Research Project Title:

Variation and intensity of medical therapy in patients undergoing vascular surgery procedures

Principal Investigator:
Randall R. DeMartino, M.D., M.S.

Co-Investigators:
Philip P. Goodney, MD, MS
Jack L. Cronenwett, MD
Yuanyuan Zhao, MS
Specific Aims:
Peripheral arterial disease (PAD) affects millions worldwide, approaching 20% of those over 70 years of age. Additionally, abdominal aortic aneurysms (AAA) are present in nearly 7% of older men. Both PAD and AAA patients have a high prevalence of concomitant cardiovascular disease and approximately 75% of patients with PAD will ultimately die of cardiovascular causes. Despite the benefits and recommendations for use of antiplatelet, statin, and beta blocker medications for patients with PAD and coronary artery disease (CAD), these patients remains undertreated. Up to half of patients with PAD are not on antiplatelet or statin medication. Given that vascular surgery practice centers around treatment for symptomatic PAD and aneurysmal disease, vascular surgeons are situated to ensure proper medical care is provided to these patients. This proposal will seek to understand the variation of appropriate medical care among patients undergoing vascular procedures, seek to understand the determinants to medical care, and to identify the effect of medication on peri-operative and long term outcomes for patients with PAD and AAA.

Specific Aim 1. To describe of the variation of medication utilization among providers of vascular care
- Using the Vascular Quality Initiative (VQI) dataset, I will analyze the utilization of medications including aspirin, statins and beta blockers among patients undergoing vascular surgical procedures within centers in the VQI. The intensity of vascular care will be measured in two ways. 1) The proportion of patients on aspirin and statins and beta blockers on the procedural level. 2) The proportion of patients in aspirin, statin and beta blocker on the center and regional level.
Hypothesis: There is wide variation within the number of patients on appropriate cardiovascular medications surrounding and following their vascular procedures

Specific Aim 2. To explore the determinates of medication treatment intensity during vascular surgical procedures
- Using the VQI dataset, I will determine the characteristics of patients receiving appropriate medical management. Covariates that will be explored will include age, gender, race, and comorbidities. Additionally, systems-level covariates, including provider, hospital, and region, will be included to understand the influence of system factors on medical treatment.
Hypothesis: In addition to specific patient characteristics, systems-based factors such as provider and center will have an impact on medication utilization

Specific Aim 3. To demonstrate the association of medication utilization and intensity with both short and long term outcomes following vascular surgical procedures.
- Using the VQI dataset with long term follow up data and mortality status from the SSDI, I will demonstrate the association of medication utilization with both post-operative outcomes as well as long term survival.
Hypothesis: Increased systems-based utilization of cardiovascular medications will correlate with improved post-operative outcomes as well as long term survival.
Significance:
Peripheral arterial disease (PAD) includes atherosclerotic occlusive disease of the cerebral, visceral, and lower extremity arterial vascular beds. PAD affects millions worldwide, approaching 20% of those over 70 years of age. In addition, abdominal aortic aneurysms (AAA) remain a prevalent disease present in nearly 7% of older men undergoing population based screening. Both PAD and AAA patients have a high rate of associated cardiovascular disease. In fact, only 8% of patients undergoing major vascular surgical procedures may have normal coronary. This is translated into a high incidence of clinical coronary and cerebrovascular disease burdens among those with PAD and AAA. A recent epidemiological study has also shown that patients with AAA have a two-fold higher risk of heart attack and 1.8-fold higher risk of stroke compared with population based controls. Lastly, cardiovascular comorbidities remain a long term complication, where approximately 75% of those with PAD will ultimately die from cardiovascular causes.

