

Outcomes of a multidisciplinary team approach to cardiovascular risk reduction in patients with diabetes mellitus

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Introduction: Cardiovascular risk reduction can decrease morbidity and mortality in patients with diabetes mellitus; however, it is seldom optimally achieved with standard care. **Methods:** We herein report on the rationale and preliminary results of a clinic model using a multidisciplinary team approach to improve cardiovascular risk management in patients with diabetes mellitus. We assessed risk-factor management for glycemia, dyslipidemia, hypertension and lifestyle in a retrospective survey of patients followed for 1 year or longer, in comparison with cardiology practice patients in a separate clinic at the same institution. **Results:** We demonstrated that intervention by a team including a cardiologist, endocrinologist, certified diabetes educator, dietician, cardiovascular advanced practice nurses and an exercise physiologist resulted in a high percentage of patients at National Cholesterol Education Program goals for secondary prevention of coronary artery disease compared with standard care. A comparison was made with 40 patients in each group with a mean age of 62 years with approximately 50% of those women with an average A1c of 8%. The multidisciplinary approach resulted in a significant decrease in A1c ($p = 0.004$) and triglycerides ($p = 0.002$) compared with standard therapy. There was a trend toward a significant increase in high-density lipoprotein ($p = 0.07$). There were no differences in total cholesterol, low-density lipoprotein, or blood pressure between the two groups. **Conclusion:** Multidisciplinary team care improves risk-factor modification primarily by improving glycemia and dyslipidemia. This model may be useful for enhancing the multiple risk-factor modifications needed to reduce cardiovascular morbidity in patients with diabetes mellitus and the metabolic syndrome.

Diabetes mellitus (DM) is considered a cardiovascular disease equivalent by the National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP)III [1]. The risks of cardiovascular and coronary heart disease are increased two- to fourfold in patients with DM relative to matched control populations without the disease [2]. Even after adjustment for coexisting risks, such as hypertension and dyslipidemia, heart disease risks remain markedly elevated. Some studies suggest that the relative mortality risk for women with diabetes and myocardial infarction is particularly adversely affected [3]. Analysis of the National Health And Nutrition Examination Survey (NHANES) data follow up suggests that men with DM do not benefit from the societal reduction in coronary heart disease morbidity and mortality of the general population; moreover, women with diabetes are reported to have an increasing mortality related to heart disease relative to their peers without DM [4]. The prevalence of Type 2 DM is markedly increasing in the USA and worldwide [5,6], largely related to an increasing prevalence of obesity and sedentary lifestyle. The

number of people at high risk of diabetes, termed 'prediabetes' by the American Diabetes Association, is currently estimated to exceed 40 million people in the USA [7]. In this population, the risk for atherosclerosis is clearly increased, even prior to the diagnosis of Type 2 DM.

The prevalence of the metabolic syndrome with its multiple coronary heart disease risk factors including glucose intolerance, dyslipidemia, central obesity, hypertension and chronic inflammation, is largely responsible for the high prevalence of coronary heart disease at the onset of diabetes and even before its onset [7]. The NCEP ATP III panel has emphasized the importance of the metabolic syndrome and of the need for therapeutic lifestyle modifications in the prevention of vascular disease. Many studies suggest that neither control of lifestyle nor the medical risk factors for atherosclerosis are often achieved [8]. Lifestyle intervention in people with the metabolic syndrome, prediabetes and DM can clearly succeed, however, as exemplified by the Diabetes Prevention Program [9].

