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Long-Term Effects of Carotid Screening on Patient Outcomes and Behaviors

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Keywords

Atherosclerosis; Carotid arteries; Risk factors; Ultrasound

There have been conflicting reports regarding the effects of carotid ultrasound screening (CUS) on health-related behaviors (HRBs),^{1–3} however long-term studies have not evaluated the effects of CUS on clinical outcomes.⁴ This study's objectives were to determine if patients with advanced subclinical atherosclerosis (AdvAthero) on CUS are more likely to achieve guideline-based risk factor goals and improve their long-term cardiovascular disease (CVD) HRBs.

Methods

This study was approved by our institutional review board. Potential subjects were 40–70 year old patients with ≥ 1 risk factor and no history of CVD, who were referred by their physician to the University of Wisconsin (UW) Vascular Health Screening Program for CUS from January, 2002 through December, 2006. CUS imaging was performed using the carotid intima-media thickness (CMT) protocol from the Atherosclerosis Risk in Communities study.⁵ AdvAthero was defined as the presence of CMT $> 75^{\text{th}}$ percentile for age, sex, and race or carotid plaque presence.^{4,5} All subjects had a primary care provider in the UW Health medical practice and insurance coverage for CUS. Qualifying patients were invited to participate by mail. To reduce selection bias, a waiver of consent for electronic medical record (EMR) review was obtained for subjects who could not be contacted.

A patient questionnaire evaluated HRBs and adherence to lifestyle and pharmacotherapy recommendations. The EMR was reviewed for achievement of low-density lipoprotein cholesterol (LDL-C)⁶ and systolic blood pressure (SBP)⁷ goals. Multivariable logistic regression models evaluated predictors of correct recall of CUS results and recommendations, and achievement of LDL-C and SBP goals. For each outcome, a multivariable model was created that included age, sex, and presence of AdvAthero. Baseline variables were added to each model, including: LDL-C, high-density lipoprotein

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Conflict of Interest Disclosures

James H. Stein has served as a Principal Investigator on Research Grants to University of Wisconsin (Astra-Zeneca, PreMD, Sanofi-Aventis, Siemens Medical Solutions, Sonosite), a Consultant to PreMD, a Member of Data Monitoring Committees (Abbott, Lilly, Takeda), and is an Inventor of patent #US 6,730,0235 "Ultrasonic Apparatus and Method for Providing Quantitative Indication of Risk of Coronary Heart Disease." This patent has been assigned to the Wisconsin Alumni Research Foundation, from whom Dr. Stein receives royalties. Claudia E. Korcarz previously served as a Consultant to Siemens Medical Solutions.

The other authors have nothing to disclose.

cholesterol, SBP, Framingham Risk Score, family history of premature CVD, body-mass index, hypertension history, dyslipidemia history, educational level, and length of follow-up.

Results

Of 1,165 patients that had CUS examinations, 602 met inclusion criteria and were invited to participate; only 73 declined. Of the 529 subjects (Table 1), 100% underwent EMR abstraction; 59.6% returned questionnaires. AdvAthero was identified in 58.6%.

One year after CUS, LDL-C goal achievement increased from 62.1% to 84.1%, ($p<0.001$), in all subjects. Among subjects with AdvAthero, only 61.2% were at LDL-C goal at baseline, but 86.7% were at goal one year after CUS ($p<0.001$). Similarly, among subjects without AdvAthero, 63.2% were at LDL-C goal at baseline, whereas 80.2% were at goal after CUS ($p<0.001$). The presence (odds ratio [95% confidence interval]) of AdvAthero (OR 2.15 [1.38–3.34], $p<0.001$), but not baseline LDL-C ($p=0.990$), independently predicted prescription of lipid-lowering medication after CUS, but the interaction between prescription of lipid-lowering therapy and presence of AdvAthero on achieving LDL-C goal was not significant ($p_{int}=0.103$). Thus, having AdvAthero on CUS did not influence the use of lipid-lowering therapy to achieve LDL-C goals.