The most commonly recognized medical treatment for patients with PAD and coronary artery disease (CAD) is acetylsalicylic acid (aspirin). Numerous studies have consistently demonstrated the benefit of aspirin in high risk cohorts. In a meta-analysis of 195 randomized studies of antiplatelet therapy versus placebo, there is a 25% reduction in cardiovascular events, including stroke, among those with PAD on aspirin therapy. This has lead multiple organizations to recommend aspirin therapy to patients with symptomatic PAD. In addition, the CAPRIE trial demonstrated that clopidogrel is as effective as aspirin in patients with PAD in reducing cardiovascular events. Due to its effect on patient with cerebrovascular disease, antiplatelet therapy is also recommended for all patients with extracranial cerebrovascular disease. This has lead to a National Quality Forum measure for antiplatelet use surrounding carotid revascularization. Although no specific recommendations for aspirin therapy in patients with AAA exist at present, epidemiologic data demonstrate patients with AAA are at elevated risk for cardiovascular events and carry high rates of cardiac comorbidities. Aspirin is widely accepted as basic medical therapy for those with CAD.

In addition to aspirin therapy, the use of HMG-CoA reductase inhibitors (statins) is standard practice for patients with PAD and those undergoing major vascular surgery. The POISE III trial demonstrated a 9% absolute risk reduction and 55% relative risk reduction in myocardial ischemic events with a similar effect on all cardiovascular death after AAA repair, carotid endarterectomy, and arterial reconstruction for occlusive disease. For this reason, statin usage is recommended for symptomatic PAD patients and those with coronary disease by multiple guidelines. Despite these benefits, some evidence has suggested statin use is associated with insulin resistance and risk of diabetes. However, the benefit of statins on cardiac events far outweighs the risks of diabetes.

Beta-blocker therapy has been shown to be effective in reducing cardiac related morbidity among patient undergoing non-cardiac and vascular surgery. However, this has been meet with conflicting results, making the net benefit of beta-blocker therapy a topic of debate. Despite this, beta-blocker therapy remains a prominent measure of care quality and it is recommended for patients at intermediate to high cardiac risk, or known stress induced ischemia in the peri-operative period. Although work within the Vascular Study Group of New England has shown that overall increases in beta blocker usage did not decrease cardiac morbidity, we have also increased out ability to better risk stratify patients at high cardiac risk. Thus, the opportunity exists to understand and describe the variation in beta blocker usage and its relation to high risk vascular surgery patients and their outcomes.

Many patients with PAD remain undertreated. Of all PAD patients, 40-60% of patients are not on antiplatelet agents and 40-70% are not on statins. This is correlated with increased risk of mortality, even in those with no known associated CAD. This has prompted the Department of Health and Humans Services to initiate the Million Hearts Campaign to promote proper medical management to prevent strokes and death from cardiovascular causes.
Date from the VSGNE has shown similar trends of medication use. We have recently studied the use of antiplatelet medication and statin use among patients undergoing carotid interventions (CAS and CEA), infra and suprainguinal bypass, and aneurysm repair (open and EVAR). Within New England, many patients on not on antiplatelet (AP) and statin medication in the peri-operative period who should be treated (Figure 1, unpublished data). From 2005 to 2012, we have improved the number of patients on both AP and statin medications at pre-op and discharge (54% in 2005 to 67% in 2012, p<0.001). However our overall rate of AP and statin use pre-op and discharge has not improved over the past few years, averaging 65-70% of eligible patients.

Despite this modest improvement, the ability to place patients on AP and statin medications before their operation and at discharge varies significantly by center and by procedure (Figure 2, unpublished data). This demonstrates that there are likely center effects that relate to the ability to ensure that patients are placed on appropriate therapy. This may be due to surgeon preference or processes of care within each center.