Keywords: atherosclerosis, cardiovascular disease, diabetes, dyslipidemia, multidisciplinary, outcomes



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Control of hyperglycemia in DM is an important factor for control of dyslipidemia and coronary heart disease risk, although the findings of the UK Diabetes Prospective Study Group (UKPDS) intensive intervention study just missed significant reduction (16% reduction; $p = 0.052$) in myocardial infarction through a median A1c reduction of 0.9% [10,11]. Therapies such as insulin to control hyperglycemia are likely to be especially beneficial to the heart based on studies such as Diabetes Mellitus Insulin-Glucose Infusion in Acute Myocardial Infarction (DIGAMI) [12] and recent work showing benefits of glycemic control in critically ill patients with hyperglycemia [13]. Control of glycemia and use of insulin are not approaches that cardiologists are able to routinely effectively implement in their practices. Classic studies such as the Diabetes Control and Complications Trial (DCCT) and recent work have suggested the importance of nonphysician professional and interim (i.e., between physician scheduled visits) patient contacts as crucial to achieving recommended glycemic targets [14,15].

Lifestyle intervention for therapeutic benefit to cardiovascular risk and control of the metabolic syndrome are also seldom applied effectively. In order to circumvent such limitations, the Heart Center at the University of Virginia, USA, in conjunction with the Division of Endocrinology and Metabolism, has initiated a clinical program encompassing a multidisciplinary team approach to improve prevention – including therapeutic, lifestyle and glycemic control. This particular team approach is unique in that it consists of an endocrinologist, cardiologist, cardiovascular advanced practice nurses, dietician, certified diabetes educator and exercise physiologist as a single team providing collaborative patient care. The results presented here represent a

retrospective, cross-sectional comparison between multidisciplinary care and conventional care and are a preliminary look at whether there is evidence for the success of this approach.

Methods
Patient population & study design

This study was a retrospective analysis of risk factor modification in patients with DM and cardiovascular disease. Patients with a previous diagnosis of DM as defined by the American Diabetes Association (ADA) and some form of cardiovascular disease as documented by the cardiologist were included. Patients were either treated with conventional therapy or by a team-based approach in the Diabetes Cardiovascular Clinic. Patients treated in the Diabetes Cardiovascular Clinic were previously referred by either their primary care physician or, more often, their cardiologist. A total of 40 patients were analyzed in each group with the majority (>95%) of patients having Type 2 DM. Laboratory data represent fasting values obtained at initiation of treatment and after at least one year and up to 2 years of care. All data were obtained by review of patient medical records and clinic charts. Baseline characteristics are shown in Table 1.

Details of treatment regimens

Conventional therapy in this study consisted of management of cardiovascular disease by a cardiologist at the University of Virginia and management of DM by either a primary care physician or endocrinologist either within the university or in the private sector. No specific educational program was used among participants nor was any specific education given to physician caregivers. It was assumed that all physicians were aware of the current guidelines for cardiovascular and diabetes management as

Table 1. Baseline and final measurements.					
	Conventional		Team approach		p-value*
	Initial	Final	Initial	Final	
Hemoglobin A1c	8.0 ± 0.46	8.27 ± 0.35	79 ± 0.21	7.08 ± 0.35	0.004
Total cholesterol	176 ± 10.5	159 ± 8.6	178 ± 7.1	165 ± 6.2	0.54
Low-density lipoprotein	96 ± 8.8	88 ± 5.3	102 ± 3.9	94 ± 5.4	0.40
High-density lipoprotein	43 ± 0.46	40 ± 1.7	41 ± 1.4	45 ± 1.9	0.07
Triglycerides	211 ± 24	222 ± 20	203 ± 22	148 ± 12	0.002
Systolic BP	140 ± 3.1	128 ± 3.2	141 ± 3.2	130 ± 2.8	0.64
Diastolic BP	79 ± 1.6	79 ± 1.8	80 ± 1.5	74.3 ± 1.7	0.73

*p value represents a comparison of final values between groups.
BP: Blood pressure.

set forth by the NCEP ATP III panel and the ADA and/or American College of Endocrinology and that therapeutic targets included achievement of these recommended goals. Referral to diabetes educators, nutritionists or exercise physiologists for lifestyle modification was left to the discretion of the physician.

