Cardiovascular disease is a major health problem throughout the world and a growing health problem in developing nations. Since 1919, it has been the leading cause of death in the United States, claiming a life every 33 seconds. The magnitude of prevalence of, and mortality statistics associated with cardiovascular disease mandate that healthcare systems focus on strategies to prevent risks. Risk status is defined by the absence (primary prevention) or presence (secondary prevention) of atherosclerotic disease. Primary prevention offers the greatest opportunity for reducing the prevalence of disease by addressing risk factors in individuals with no current evidence of cardiovascular disease. Secondary prevention measures are strategies for patients with an established diagnosis of cardiovascular disease and are designed to retard or prevent recurrent coronary events and cardiac death. The intensity of treatment strategy is based on risk status and includes pharmacological therapy and lifestyle modifications (ie, smoking cessation, diet, exercise).

Review of the Literature
High-Risk Populations
Progression of atherosclerosis is a significant healthcare problem as the population with cardiovascular disease has continued to increase. More than 61 million people live with the diagnosis, according to current estimates. Complete recovery from atherosclerosis is unlikely, and as the leading cause of premature permanent disability in the United States workforce, it places a great burden on the healthcare system and economy, with estimates of annual cost as high as $300 billion.

Various organizations have identified the problems related to the prevalence of cardiovascular disease and the need for secondary prevention. The Second Joint Task Force of European and Other Societies in Coronary Prevention strongly stated that prevention priorities must be directed at patients with established cardiovascular or other atherosclerotic disease. In their consensus statement on secondary prevention that was also endorsed by the American College of Cardiology, the American Heart Association (AHA) supports the merits of aggressive risk-reduction therapies for patients with atherosclerotic cardiovascular disease.

Although many organ systems are affected by atherosclerosis, the clinical signs and symptoms are most commonly related to cardiac, neurological, or peripheral vascular events manifested as myocardial infarction, stroke, or claudication. Cardiovascular interventions are not a cure, but rather a treatment to enhance and restore blood flow. According to the AHA 2003 update, the number of cardiovascular operations and procedures performed increased 397% between 1979 and
2000. Although many patients think that they are “fixed” after their procedure, restenosis rates can be as high as 40% within 6 months. Thus, the need for aggressive strategies to reduce risks is apparent.

The Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III or ATP III) published in 2001 asserted that noncoronary forms of atherosclerotic disease (peripheral arterial disease, abdominal aortic aneurysm, and symptomatic carotid artery disease) place patients at a risk equal to that of patients with coronary disease. Therefore, both populations need major aggressive management to reduce risks.

In addition to the noncoronary form of cardiovascular disease, the association between diabetes mellitus (type 1 and type 2) and the development of cardiovascular disease has been well documented and supported by ATP III. The report concluded that patients with diabetes mellitus are at risk for cardiovascular events because their risk for myocardial infarction and coronary death is greater than the risk of patients without diabetes. In addition, their prognosis for long-term survival after myocardial infarction is worse than that of patients without diabetes.

Secondary Prevention

Secondary risk reduction strategies for atherosclerotic disease encompass 2 essential aims: pharmacological therapy and behavior modification. Implementation of pharmacological standards of practice established by the ATP III has resulted in significant reductions in the clinical end points of death, myocardial infarction, and stroke. Therapies include administration of antiplatelet agents, angiotensin-converting enzyme (ACE) inhibitors or angiotensin II receptor blockers (ARBs), β-blockers, and lipid-lowering agents. In addition, monitoring of patients’ lipid profiles and aggressive management of diabetes contribute to positive outcomes.

Favorable behavior modifications include changes in diet, stress reduction, weight management, and smoking cessation. Smoking cessation may be the single, controllable, most effective means of reducing mortality in high-risk populations. The adverse effects of smoking (toxic effects on endothelium and vasoconstriction) have been reported. One year of smoking cessation results in a reduction by half or more of the excess risk associated with current smoking. Many years of abstinence are required before a smoker’s risk is reduced to that of a nonsmoker. The achievement of ideal body weight through diet modification and exercise is a goal for patients with abnormal lipid profiles. These lifestyle changes will also favorably affect other risk factors such as hypertension and diabetes.