Finally, our analysis has shown that optimal AP and statin therapy has a significant effect on per-operative and long-term mortality. Pre-operative AP and statin use was associated with lower 30-day mortality (0.97 vs 1.58%, RR 0.61, p<0.01). This remained significant after adjustment for patient factors (OR 0.66, 95% CI 0.5-0.9, p=0.01). Additionally, optimal medical therapy with AP and statin was also associated with improved 5-year survival, with the effect additive for both AP and statin use (Figure 3, unpublished data). This effect remained significant after adjustment for patient characteristics.
**Innovation:**

As discussed, despite their benefits, many patients remain on suboptimal medical regimens. This results from complex interactions between providers, patients and the systems of care that they interact within. Understanding these dynamic forces can help to improve the quality of care delivered, as well as improve outcomes. In this effort, the Society for Vascular Surgery Patient Safety Organization (SVS-PSO) and the Vascular Quality Initiative (VQI) were established. Based on regional quality efforts in New England, the VQI has established itself as a national, multi-institutional collaborative to improve the care of patients with vascular disease.

The VQI is uniquely detailed to study the association of medical management surrounding vascular operations in ways not possible by other means. First, the VQI records aspirin use. Apart from chart review, tracking aspirin use is difficult, given its over-the-counter availability. Administrative databases, Medicare Part D, or other databases are unable to correctly track its use. This makes the VQI valuable to understanding its use surrounding vascular surgical procedures across centers. Second, the VQI tracks the use of aspirin, statin, and beta-blocker usage pre-operatively, at discharge, and at one year follow up. This permits the ability to study how effective medications are utilized during the peri-operative period and if they are maintained long term. Finally, by linking with the Social Security Death Index (SSDI), we can establish vital status of post-operative patients. Since the vast majority of PAD patients will die of cardiovascular causes, this is an ideal outcome for assessment since these medications are known to prevent cardiovascular events.

This analysis establishes a novel approach to analyzing medication utilization. While our group has confirmed that many patients remain undertreated, understanding the overall effect on suboptimal medical care following vascular operations remains unknown. In addition, little is know about the contributing factors, such as regional variation and other determinants of optimal medical care. Once the drivers for suboptimal care are identified, quality improvement initiatives can be focused to improve these measures and improve the medical care provided. Work within the Vascular Study Group of New England has shown that use of these data can be used to augment physician practice for process improvement, making this analysis a step towards providing better medical care.

**Research Strategy**

**Methods**

*Overall approach:* To conduct our analysis, we will utilize the Vascular Quality Initiative (VQI) national dataset from inception to present. We will analyze all elective procedures, including patients undergoing carotid endarterectomy, carotid artery stenting, infrainguinal bypass, suprainguinal bypass, peripheral vascular interventions, and open and endovascular aneurysm repair (infrarenal and thoracic). Only patients with CAD or PAD history who underwent aneurysm repair will be included, as aortic aneurysmal disease alone carries no endorsed medication recommendations. Patients will be censored after their first operation in the VQI dataset. Thus, patients cannot be analyzed twice if they undergo a second operation in the dataset. This will help understand the processes of care present within each center and region for all patients at their initial presentation. Patients undergoing multiple procedures may have medication changes not reflective of the standard practice, potentially due to complications or procedural failures. This may bias the findings in ways not easily accounted for within the dataset. Fortunately, our group has extensive experience with the VQI dataset from the Vascular Study Group of New England.

**Aim 1. To describe the variation of medication utilization among providers of vascular care.**

First, to understand the variation present in medication utilization, I will characterize the centers present within the VQI. As noted above, I will create my study population, a cohort based on patients undergoing their first procedure within the VQI. The unit of analysis will be the patient, aggregated at the center and regional level. The main outcome measure will be the intensity of medical treatment surrounding the patient’s procedure. Intensity will be characterized in three ways. 1) The number of patients on antiplatelet medications (defined as
aspirin or clopidogrel), statin, or beta blockers before their surgery, at discharge, and at the most recent long
term follow up. 2) Higher intensity care will be defined as at least antiplatelet and statin usage at pre-operatively
and discharge for those undergoing operations for PAD, carotid revascularization or aneurysm repair with
cardiovascular risk factors (defined as those with any coronary disease, prior coronary revascularization, prior
bypass or stenting or prior carotid endarterectomy). 3) Beta blocker usage will be assessed as proportion of high
heart risk patients on chronic or pre-operative beta-blocker therapy undergoing major vascular surgery
procedures (open AAA, lower extremity bypass). Data will be aggregated at the center level into tertiles on
intensity of care. This will be utilized for further analysis on outcomes to ensure the anonymity of any one
center.