Multidisciplinary therapy was delivered by a cardiologist, an endocrinologist, cardiovascular advanced practice nurses, a certified diabetes educator, a dietician and an exercise physiologist. The patient was assessed by each of the team members at a single initial visit and follow-up was tailored to individual needs. Physician visits occurred on an average of every 3 to 4 months, with nonphysician visits occurring on a more frequent basis as deemed necessary by the team. The goal of intensive therapy was to achieve NCEP ATP III and/or ADA guidelines for A1c (<7%), total cholesterol (<200 mg/dl), low-density lipoprotein (LDL) (<100 mg/dl), high-density lipoprotein (HDL) (>45 mg/dl), triglycerides (<150 mg/dl), blood pressure (systolic <130mmHg, diastolic <80mmHg) (Table 2).

Goals also included advice on healthy body-mass index (BMI), smoking cessation, and exercise and nutrition counseling. Diabetes education was aimed toward achieving an understanding of the behaviors needed for self care. This included information about blood glucose monitoring, relationship of food/nutrients to blood glucose, using glucose-lowering medications properly, (including insulin and various insulin delivery systems), effect of stress on glucose, effects of smoking on cardiovascular

disease, as well as the importance of exercise in reducing cardiovascular events and controlling diabetes. Nutrition prescriptions were individualized based on patient needs. Exercise regimens were designed according to the level of patient fitness and referrals made to cardiac rehabilitation programs as deemed necessary by the team. The National Diabetes Education Program (NDEP) message emphasizing the link between heart disease and diabetes control is included in the team's overall approach to reaching target goals – ABC's of diabetes [101]:

- A: A1c hemoglobin
- B: Blood pressure
- C: Cholesterol and lipid control

Dyslipidemia was managed with initial use of a statin drug and addition of a second agent (i.e., fibrates, ezetimibe, niacin, thiazolidinediones and omega 3 fatty acids) if needed to further reduce LDL, raise HDL, or reduce triglycerides to meet recommended goals. Hypertension was managed using a stepwise approach with the goal of all patients receiving angiotensin-converting enzyme inhibitor and/or angiotensin receptor blocker therapy unless contraindicated.

Measurements

Blood samples were obtained after overnight fasting (at least 8 h) and prior to morning medications. Results represent at least 1, but not more than 2 years, of therapy in the multidisciplinary group. Results were obtained for HbA1c, total cholesterol, LDL, HDL, triglycerides, systolic and diastolic blood pressure. Results are reported as the final value and as the percentage of patients reaching goal in each group.

Statistical analysis

Results are expressed as the geometric mean plus standard error of the mean, unless otherwise indicated. Statistical significance was determined using a non-paired, two-tailed t-test with the level of significance set at 0.05.

Results

Baseline characteristics for participants

The mean age in the team-based approach group was 62.1 with 45.2% female and the mean patient age in the conventional-approach group was 62.3 with 50% female. Baseline measurements are shown in Table 1. It should be noted that for each risk factor category below, there was no statistically significant difference between the levels achieved in men and women.

Table 2. Current guidelines for risk factor modification in diabetes.

Risk factor	
LDL	<100 mg/dl*
High-risk LDL	<70 mg/dl*
HDL Men	>40 mg/dl*
HDL Women	>50 mg/dl*
Triglycerides	<150 mg/dl*
Non-HDL-C	<130 mg/dl†
A1c	<7.0%‡
Blood pressure	<130/80 mmHg§

*NCEP ATP III and ADA recommendations; †NCEP ATPIII recommendations if triglycerides > 200 mg/dl;

‡American Diabetes Association recommendations.

HDL: High-density lipoprotein; LDL: Low-density lipoprotein; NCEP ATP: National Cholesterol Education Program Adult Treatment Panel.