One year after CUS, subjects with AdvAthero had lower LDL-C ($\Delta=12$ mg/dL, $p<0.001$) compared to subjects with normal scans; however, 32.7% of subjects that started lipid-lowering medication after CUS did not have AdvAthero. There was no significant change in SBP. AdvAthero ($p=0.809$) did not predict SBP goal achievement or prescription of antihypertensives ($p=0.198$). AdvAthero predicted prescription of aspirin (OR 2.25 [1.43–3.54], $p<0.001$).

Survey follow-up was mean (standard deviation) 55.6 (19.1) months after CUS. AdvAthero presence did not increase subjects' perceived risk of current ($p=0.151$) or future ($p=0.213$) CVD. Subjects accurately recalled 83.0% of prevention recommendations; however, the AdvAthero presence only modestly predicted correct recall of CUS results (OR 3.20 [0.01–2.31], $p=0.047$). With longer follow-up after CUS, subjects were less likely to remember their results ($p=0.011$), or post-CUS dietary ($p=0.005$) and exercise ($p=0.008$) recommendations. AdvAthero did not predict changes in diet, exercise frequency, or long-term HRBs.

Comment

This is the first study to evaluate long-term clinical outcomes after patients undergo CUS for measurement of CIMT and carotid plaque detection. Major limitations include retrospective EMR abstraction, use of questionnaires that relied on recall and self-report, and referral bias. However, all subjects were part of an academic health network and had medical insurance coverage that paid for the test. AdvAthero did *not* predict LDL-C goal achievement. Nearly one-third of subjects prescribed lipid-lowering therapy after CUS did *not* have AdvAthero. This suggests that achievement of LDL-C goals after CUS was not primarily due to abnormal screening results. It may be that doctors who ordered the test were predisposed to prescribe lipid medication, regardless of the results, and LDL-C improvements were from the screening and management process, not the results. Over time, CVD risk perception among those with AdvAthero decreased. Despite intensive counseling about their CUS results and recommendations, our subjects had inappropriate risk perception, decay in recall over time, and poor adoption of lifestyle changes. These observations support the importance of recurring CVD risk education and counseling, and emphasize the lack of

long-term effectiveness of one-time interventions, even if they are as powerful as arterial imaging.⁸

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Table 1

Baseline Subject Characteristics (N = 529)

	Mean	Standard Deviation	Range
Age, years	53.7	6.81	33–73
Female, %	43.3	-	-
Framingham risk score, %/10 years	5.5	4.78	1–25
History of hypertension, %	37.4	-	-
On antihypertensive medication, %	35.3	-	-
Systolic blood pressure (mmHg)	124.0	15.2	80–177
Diastolic blood pressure (mmHg)	75.0	9.02	56–108
History of dyslipidemia, %	52.2	-	-
On lipid-lowering medication, %	42.0	-	-
Total cholesterol (mg/dL)	201.6	42.98	101–392
Triglycerides (mg/dL)	133.9	187.3	21–2761
High-density lipoprotein cholesterol (mg/dL)	56.3	16.69	23–115
Low-density lipoprotein cholesterol (mg/dL)	119.9	34.9	41–223
History of diabetes mellitus, %	5.5	-	-
On aspirin therapy, %	25.3	-	-
Cigarette use in the past year, %	7.6	-	-
Family history of premature CVD, %	51.8	-	-
Body-mass index (kg/m ²)	27.6	5.41	17–52
Screening referral source, %	100.0		
Internal medicine or family practice	95.8		
General cardiology	4.2		
Composite common carotid artery CIMT (mm)	0.784	0.184	0.420–1.688
Carotid intima-media thickness >75 th percentile, %	58.4	-	-
Carotid plaque present, %	43.7	-	-
Presence of advanced atherosclerosis, %	58.6	-	-
Carotid plaque and increased CIMT, %	21.4		