Potential Problems with Aim 1: One potential problem will be centers with low case volumes. Centers with only
a few cases will increase the potential for measurement error in understanding their practice patterns for medical
management. I will limit my center analyses to only those centers with >100 cases to limit this problem.
Another potential problem will involve medication intolerance. In my analysis, I will exclude patients that are
intolerant of both medications. For composite endpoints (such as being on AP and statin), patients will be
credited for optimal therapy if they are one medication, but intolerant of the other medication. This will ensure
centers and providers are credited for proper “intention to treat” with respect to optimal medical management. I
will also run my analysis with all patients who have medication intolerance removed to see how this affects our
findings.

Aim 2. To explore the determinates of medication treatment intensity during vascular surgical
procedures
To understand the determinates in the intensity medical management surrounding vascular surgical procedures,
I will use available data within the VQI dataset to associate specific variables with medical treatment. For this,
the unit of analysis will be the patient and the outcome of interest (dependent variable) will be pre-operative and
discharge antiplatelet and statin medication usage following carotid interventions, procedures for PAD and
aneurysm repair. Beta blocker usage will be assessed on pre-operative and discharge for high risk procedures as
noted above. The exposure (independent variables) will include medical co-morbidities, race, gender, age,
surgeon, center and region. The later two will remain anonymous. I will look to understand and identify
potential interactions among surgeon and center, as these may be related by system factors. I will use
multivariable logistic regression analyses to explore the relationships between my exposures and the intensity of
medical treatment.

Potential Problems with Aim 2: There may be missing data for patients within the VQI. Since at this time, we
do not understand if these data are missing at random, all logistical analyses will be based on patients with no
missing data for significant variables. Additionally, to ensure that medication use is recorded correctly, we will
perform site specific random audits to verify the VQI medication data.

Aim 3. To demonstrate the association of medication utilization and intensity with both short and long
term outcomes following vascular surgical procedures.
Once terciles of medication intensity are created, they can then be applied to understand what effect both
center level contextual variables and patient level medication use have on outcomes. Three outcomes will be
identified. 1) First, strata of medication intensity use will be evaluated on thirty-day mortality following each
operation. Thirty day or in hospital death will be defined as a combination of a discharge status of death within
the VQI and by death <30 days following a patient’s operation by SSDI (the outcome). I will explore patient
demographics, center, and medication use (exposures) on 30-day mortality while adjustments are done for
patient covariates using logistic regression techniques. This will include hierarchical modeling techniques
(center level terciles medication intensity) to understand what effect center intensity of care has on outcomes. 2)
Similar techniques will be employed to understand the effect of optimal medication usage on cardiovascular
morbidity, defined as post-operative death, myocardial infarction, dysrhythmia, or congestive heart failure. 3)
Finally, the effect of medication utilization on long term mortality (outcome) will be analyzed. Using life table
methods with Cox proportional hazards techniques, the association of patient demographics, optimal medication utilization, and center intensity of care (exposures) will be described.

Potential Problems with Aim 3: As in Aim 2, there may be missing data for patients within the VQI. For logistic and survival analyses, I will limit the multivariate models to patients without missing data on significant variables.

Timeline:

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<th>1-3 months</th>
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Budget:
Analyst Support: $2,000
Presentation and Dissemination of findings at Regional/National Academic Vascular Meeting: $1,000

Funds for the above budget will be provided by grant support for Philip Goodney, MD, via support from exiting grant funding mechanisms.
References:
BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2. Follow this format for each person. DO NOT EXCEED FOUR PAGES.