Diabetes management

There was a significant difference between final A1c values in the team-approach group versus the conventional group: $7.08\% \pm 0.35$ vs. $8.27\% \pm 0.35$, respectively; $p = 0.004$ (Figure 1), which represents an A1c difference (1.19%) greater than achieved in UKPDS. The percentage of patients reaching the ADA goal of less than 7% A1c was 57.5% for the team approach versus 30% for the conventional approach (Figure 2). Indeed, a 30% achievement of A1c goals is consistent with published data providing further evidence that the multidisciplinary approach produces more favorable outcomes [16,17]. Furthermore, if one were to use the more stringent glycemic standards of the American College of Endocrinology (ACE) the percentage of patients reaching the ACE target goal of less than 6.5% was 42.5% (17 out of 40) in the team-approach group and 17.5% (7 out of 40) in the conventional group. Indeed, there was a small increase in average A1c in the conventional group. Comparison to baseline levels is shown in Table 1.

Lipid management

Final total and LDL cholesterol levels did not differ between groups. Patients in the team-approach group had total cholesterol levels of

$165.3 \text{ mg/dl} \pm 6.2$, compared with $159 \text{ mg/dl} \pm 8.6$ in the conventional group; $p = 0.5$ (Figure 3). Similarly, there was no difference in the percentage of patients reaching target goal of less than 200 mg/dl: 86.8% (33 out of 38) in the team-approach group and 84.2% (32 out of 38) in the conventional group (Figure 2). Comparison to baseline levels is shown in Table 1.

LDL levels between groups were $94.4 \text{ mg/dl} \pm 5.4$ in the team-approach group and $88 \text{ mg/dl} \pm 5.3$ in the conventional group, $p = 0.4$ (Figure 4). Percentages of patients reaching the target goal of less than 100 mg/dl were 60.5% (23 out of 38) in the team-approach group and 71% (27 out of 38) in the conventional group (Figure 2). It should be noted that the percentage of patients reaching LDL goal in both groups is high in comparison to the 33% suggested in literature [16]. Comparison to baseline levels is shown in Table 1. As this study was completed prior to new recommendations from the NCEP ATP III panel, it should also be noted that current guidelines are less than 70 mg/dl in very high-risk patients including those with an acute coronary syndrome and those with cardiovascular disease and one of the following comorbidities: DM, metabolic syndrome, poorly controlled hypertension or smoking.

There was a significant reduction in the triglyceride levels achieved with multidisciplinary team care: $148 \text{ mg/dl} \pm 12$ in the team-approach group and $222 \text{ mg/dl} \pm 20$ in the conventional group; $p = 0.002$ (Figure 5). A total of 63.2% (24 out of 38) of patients in the team-approach group reached a goal of less than 150 mg/dl versus 34.2% (13 out of 38) in the conventional group (Figure 2). Furthermore, final values in the conventional group were higher than initial values. A comparison to baseline levels is shown in Table 1. The NCEP ATP III recommends in patients with triglycerides greater than 200 mg/dl, typical of DM and the metabolic syndrome, that a non-HDL-cholesterol goal of less than 130 mg/dl be achieved after LDL goal is reached. Non-HDL-cholesterol levels between groups were not statistically different: $120 \text{ mg/dl} \pm 6.3$ in the multidisciplinary group and $118 \text{ mg/dl} \pm 8.9$ in the conventional group, $p = 0.9$ (Figure 6). There was a trend towards improved HDL levels in the team-approach group with $45.3 \text{ mg/dl} \pm 1.9$ versus $40.5 \text{ mg/dl} \pm 1.7$ in the conventional group; $p = 0.07$ (Figure 7). A total of 55.3% (21 out of 38) reached the target goal of 45 in the team-approach group versus 31.6% (12 out of 38) in the conventional group (Figure 2). Comparison with baseline levels is shown in Table 1.

Figure 1. Final A1c values in the team-approach group versus the conventional group.

