

Bullitt E, Liu A, Pizer SM (1997) Three dimensional reconstruction of curves from projection views. II. Analysis of error. *Medical Physics* 24:1679-87.

Bullitt E, Liu A, Aylward S, Coffey C, Stone J, Mukherji S, Muller K, S, Pizer SM (1999) Registration of 3D cerebral vessels with 2D digital angiograms: Clinical evaluation *Acad. Radiol.* 6:539-546.

Bullitt E, Aylward S, Bernard E, Gerig G (2001) Special Article. Computer-assisted visualization of arteriovenous malformations on the home pc (2001) *Neurosurgery*: 48: 576-583. **Featured paper.**

Bullitt E, Aylward S, Smith K, Mukherji S, Jiroutek M, Muller K (2001) Symbolic Description of Intracerebral Vessels Segmented from MRA and Evaluation by Comparison with X-Ray Angiograms. *MedIA* 5:157-169.

Aylward S, Bullitt E (2002) Initialization, noise, singularities and scale in height ridge traversal for tubular object centerline extraction. *IEEE-TMI* 21:61-75.

Bullitt E, Aylward S (2002) Volume Rendering of Segmented Image Objects *IEEE-TMI* 21:998-1002.

Aylward SR, Jomier J, Weeks S, Bullitt E (2003) Registration and analysis of vascular images *IJCV* 55:123-138.

Joshi S, Lorenzen P, Gerig G, Bullitt E (2003) Structural and Radiometric Asymmetry in Brain Images. *MedIA* 7:155-170.

Bullitt E, Gerig G, Pizer S, Aylward SR (2003) Measuring tortuosity of the intracerebral vasculature from MRA images. *IEEE-TMI* 22:1163-1171.

- Prastawa M, Bullitt E, Moon N, Van Leemput K, Gerig G (2003) Automatic brain tumor segmentation by subject specific modification of atlas priors. *Acad. Radiol.* 10:1341-1348
- Lin W, An H, Chen Y, Nicholas P, Zhai G, Gerig G, Gilmore J, Bullitt E (2003) Practical considerations for 3T imaging. *Magn. Reson. Imaging Clin. N. Am.* 11:615-639.
- Prastawa M, Bullitt E, Ho S, Gerig G (2004) A brain tumor segmentation framework based on outlier detection. *MedIA* 8:275-283.
- Fridman Y, Pizer S, Aylward S, Bullitt E (2004) Extracting branching tubular object geometry via cores. *MedIA* 8:169-176.
- Bullitt E, Ewend MG, Aylward S, Lin W, Gerig G, Joshi S, Jung I, Muller K, Smith JK (2004) Abnormal vessel tortuosity as a marker of treatment response of malignant gliomas: Preliminary report. *Technology in Cancer Research and Treatment* 3:577-584.
- Parikh A, Smith JK, Ewend MG, Bullitt E (2004) Correlation of MR perfusion imaging and vessel tortuosity parameters in assessment of intracranial neoplasms. *Technology in Cancer Research and Treatment* 3:585-590.
- Bullitt E, Muller K, Jung I, Lin W, Aylward SR (2005) Analyzing attributes of vessel populations. *MedIA* 9:39-49.
- Maupu D, Van Horn M, Weeks S, Bullitt E (2005) 3D stereo interactive visualization for the TIPS procedure. *IEEE Computer Graphics and Applications* 25:67-71.
- Bullitt E, Zeng D, Gerig G, Aylward S, Joshi S, Smith JK, Lin W, Ewend MG (2005) Vessel tortuosity and brain tumor malignancy: A blinded study. *Academic Radiology* 12:1232-1240; **winner 2006 Herbert M. Stauffer Award by the Association of University Radiologists.**
- Brubaker L, Bullitt E, Yin C, Van Dyke T, Lin W (2005) MRA visualization of abnormal tumor vasculature in genetically engineered mice. *Cancer Research* 65: 8218-8223. **Featured paper.**
- Lorenzen P, Prastawa M, Davis B, Gerig G, Bullitt E, Joshi S (2006) Multi-modal image set registration and Atlas Formation. *MedIA* 10:440-451.
- Bullitt E, Wolthusen A, Brubaker L, Lin W, Zeng D, Van Dyke T (2006) Malignancy-associated vessel tortuosity: A computer-assisted, MRA study of choroid plexus carcinoma in genetically engineered mice. *AJNR* 27: 612-619.
- Bullitt E, Lin NU, Smith JK, Zeng D, Winer EP, Carey LA, Lin W, Ewend MG (2007) Blood Vessel Morphological Changes as Visualized by MRA During Treatment of Brain Metastases. *Radiology* 245:824-830. **Cover paper.**
- Bullitt E, Aylward SR, Van Dyke T, Lin W (2007) Computer-Assisted Measurement of Vessel Shape from 3T Magnetic Resonance Angiography of Mouse Brain. *ElsevierMethods* 43:29-34.
- Bullitt E, Reardon DA, Smith JS (2007) A Review of Micro and Macro Vascular Analyses in the Assessment of Tumor-Associated Vasculature as Visualized by MR. *NeuroImage* 37 Supp 1: 116-119 <http://dx.doi.org/10.1016/j.neuroimage.2007.03.067>
- Lin N, Carey LA, Liu MC, Younger J, Come SE, Ewend M, Harris GJ, Bullitt E, Van den Abbeele AD, Henson JW, Li X, Gelman R, Burstein HJ, Kasparian E, Kirsch DG, Crawford A, Hochberg F, Winer EP (2008) Phase 2 trial of lapatinib for brain metastases in patients with HER2-positive breast cancer. In press *JCO*.
- Budin F, Zeng D, Ghosh A, Bullitt E (2008) Preventing facial recognition when rendering MR images of the head in three dimensions. In press *MedIA*.