Programs to reduce cardiovascular risks that focus on the initiation of secondary prevention measures before hospital discharge are highly effective. Aggressive management of risk factors clearly improves patients’ survival, reduces recurrent events and the need for intervention, procedures, and improves the quality of life for these patients. The extent to which interventions to reduce risks is effective may depend on adherence to the treatment plan.

Discussion of secondary prevention therapies while still in the hospital uses the “teachable moment” and will improve clinical outcomes. (Patients are a captive audience and may be more receptive to education.)

Background

In response to the ATP II guidelines published in 1993, Advocate Lutheran General Hospital (a 500-bed teaching facility that provides a broad range of cardiovascular services) participated in a quality assurance study conducted by a major pharmaceutical company. The purpose of this national study, established and funded by Merck & Co, Inc, was to identify and compare practice patterns for management of cardiovascular disease. More than 58,000 patients with known cardiovascular disease were included in the study. Patients were included if any of the following were documented in their charts: myocardial infarction, coronary artery bypass grafting, coronary intervention (stenting, angioplasty), atherosclerotic heart disease, or congestive heart failure. At our institution, staff pharmacists used the same criteria to audit the inpatient records. Specific outcome measurements included whether ACE inhibitors or ARBs and lipid-lowering agents were prescribed at the time of discharge. Documentation of patients’ lipid profiles was also audited.

The results of the audit were disconcerting. Previous studies had indicated a low compliance in lipid profile measurements and lipid-lowering therapy. Overall, only 39% of patients in this study had either as part of their plan. Data related to use of ACE inhibitors were also suboptimal; only 50% of patients were
receiving such therapy. The study results indicated that current practice patterns in the management of these patients seemed inadequate and merited further investigation.

**Risk Evaluation in Action for Cardiovascular Health Development of the Program**

Through the efforts of a multidisciplinary hospital team (physicians, nurses, pharmacists, and information systems personnel), a program was developed to improve the management of inpatients most likely to benefit from therapies to reduce secondary risks. The challenge was to use multiple, disparate patient information systems to identify high-risk patients, assess risk factors, initiate appropriate interventions, and communicate this assessment to healthcare providers.

The focus of the Risk Evaluation in Action for Cardiovascular Health (REACH®) program is reduction of secondary risks in the following high-risk populations: (1) patients who have acute cardiovascular disease with or without intervention (ie, cardiac surgery, cardiac stenting); (2) patients with a history of cardiac, cerebrovascular, or peripheral vascular disease; and (3) patients with diabetes. Patient information databases that already exist in the hospital are used in the program, allowing prospective identification of high-risk patients upon admission and assessment of risk factors and treatment strategies upon discharge.

CareNet is a home-grown intranet-based clinical data repository available to physicians affiliated with the Advocate Health Care System. Through census screens, information on patients (results of laboratory tests, radiology results, etc) is continuously available to healthcare professionals. Physicians can access the system from either within or outside the hospital. For this program, the system was enhanced to enable physicians to prospectively identify high-risk patients. On the basis of an established set of parameters defined by the team, a “heart icon” alert appears next to each qualifying patient’s name (Figure 1). The AHA ATP III guidelines were used as a resource for selecting laboratory...
parameters that indicate high-risk patients. These included abnormalities in lipid profiles, fasting and non-fasting glucose levels, and troponin levels. Admitting diagnoses were also used to identify high-risk patients. An established “picklist” used by the Patient Admission Department was reviewed. Diagnoses associated with high-risk patients (ie, transient ischemic attack, chest pain) were added to the parameters as heart icon alerts (Table 1).