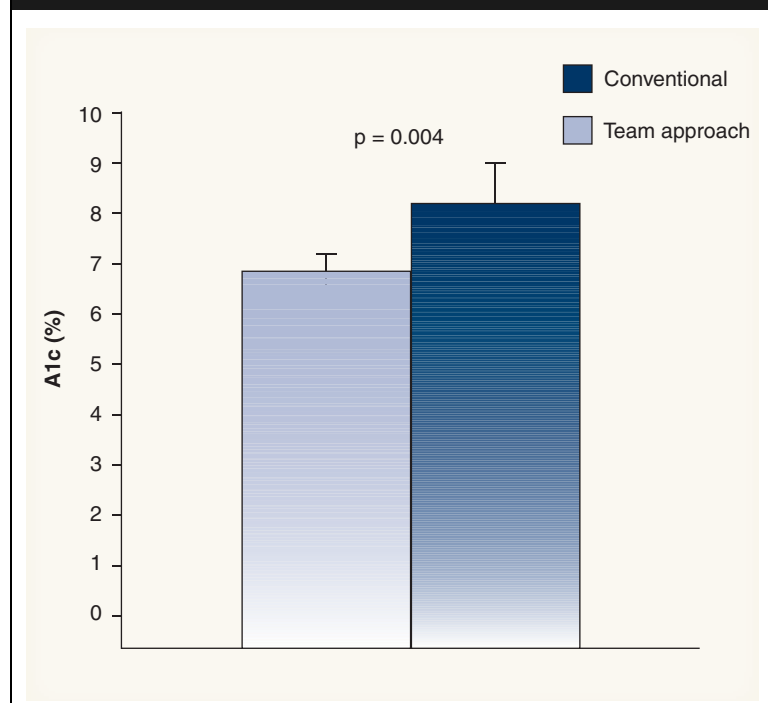
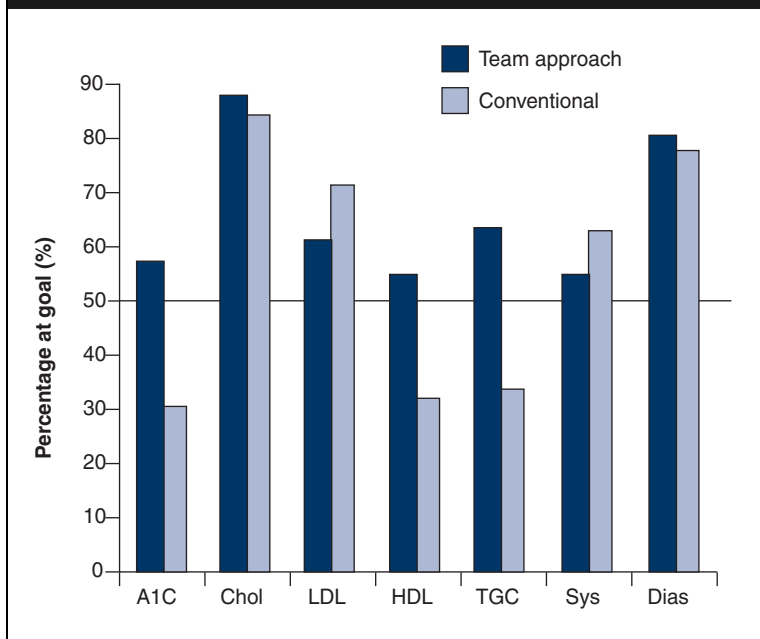


Figure 2. Percentage of patients reaching the ADA goal of less than 7% A1c for the team approach versus the conventional approach.