<table>
<thead>
<tr>
<th>NAME</th>
<th>POSITION TITLE</th>
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<tbody>
<tr>
<td>Randall De Martino</td>
<td>Chief Resident</td>
</tr>
<tr>
<td>eRA COMMONS USER NAME (credential, e.g., agency login)</td>
<td>Section of Vascular Surgery Dartmouth-Hitchcock Medical Center</td>
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EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

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<td>University of Richmond</td>
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<td>Virginia Commonwealth Univ. School of Med.</td>
<td>MD</td>
<td>2007</td>
<td>Medicine</td>
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<tr>
<td>Dartmouth College</td>
<td>MS</td>
<td>2011</td>
<td>Clinical &amp; Health Services Research</td>
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<td>-</td>
<td>2007-P</td>
<td>Vascular Surgery</td>
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A: Personal Statement

I am a vascular surgery resident at Dartmouth-Hitchcock Medical Center. I am also a health services researcher interested in comparative effectiveness and quality of care. In addition to my surgical training, I completed a Master’s degree in Clinical and Health Services Research at The Dartmouth Institute. My prior work with the Vascular Study Group of New England has focused on improving patient selection and has enabled me to become facile with the Vascular Quality Initiative dataset. The aim of this proposal is to understand the variation and effect of medication utilization across centers within the Vascular Quality Initiative. In addition, this proposal is well aligned with my long-term research goal, which is to better characterize the effect of quality vascular care and understand the barriers to providing such care in an effort to improve outcomes.

B. Positions

Vascular Surgery Resident
Dartmouth-Hitchcock Medical Center
(Mark F. Fillinger, M.D.)

Masters Degree Clinical and Health Services Research
The Dartmouth Institute, Dartmouth College
(Philip P Goodney, MD, MS)

Honors:

Joint Surgical Advocacy Conference Scholarship, Society for Vascular Surgery 2011
Chairman’s Scholarship, Dartmouth-Hitchcock Medical Center 2010
Gold Foundation Humanism and Excellence in Teaching Award 2010
Dean’s Merit Scholarship Award, VCU School of Medicine 2003-2007
Willie M. Reams Award in Biology, University of Richmond 2003
University of Richmond Summer Research Fellowship, University of Richmond 2001-2003
Merck/AAAS Fellowship for Biochemical Research, University of Richmond 2001-2002

B: Peer-Reviewed Publications


BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2. Follow this format for each person. DO NOT EXCEED FOUR PAGES.

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<th>FIELD OF STUDY</th>
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<tr>
<td>Philip Goodney</td>
<td>Assistant Professor</td>
<td>University of Connecticut</td>
<td>BS</td>
<td>1995</td>
<td>Chemistry</td>
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<td></td>
<td>University of Connecticut School of Medicine</td>
<td>MD</td>
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<td></td>
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<td>MS</td>
<td>2003</td>
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<td>Dartmouth-Hitchcock Medical Center</td>
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<td></td>
<td>2008</td>
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A: Personal Statement

I am a vascular surgeon and health services researcher at Dartmouth. During surgical training, I completed a Master's degree in Evaluative Clinical Sciences during a two-year research fellowship at The Dartmouth Institute. After joining the faculty at Dartmouth in 2008, I received a Career Development Award from the NHLBI in 2010, as well as the Lifeline Research Award from the Society for Vascular Surgery in 2011. In my research, I've enjoyed studying ways to determine which patients are most likely to benefit from surgical treatments (References 3, 4, 5-8, and 14), and examining variation in the use and effectiveness of revascularization for peripheral arterial disease (PAD) (References 1, 2, 6, and 13). The aim of this proposal is to understand variation and effectiveness of medication utilization within the Vascular Quality Initiative. My innovative research approaches have combined administrative claims with granular detail about patients, procedures, and prevention, and advanced analytic tools such as hierarchical and econometric models. We will utilize some of these methods for this proposal. Our results will impact the quality of care for patients undergoing vascular surgery, by informing patients and physicians of the relative importance of medical management. This proposal is well aligned with my long-term research goal, which is to better inform, patients, physicians, and policymakers about quality of care in vascular surgery.