By clicking on the heart icon, a link is made to the REACH page (Figure 2). This page explains the program and describes the risk factors for that particular patient. For example, the abnormal laboratory value of low-density lipoprotein greater than 2.59 mmol/L (100 mg/dL) or the diagnosis of cerebrovascular accident that caused the heart icon to be flagged would be highlighted on the page. In this way, physicians are made aware of their high-risk patients and why their patients are at high risk. Additional references, specifically the AHA patient management protocols, are linked to this page. Information about blood pressure management, smoking cessation, and medication management is available through these links. The heart icon continues to appear with subsequent admissions to Advocate Lutheran General Hospital as long as the patient meets the risk factor parameters.

Nurses use computer-based systems, Eclipsys and LOGICARE Clinical Teachers PET (Logipet), to document patients’ care and summarize discharge instructions. These systems have been part of nursing practice since the mid 1990s and offered an avenue to involve nurses in the program. A screen enhancement that showed a summary of cardiac risk was developed; it lists vital signs, daily weight, body mass index, and laboratory values. These parameters are referred to by nurses during the discharge process. An assessment script was written by the director of clinical informatics and incorporated into the discharge instructions software. The script includes questions about smoking, blood pressure, body mass index, levels of low-density lipoprotein, and secondary risk-reduction therapy if that has not already been done.

**Physicians’ Resources**

Initial efforts to provide physicians with resources that illustrated the AHA guidelines and pharmacological recommendations included the development of chart dividers and posters. These dividers (Figure 4) became a component of the medical records of adults and are located behind the progress notes. The posters were strategically placed in adult patient care units and served as a resource for all health professionals. The information systems physician-liaison provided “hands-on” demonstration/education in the physicians’ lounge of the enhancements to the CareNet System. Physicians were able to simulate links from the census screen and visualize identification of high-risk patients. They also were provided with an example

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**Table 1** Parameters used to trigger REACH alerts

<table>
<thead>
<tr>
<th>Laboratory values (based on American Heart Association’s Adult Treatment Panel III guidelines)</th>
<th>Admitting diagnoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-density lipoprotein cholesterol &gt;2.59 mmol/L (&gt;100 mg/dL)</td>
<td>Acute myocardial infarction</td>
</tr>
<tr>
<td>Fasting blood glucose &gt;6.9 mmol/L (&gt;125 mg/dL)</td>
<td>Angina</td>
</tr>
<tr>
<td>Triglycerides &gt;2.26 mmol/L (&gt;200 mg/dL)</td>
<td>Arrhythmia</td>
</tr>
<tr>
<td>High-density lipoprotein cholesterol &lt;1.03 mmol/L (&lt;40 mg/dL)</td>
<td>Cardiac arrest</td>
</tr>
<tr>
<td>Troponin I &gt;0.1 µg/L*</td>
<td>Cerebrovascular accident</td>
</tr>
<tr>
<td>Nonfasting blood glucose &gt;11.1 mmol/L (&gt;200 mg/dL)*</td>
<td>Chest pain</td>
</tr>
<tr>
<td></td>
<td>Congestive heart failure</td>
</tr>
<tr>
<td></td>
<td>Coronary artery disease</td>
</tr>
<tr>
<td></td>
<td>Diabetes</td>
</tr>
<tr>
<td></td>
<td>Gangrene</td>
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<tr>
<td></td>
<td>Hypertension</td>
</tr>
<tr>
<td></td>
<td>Pulmonary edema</td>
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<tr>
<td></td>
<td>Renal failure</td>
</tr>
<tr>
<td></td>
<td>Transient ischemic attack</td>
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</tbody>
</table>

* Values not part of American Heart Association guidelines but included to expand our identification of high-risk population.
Nurses' Involvement

Nurses' role in the REACH Program included performing the risk assessment and teaching patients about risk-reduction strategies. Incorporating the risk assessment into the existing discharge instruction template required minimal education because the additions were intuitive to the end users. The educational goal was to get more than 900 nurses (critical care and adult medical-surgical) educated in all aspects of secondary prevention strategies. Videotape and self-study training materials

of the risk assessment summary that a nurse would complete at discharge.