Blood pressure management

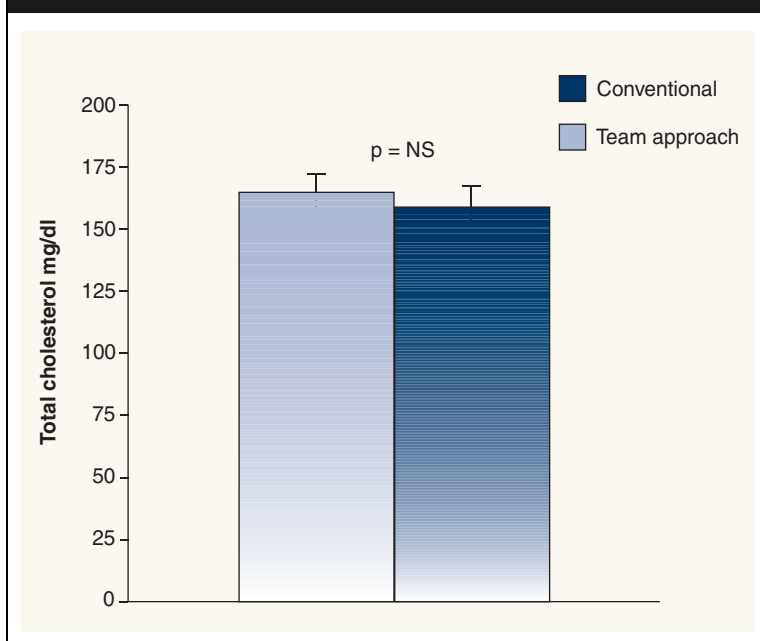
There were no significant differences between systolic and diastolic blood pressures in the final measurements between the two groups. The mean systolic blood pressure in the team-approach group was $130.2 \text{ mmHg} \pm 2.8$ versus $128.2 \text{ mmHg} \pm 3.2$ in the conventional group; $p = 0.6$ (Figure 8). The

mean diastolic blood pressure in the team-approach group was $74.3 \text{ mmHg} \pm 1.7$ versus $73.4 \text{ mmHg} \pm 1.8$ in the conventional group, $p = 0.7$ (Figure 8). A total of 55.0% (22 out of 40) reached target systolic blood pressure ($<130 \text{ mmHg}$) in the team-approach group versus 62.5% (25 out of 40) in the conventional group (Figure 2). A total of 80% (32 out of 40) reached target diastolic blood pressure ($<80 \text{ mmHg}$) in the team-approach group versus 77.5% (31 out of 40) in the conventional group (Figure 2). Again it should be noted that the percentage of patients reaching blood-pressure goals in both groups is much higher than that suggested in the literature [16]. A comparison with baseline values is shown in Table 1.

Other lifestyle modifications

Rates of counseling patients for smoking cessation, exercise and diabetes education were high in the team approach. At the end of the observation period, 89% of patients were nonsmokers, while 83% had exercise counseling documented and 98% had referral for nutrition counseling that was documented. The average BMI of the team-approach group was 32.6 at initiation and 32.4 at end. There were several patients who had a significant decrease in BMI; however, most did not. This may potentially be due to insulin use or muscle-weight gain secondary to exercise. Due to incomplete or difficult-to-identify documentation in charts regarding these issues in the conventional approach, we have not felt that we could make a valid statistical or numerical comparison.

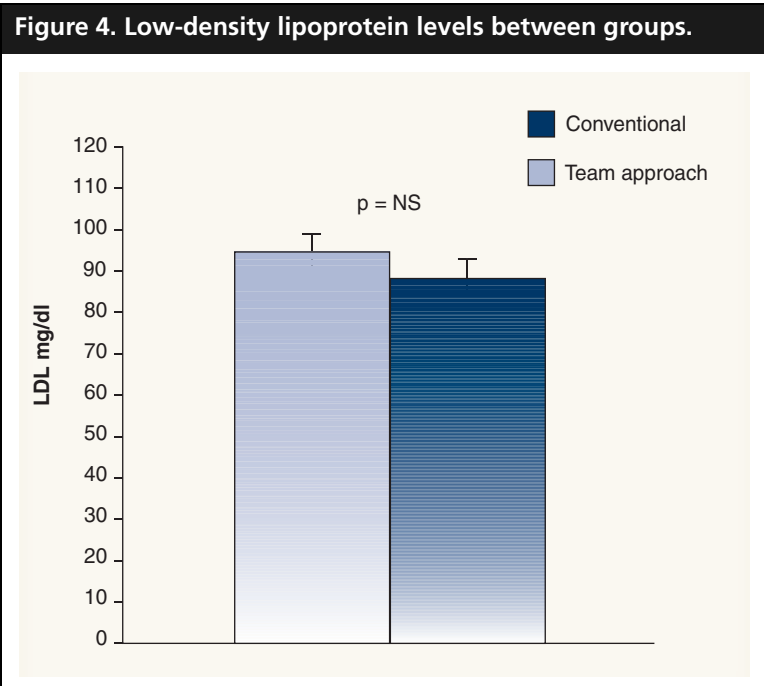
Figure 3. Total cholesterol levels in the team-approach versus the conventional group.