B. Positions

General Surgery Residency 1999 - 2001
Dartmouth-Hitchcock Medical Center (Richard W. Dow, M.D.) 2003 - 2006

VA Special Fellowship in Outcomes Research 2001 - 2003
VA Outcomes Group, White River Junction, Vermont (John D. Birkmeyer, M.D.)

Masters Degree in Evaluative Clinical Sciences 2001 - 2003
Center for Evaluative Clinical Sciences, Dartmouth (Elliott S. Fisher, MD, MPH)

Vascular Surgery Fellowship 2006 - 2008
Dartmouth-Hitchcock Medical Center (Jack L. Cronenwett, M.D.)

Assistant Professor, Section of Vascular Surgery 2008-current
Dartmouth-Hitchcock Medical Center
Lebanon, NH

Assistant Professor 2008-current
The Dartmouth Institute for Health Policy and Clinical Practice

Director (Interim), Surgical Outcomes Research 2012-current
The Department of Surgery
Dartmouth Hitchcock Medical Center

Honors:

Distinguished Fellow, Society for Vascular Surgery 2012
NIH Loan Repayment Program 2010
Faculty Loan Repayment Award, DHHS 2009
Harmes Research Award, Department of Surgery, DHMC 2009
Darling Award, New England Society for Vascular Surgery 2008
Thomas P. Almy Housestaff Teaching Award 2006
Jobst Award, Frederick A. Coller Surgical Society 2007
Peripheral Vascular Surgery Society Academic Award 2007
Dartmouth Medical School Class of 2007 Teaching Award 2007

B: Selected Peer-Reviewed Publications (of a total of 80)

Most Relevant to Current Proposal


Additional Publications of Importance


C: Research Support

Current:

Dartmouth SYNERGY Award: Toward Understanding the Cost and Cost-Effectiveness of Carotid Stenting and Endarterectomy. Principal Investigator $50,000

NHLBI K08 Career Development Award (1K08HL05676-01) Understanding Regional Variation in Treatment Intensity with PAD Principal Investigator (Mentor = Elliott S. Fisher, MD, MPH) $699,570

American Vascular Association / American College of Surgeons Lifeline Award Supplemental Funding Award. Understanding Regional Variation in Treatment Intensity with PAD. $250,000

Department of Health and Human Services Faculty Loan Repayment Award Regional Variation in Treatment Intensity with Lower Extremity PAD Principal Investigator $35,451

National Institutes of Health Loan Repayment Award Understanding Regional Variation in Treatment Intensity with PAD $34,576

Peripheral Vascular Surgery Society Academic Award Development of a disease-specific quality of life measure for patients 2011-2012
with critical limb ischemia  (Co-Investigator with Bjoern Suckow, MD)
$14,500

Hitchcock Foundation Seed Grant
Development of a Glucose Management Service for Vascular Surgery Patients  Co-Investigator with Jessica Wallaert, MD
$10,500

Completed

Peripheral Vascular Surgery Society Academic Award (Goodney, PI)
Peripheral Vascular Surgery Society  Risk Prediction Model for Complications Following Lower Extremity Revascularization
Using data from the Vascular Study Group of Northern New England, this project entails constructing a risk prediction model to allow surgeons to select optimal candidates for lower extremity revascularization.  
$14,500

Society for Vascular Surgery Clinical Seed Grant (Goodney, PI)
Society for Vascular Surgery  Development of a Risk Prediction Model for Complications and Functional Outcomes Following Lower Extremity Revascularization Using a Prospective Regional Database
Using data from the Vascular Study Group of Northern New England, this project entails constructing a risk prediction model to identify and examine the incidence of functional outcomes after lower extremity revascularization.  
$15,000

Hitchcock Foundation Grant  (Goodney, PI)
Hitchcock Foundation, Dartmouth-Hitchcock Medical Center
Has Carotid Stenting Affected the Incidence of Carotid Endarterectomy?
This project examined the utilization of carotid revascularization in Medicare patients, and examines regional variation in this procedure as well as its effect on outcomes.  
$10,000