Abbreviations: BP, blood pressure; FBS, fasting blood glucose; LDL, low-density lipoprotein cholesterol; NCEP ATP III, National Cholesterol Education Program Adult Treatment Program III; REACH, Risk Evaluation in Action for Cardiovascular Health.

Figure 2 REACH page.
modules were selected as educational formats for the nursing professionals.

In conjunction with the media services department of the Advocate Health Care System, a nursing education video was developed that reviewed risk for coronary heart disease, clinical practice guidelines, and the new program. A REACH team cardiologist participated in an on-camera discussion about the magnitude of cardiovascular disease and contributions that healthcare providers can make to the management of this disease. In addition, the video showed a nurse completing the on-line risk assessment and sharing the information with a patient during the discharge process. The self-study module complemented the video and served 3 purposes: it reinforced information about cardiovascular risk prevention, provided staff members with a tangible resource, and provided managers with a mechanism to track participation by means of a module completion quiz. The educational process for nurses started 30 days before the “go live” date. Starting this early provided ample time for staff members to complete the process and internalize this content. It also allowed team members to interact with staff informally and to provide additional information about the program.

Patients’ Education

Education materials for patients are available in pamphlet format for distribution or video format for observation. The Logipet system was modified to include information sheets about cholesterol management and risk factors as well as content on smoking cessation. Nurses can access this information and give it to patients to take home. A video was developed and is shown to patients on the hospital’s educational channel. The video reviews information on reducing secondary risks, including all aspects of atherosclerotic vascular disease, diabetes, signs and symptoms of disease, risk factors, and treatments, including pharmacological and behavioral therapies. It is shown several times during the day for patients to view in their hospital rooms.

Implementation

Implementation of the program was divided into 2 phases: the first phase included critical care units...
and the cardiac catheterization laboratory; the second, 7 adult medical-surgical units. This division was done for 2 reasons. Critical care units are involved in the majority of hospital discharges for cardiovascular diagnoses. In addition, by limiting the scope to a few units, the team was able to evaluate the effect of the program on current processes.

Before implementation, the nurses on the team met with the nursing director and managers of critical care units to explain the program and how we hoped to affect patients’ management. The managers’ support of this initiative was a valuable asset in the implementation phase, because they agreed to participate in the program and to provide evaluation. This phase resulted in minor “tweaking” of the risk assessment script. Generally speaking, the team was more than satisfied and began planning for implementation in the medical-surgical units.

In preparation for phase 2, a subgroup of the team met with the director and managers of the medical-surgical section to present the program. Targeting patients with cerebrovascular disease, peripheral vascular disease, and diabetes was the focus of the presentation. After support was obtained from the medical-surgical group to include assessment of risk factors and management of their identified patients at discharge, phase 2 implementation was launched. Nursing personnel were educated through the same program as established for critical care. This training was done 30 days before implementation in April 2002.

**REACH Methodology**

As stated earlier, the outcomes measurement used for REACH included evidence of AHA-endorsed management strategies in high-risk patients. Management strategies evaluated were limited to the AHA recommended pharmacological therapy for risk reduction as part of the treatment plan on the day of discharge.

High-risk patients included 4 subgroups (Table 2). Three subgroups were queried on the basis of their discharge diagnoses: cardiac diagnosis or procedure (group 1), cerebrovascular diagnosis or procedure (group 2), and peripheral vascular diagnosis or procedure (group 3). Cardiac diagnoses were based solely on diagnosis-related groups, whereas peripheral and cerebrovascular groups were obtained by checking codes from the
International Classification of Diseases, 9th Revision. Previous hospital data indicated that the majority of admissions for acute coronary syndromes were managed by using coronary interventions or surgery. Therefore, use of the diagnosis-related group format would include this high-risk category. The fourth group included patients who had diabetes as a secondary diagnosis. Regardless of their admitting diagnosis, patients who also were diabetic were included in this group. In this way, general medicine and surgical patients with diabetes who were not included in the previous high-risk groups could be evaluated.