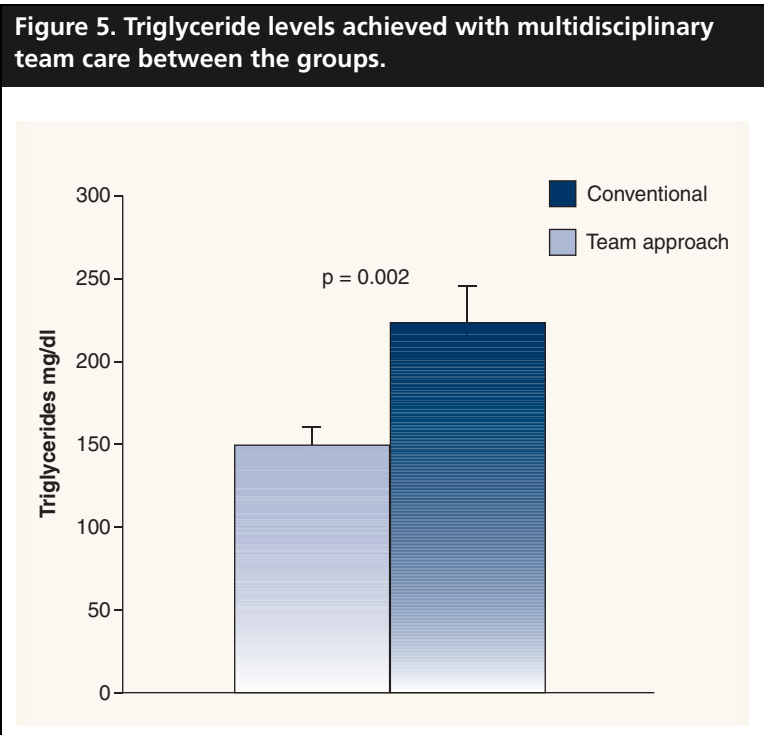
Discussion & expert commentary

The primary finding of this preliminary investigation is that a multidisciplinary team approach can enhance cardiovascular risk management in patients with DM. It is certainly important to note that both the team and conventional care achieve equal and substantial risk reduction for blood pressure (55 and 62.5% for systolic, and 80 and 77.5% for diastolic), goals commonly not achieved in reported literature [16,18]. Similarly, NCEP goals for LDL and total cholesterol levels were achieved in most patients using both the conventional cardiology and team approach and results far exceed literature reports on their achievement [8,16,17,19,20].

The areas in which the team approach benefits come through in this setting are most clearly in improved glycemic and dyslipidemic metabolic control. A1c is clearly reduced (by more than 1%) and it is very likely that such a reduction is also an important factor in reducing the serum triglycerides. Although not estimated in this