Quality Research Grant Program (Chang, Goodney, PIs)
Hitchcock Foundation, Dartmouth-Hitchcock Medical Center
Percutaneous arterial closure – Can we decrease morbidity?
In this quality improvement project we designed, implemented, and measured the effects of a clinical pathway used to obtain hemostasis after percutaneous endovascular procedures.  
$8,000

Abbott Vascular, Inc. (Cronenwett, Goodney, PIs)
Standardizing Arterial Closure Technique following Percutaneous Arterial Intervention: A Feasibility Study
This project was an industry-sponsored study examining the indications, use and results of different methods of obtaining arterial closure following endovascular procedures.  
$6,000
A. Personal Statement.

I strongly support Dr. De Martino's application to understand variation and the effectiveness of medical management surrounding vascular surgery. This has high probability of improving care as well as reducing variation and cardiovascular complications following vascular surgical operations. I am in a unique position to support this activity as a co-investigator. During the past 10 years, I founded and serve as Medical Director of the Vascular Study Group of New England (VSGNE). This effort has demonstrated improvement in processes and outcomes associated with vascular procedures, and has directly led to the current national Vascular Quality Initiative (VQI) of the Society for Vascular Surgery (SVS). I led the development of the SVS Patient Safety Organization (SVS PSO), and now serve as the Medical Director of this effort, which began this year, and already involves > 100 hospitals in 30 states. I am appropriately positioned to work with Dr. De Martino in understanding variation in medical management. This project is in alignment with efforts by the Vascular Quality Initiative to reduce variation and improve the quality of care provided to improve outcomes.

B. Positions and Honors.

Academic Appointments:
1980 - 1983 Research Associate, Veterans Administration, Medical Center, Ann Arbor, Michigan
1980 - 1984 Assistant Professor, Department of Surgery, University of Michigan, Ann Arbor, Michigan
1984 - 1989 Associate Professor, Department of Surgery, Dartmouth Medical School, Hanover, NH
1989 - Professor, Department of Surgery, Dartmouth Medical School, Hanover, NH
2002 - Professor, Department of Community and Family Medicine, Dartmouth Medical School, Hanover, NH
2009 - Professor, The Dartmouth Institute for Health Policy and Clinical Practice, Hanover, NH

Professional Positions:
1980 - 1984 Director, Vascular Diagnostic Unit, Veterans Administration, Medical Center, Ann Arbor, Michigan
1980 - 1984 Attending Surgeon, University of Michigan Hospitals
1980 - 1984 Staff Surgeon, Veterans Administration, Medical Center, Ann Arbor, Michigan
1984 - 1987 Director, Vascular Laboratory, Dartmouth-Hitchcock Medical Center
1984 - 2007 Chair, Section of Vascular Surgery, Dartmouth-Hitchcock Medical Center
1988 - 2007  Program Director, Vascular Surgery Residency, Dartmouth-Hitchcock Medical Center
1996 - 2002  Residency Review Committee for Surgery, Member
2000 - 2002  President, Association of Program Directors in Vascular Surgery
2002 - 2003  President, Society for Vascular Surgery
2003 - 2011  Senior Examiner, Vascular Surgery, American Board of Surgery
2002 - 2011  Medical Director, Vascular Study Group of New England
2011 - 2011  Medical Director, Society for Vascular Surgery Patient Safety Organization

Honors:
1973  Senior Surgical Award, Stanford Medical School
1977  Frederick A. Coller Award for Research by Surgical Residents
1977  Conrad Jobst Award for outstanding contributions in vascular research
1977  Resident Research Award, Association for Academic Surgery
1987 - 2011  48 Visiting professorships
1991  Traveling Fellow, Australia and New Zealand Chapter of the ACS
1994 - 2011  27 Honorary lectures
1994 - 2011  Listed in “The Best Doctors in America”
1998  The Chairman's Award, Department of Surgery, Dartmouth Medical School
2001 - 2011  Listed in Castle Connolly "America’s Top Doctors”
2002  Honorary Member, Canadian Society for Vascular Surgery
2003  Honorary Member, Southern Association for Vascular Surgery
2010  Julius H. Jacobson Physician Excellence Award, Vascular Disease Foundation