The hospital’s quality management department obtained data by using Transition Systems International, which is an electronically based hospital financial system. The system was used to obtain outcome criteria on the day of discharge for the 4 high-risk groups. Three time intervals were evaluated: REACH baseline (January-June 2001), 1 year (2002), and 2 years (2003) after REACH implementation. For discussion purposes, analysis is limited to results from the baseline before REACH and from 2 years after REACH was implemented. A t test was used to compare the baseline and 2-year proportions. Statistical significance level was set at .05. Statistical analysis was completed by using a software package (SPSS 7.5 for Windows, SPSS Inc, Chicago, Ill) as determined by the Advocate Health Care System research department.

### REACH Results

Improvement was noted in all 4 high-risk groups at the second year of implementation. Patients in group 1 (cardiac diagnosis or procedure) had significant improvement in 3 of the 5 outcomes (Figure 5). Patients receiving antiplatelet therapy (P = .30) and ACE inhibitors or ARBs (P = .08) at the time of discharge both showed improvement, although not significant. This group had a mean of 1500 patients annually and had the most improvement overall. Group 2 (cerebrovascular diagnosis or procedure) included half as many participants as group 1 but had significant improvement in all 5 outcomes (Figure 6). Group 3 (peripheral vascular diagnosis or procedure) involved a small sample size and had significant improvement in 2 outcomes: lipid therapy (P = .05) and β-blockers (P < .001; Figure 7). Group 4, which includes patients with diabetes, was the largest high-risk group.

### Table 2 REACH high-risk subgroups

<table>
<thead>
<tr>
<th>Group 1, Cardiac diagnosis or procedure</th>
<th>Diagnostic cardiac catheterization</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Coronary artery bypass surgery</td>
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<tr>
<td></td>
<td>Coronary intervention (ie, angioplasty, stenting)</td>
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<tr>
<td></td>
<td>Coronary valve surgery</td>
</tr>
<tr>
<td></td>
<td>Congestive heart failure</td>
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<tr>
<td>Group 2, Cerebrovascular diagnosis or procedure</td>
<td>Cerebrovascular accident</td>
</tr>
<tr>
<td></td>
<td>Transient ischemic attack</td>
</tr>
<tr>
<td></td>
<td>Carotid artery intervention (ie, angioplasty, stenting)</td>
</tr>
<tr>
<td></td>
<td>Carotid endarterectomy</td>
</tr>
<tr>
<td>Group 3, Peripheral vascular diagnosis or procedure</td>
<td>Peripheral vascular disease</td>
</tr>
<tr>
<td></td>
<td>Peripheral vascular intervention (ie, angioplasty, stenting)</td>
</tr>
<tr>
<td></td>
<td>Peripheral vascular bypass surgery (ie, iliac, femoral)</td>
</tr>
<tr>
<td>Group 4, Secondary diagnosis of diabetes</td>
<td></td>
</tr>
</tbody>
</table>


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**Figure 5** Patients with cardiac diagnosis or procedure (cardiac surgery, cardiac intervention, heart failure). Antiplatelets category includes aspirin, clopidogrel, dipyridamole, and ticlopidine. Total number of patients: January-June 2001, 783; 2002, 1521; 2003, 1444.
The annual number of patients (mean 3815) within this group clearly indicates the potential impact of the program. Significant improvement in 4 of the 5 outcomes ($P < .001$ in lipid therapy, $\beta$-blockers, and lipid profile monitoring; $P = .003$ in ACE inhibitors or ARBs) was achieved (Figure 8).

Improvement was also noted in antiplatelet therapy, although it was not statistically significant.