Full-Length Peer-Reviewed Papers on Medical Imaging Published in Conference Proceedings (2005-present only)

- Mortamet B, Zeng D, Gerig G, Prastawa M, Bullitt E (2005) Effects of healthy aging measured by intracranial compartment volumes using a designed MR database. *MICCAI 2005; LNCS 3749: 383-391.*
- Pathak C, Van Horn M, Weeks S, Bullitt E (2005) Comparison of simultaneous and sequential two-view registration for 3D/2D registration of vascular images. *MICCAI 2005; LNCS 3750:239-246.*
- Aylward S, Jomier J, Vivert C, Ledigarcher V, Bullitt E (2005) Spatial graphs for intracranial vascular network characterization, generation, and discrimination. *MICCAI 2005; LNCS 3749: 59-66.*
- Prastawa M, Bullitt E, Gerig G (2005) Synthetic ground truth for validation of brain tumor MRI segmentation. *MICCAI 2005; LNCS 3749:26-33.*
- Bullitt E, Aylward SR. Visualizing blood vessel trees in three dimensions: Clinical Applications (2005) Keynote speech SPIE 2005; Eckstein MP, Jiang Y (eds) *Image Perception, Observer Performance, and Technology Assessment, Proceedings SPIE 2005 vol 5749.*
- Bullitt E, Lin N, Ewend M, Zeng D, Winer E, Carey L, Smith JK (2006) Tumor Therapeutic Response and Vessel Tortuosity: Preliminary Report in Metastatic Breast Cancer. *MICCAI 2006; LNCS 4191:561-568.*
- Jomier J, Bullitt E, Van Horn M, Pathak C, Aylward S (2006) 3D/2D Model-to-Image Registration Applied to TIPS Surgery. *MICCAI 2006; LNCS 4191:662-669.*
- Kilpatrick M, Bullitt E, Ewend M (2006) Bidimensional Measurements appear Superior to Unidimensional Measurements when Measuring Response of Metastatic Brain Tumors. *Proceedings MICCAI 2006 Workshop "Medical Image Processing: Challenges in Clinical Oncology"* (Veenland J, Niessen W eds) 47-52.
- Davis B, Fletcher PT, Bullitt E, Joshi S: Population shape regression from random design data. *ICCV 2007. Winner of Marr Prize at ICCV.*
- Enquobahrie A, Ibanez L, Bullitt E, Aylward S (2007) Vessel Enhancing Diffusion Filter. *MICCAI Open Science Workshop.*

C. Research Support. List selected ongoing or completed (during the last three years) research projects (federal and non-federal support). Begin with the projects that are most relevant to the research proposed in this application. Briefly indicate the overall goals of the projects and your role (e.g. PI, Co-Investigator, Consultant) in the research project. Do not list award amounts or percent effort in projects.