C. Selected peer-reviewed publications (from a total of 180):
Most Relevant to Current Proposal

Additional Publications of Importance (in chronological order)

D. Research Support:

Ongoing Research Support:

Vascular Study Group of New England Cronenwett (PI) 2009 - This is an ongoing quality improvement project funded by a consortium of 28 hospitals in New England to generate benchmarked, risk-adjusted outcomes reports, with derivative quality research designed to improve clinical care.

Completed Research Support

Centers for Medicare and Medicaid Cronenwett (PI) 2001 - 2009
"Northern New England Vascular Surgery Quality Improvement Initiative"
This is a regional quality improvement initiative comprised of 13 hospitals in 3 states collecting data about vascular surgery procedures in order to identify process induced variation and improve outcomes. I am the PI of this project.

Centers for Medicare and Medicaid Cronenwett (PI) 2001- 2003
"Aortic Aneurysm Screening in Medicare Beneficiaries"
This was a study to determine the prevalence of AAAs in Medicare patients in 3 sites to calculate the cost-effectiveness of screening in the general population. I was the PI in this multicenter study.

"Dartmouth Atlas of Vascular Healthcare"
This was a study of all vascular surgical procedures performed in the US based on small area analysis to identify variation in provider type, rates of intervention, and variation in outcome by hospital referral region. I was the PI.

National Institutes of Health, NHLBI (R01-HL35102) Cronenwett (PI) 1985 - 1988
"Pharmacologic modification of vascular graft patency."
This was one of multiple basic research studies performed in my early career.
**A. Personal Statement**

I am a Statistical Research Analyst at Section of Vascular Surgery, DHMC. I have a strong background in statistical theory and excellent experiences in medical data analysis. As a Statistical Research Analyst at Section of Vascular Surgery, I conduct statistical analysis in clinical research in Section of Vascular Surgery and Vascular Study Group of New England (VSGNE); assist data cleaning and management; coauthor research paper published and abstracts presented in academic conferences; review manuscript and abstracts before submission. I have rich experiences in multivariate linear regression analysis, categorical data analysis, survival analysis and longitudinal data analysis in medical and health science and programming in SAS 9.2. In the past I have demonstrated the ability to collaborate with colleagues in all kinds of projects. My expertise and experience have prepared me to participating in this proposed project.

**B. Positions and Honors**

**Positions and Employment**

<table>
<thead>
<tr>
<th>Date</th>
<th>Position</th>
<th>Institution and Location</th>
</tr>
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<tbody>
<tr>
<td>01/2009-present</td>
<td>Statistical Research Analyst</td>
<td>Section of Vascular Surgery, Dartmouth- Hitchcock Medical Center, NH</td>
</tr>
<tr>
<td>07/2006-08/2006</td>
<td>Statistical Data Analyst</td>
<td>Tobacco Research Center, University of Minnesota, Minneapolis, MN</td>
</tr>
<tr>
<td>01/2005-12/2006</td>
<td>Computing Consultant and Graduate Assistant</td>
<td>Eastern Michigan University, Ypsilanti, MI</td>
</tr>
<tr>
<td>04/1998-07/2001</td>
<td>Senior Electrical Engineer</td>
<td>Personal Communication Sector (PCS), Motorola (China) Electronics Ltd., Tianjin, China</td>
</tr>
<tr>
<td>07/1997-04/1998</td>
<td>Electrical Engineer</td>
<td>Samsung Optical Electronics Ltd., Tianjin, China</td>
</tr>
</tbody>
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**Honors**
C. Selected Peer-reviewed Publications