**Discussion**

Results at the end of the second year indicated improvement in risk reduction management in high-risk patients. Significant improvement was seen in various categories of all 4 high-risk groups. The team, although encouraged with the results, acknowledged that suboptimal practice for secondary risk reduction continued in all 4 groups.

**Antiplatelet Therapy**

Only 1 high-risk group (cerebrovascular diagnosis or procedure) had significant improvement ($P < .001$) in antiplatelet therapy at discharge. Antiplatelet therapy included aspirin, clopidogrel (Plavix), ticlopidine (Ticlid), and dipyridamole (Persantine). This therapy reduces the risk of subsequent vascular events by 22%.

**Cerebrovascular Diagnosis or Procedure**

The data on patients who had a cerebrovascular diagnosis or procedure indicated that less than 35% of the patients had a lipid profile assessed and subsequent management before discharge. These patients were discharged from units that were involved in the phase 2 implementation. Efforts to increase availability of lipid profiles will be addressed by including this laboratory test on the prewritten admission orders for this group of patients. Availability of abnormal results of a lipid profile will trigger initiation of lipid therapy in the treatment plan to reduce secondary risks.

**Diabetes**

A deficiency exists in using CareNet to prospectively identify patients with diabetes because the triggers include only abnormal fasting and nonfasting blood glucose levels at the time of admission. The team members agree that patients...
with normal blood glucose levels, although not identified on admission, are still in a high-risk category. Fortunately, through the Logipet script, this population will be identified by nurses as being at risk and will receive a risk assessment at discharge. In order to identify all patients with diabetes at the time of admission, the trigger parameters were revised to include antihyperglycemic medications. The heart icon was enhanced with a superimposed D, distinguishing patients with diabetes from other high-risk groups. We anticipate a significant impact in the identification and management of patients with diabetes with implementation of this enhancement. Mechanisms to further engage physicians in the management of patients with diabetes include a label that is applied to the front of a patient’s chart upon admission and a link off the REACH page that provides “Diabetes Treatment Guidelines.” The label, which includes the enhanced heart icon, reminds physicians to consider secondary prevention strategies, which include obtaining a lipid profile and acting on the results.

Sharing Results
Results were shared with physicians at division meetings and nursing staff at unit meetings. Nursing unit data were presented as a comparison of the unit to the hospital as a whole. Staff members were asked for input and feedback, and a healthy exchange of comments occurred, including having staff members set goals for future measurement of outcome criteria. Nurses’ knowledge of the REACH program and its impact on their specific populations of patients were also discussed at these meetings. Nurses on the REACH team offered to collaborate with units on additional educational needs regarding the program.

REACH Substudy
The team was interested in evaluating the relationship of prospective identification to discharge assessment in the high-risk populations. Did prospective identification (heart icon alert) influence discharge management (REACH assessment)? A pharmacy intern evaluated this question in 2 high-risk groups. An audit of group 1 (cardiac diagnosis or procedure) and group 4 (secondary diagnosis of diabetes) was conducted in January 2002, and the results were compared with the results of January 2003. With sample sizes being equal, the data revealed a significant improvement (P = .05) in all outcome criteria in patients who had a cardiac diagnosis or procedure and in patients who had diabetes in January 2003.

Conclusion
Cardiovascular disease has a major impact socially, economically, psychologically, and physiologically and continues to be the leading cause of death in the United States. The ATP III guidelines must be embraced by healthcare providers and patients in order to attain the highest levels of risk reduction. Although individual practitioners carry the primary responsibility for initiating and monitoring efforts to reduce secondary cardiac risks, institutions participating in the management of these patients must also take responsibility for establishing an environment of care that promotes optimal management of patients. The results of the REACH program indicate that identification of high-risk populations has a direct effect on strategies to reduce secondary risks in the prevention of cardiovascular disease.

Acknowledgments
We thank the REACH team members for their visionary leadership and collaboration in the
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