ACTIVE

R01 EB000219 (Bullitt) 7/1/05-6/30/09
NIH-NIBIB approx \$340,000 yearly direct costs (\$1,373,095 total direct costs)
3D intracerebral vessel location for surgical planning
Role: PI (30% [will be 50% when funds from our no-cost extension of R01 HL69808 are exhausted])

The aims of this proposal are to develop a) automated methods of segmenting tumors, b) new methods of image registration, and c) new methods of assessing tumor malignancy in human brain tumor patients using statistical measures of vessel shape.

R01 CA124608 (Bullitt) 8/1/2007 – 05/31/2011
NIH-NCI approx \$300,000 yearly direct costs
Noninvasive assessment of tumor malignancy
Role: PI (50%)

The purpose of this proposal is to evaluate a new method of assessing tumor malignancy based upon measures of vessel shape using a genetically engineered murine tumor model, and to begin to evaluate the effects of targeted therapy upon tumor vasculature in these genetically engineered mice in whom whole-brain histological information is available.

K12 Mentored Clinical Research Scholars (Orringer) 4/01/03 – 3/31/08
NIH
UNC Mentored Clinical Research Scholar Program
Role: Mentor (0%)

The purpose of this grant is to provide a mentored research program for junior faculty physicians or dentists who are committed to a career in clinical research and to provide lectures to students interested in multidisciplinary research..

Duke SPORE grant (Reardon)
Duke Brain Cancer SPORE Developmental Research Program 1/1/07-12/31/08
Imaging assessment of Bevacizumab-based therapy in GBM \$50,000
Role: Investigator (no salary)

The purpose of this grant is to image the vasculature of glioblastoma patients undergoing treatment with bevacizumab

R01 HL69808 (Bullitt) 4/01/02 – 3/31/07 [currently in no-cost extension]
NIH-HLB approx \$350,000 yearly direct costs
3D Image-Guided Endovascular Surgery
Role: PI (20%)

The purpose of this proposal is to combine state-of-the-art 3D tracking and visualizations with a new method of vascular segmentation and description in order to help guide the endovascular procedure TIPS.

RECENTLY COMPLETED GRANTS

P50CA58185-AV-55P2 (PI Winer; Dana Farber Cancer Institute, UNC PL Lisa Carey) 09/01/04-08/31/05
P30 CA16086-29S1 (Lisa Carey) [these two grants are connected and create a single entity at UNC]
NIH-NCI/AVON Direct costs \$166,851
A phase II trial of GW572016 for brain metastases in patients with HER-2-overexpressing breast cancer
Cancer Center Core Support Grant: Phase II Trial of GW572016 in Breast Cancer CNS Relapse
Role: Investigator (10%)

The purpose of this multi-center proposal is to evaluate the efficacy of a new chemotherapeutic agent in the particular subset of breast cancer patients who overexpress HER-2 and have brain metastases.

R01 EB000219 (Bullitt) 4/1/01-3/31/05
NIH-NIBIB approx \$300,000 yearly direct costs
(originally R01CA67812 NIH-NCI)
3D intracerebral vessel location for surgical planning
Role: PI (40%)

Principal Investigator/Program Director (Last, First, Middle): **Bullitt, Elizabeth**

The aims of this proposal were to develop automated methods of segmenting tumors and the nidii of AVMs from medical image data and to define which vessels pass through the lesion to supply normal brain and which terminate within the lesion for surgical planning purposes. [This grant was competitively renewed 2005-2009; see above]

NLM 99-103/DJH (Aylward) 9/30/99 - 9/29/2002

NLM

Functions, Classes, and Visual Programming for Medical Image Processing

Role: Evaluator (1999-2001)

The aim of this multi-institutional collaborative project was to provide a cross-platform, extensible, and easy-to-use software library and applications as “the” standard segmentation and registration toolkit for medical image processing.