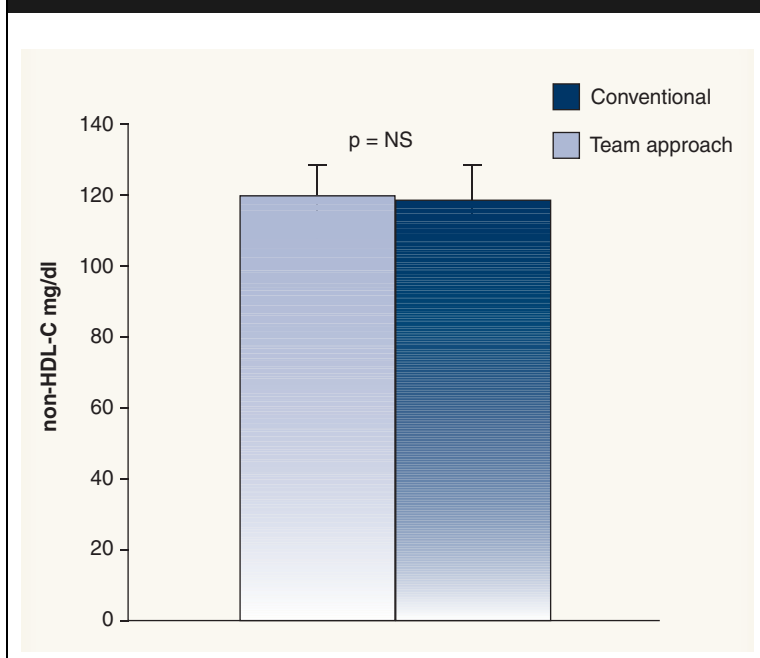
analysis, glycemic control that substantially reduces triglyceride concentrations can favorably influence the proportion of small dense LDLs present and favorably affect HDL2 fractions as well [21]. The trend for improvement in HDL (nearly a five point average change) may be related to the better metabolic control, more aggressive lifestyle modification, or possibly more aggressive use of HDL-modifying agents.



Despite heightened awareness of the need for greater cardiovascular risk-factor modification, recent studies provide evidence that current cardiovascular risk-factor modification achieved in the diabetic population is far from optimal [8,18,22,23]. For example, a prospective observational analysis of diabetic patients undergoing elective cardiac catheterization revealed that only 21% of diabetics reached A1c goals, 52% reached LDL goals, 22% of men and 18% of women reached HDL goals, 76% reached triglyceride goals, 10% reached blood pressure goals and only 10.8% reached BMI goals [8]. Furthermore, recent data from the American Diabetes Association provides evidence that only 37% of patients with Type 2 diabetes, with or without coronary artery disease, achieve target LDL levels of less than 100 mg/dl (previously recommended goal), indicating that cardiologists, endocrinologists, or primary care physicians separately are not consistently able to meet currently accepted goals.

Indeed, poor risk factor modification contributes to increased cardiovascular events and mortality in the diabetic population [24]. UKPDS presents evidence that controlling blood sugar certainly creates a trend toward lowering cardiovascular events and mortality, although not statistically significant, suggesting that a more comprehensive program of risk-factor modification and lifestyle intervention may be of benefit in the diabetic population [10]. Indeed, there is evidence to suggest that lifestyle intervention and aggressive, targeted management of multiple risk factors decrease cardiovascular events and mortality in the diabetic population to a greater degree than studies targeting one risk factor alone [11,25–28]. The Steno-2 study demonstrated a 50% reduction in cardiovascular events with intensive, multifactorial, risk factor intervention versus conventional management despite the fact that all goals were not met and not all measurements were statistically different between groups [24]. Intensive therapy significantly decreased systolic and diastolic blood pressures, fat intake, A1c, total cholesterol and LDL. Despite such intensive intervention, less than 20% reached an A1c goal of 6.5%, less than 50% reached a systolic blood pressure goal of 130 mmHg, and less than 60% reached a triglyceride goal of 150 mg/dl [24]. This study nonetheless supports the idea that small changes in multiple risk areas over time can make a large difference in patient outcomes.

The largest hurdle to aggressive risk factor modification is the development of a care organization that can effectively implement a focused

Figure 6. Non-HDL-cholesterol levels between groups.

intervention encompassing individualized patient education, lifestyle intervention, and aggressive, targeted risk-factor modification. We present a model consisting of physicians and educators in which a cardiologist, endocrinologist, cardiovascular advanced practice nurses, certified diabetes educator, dietician and exercise physiologist collectively contribute to patient care, education,

lifestyle modification, and targeted goal achievement. The benefits of this approach are several. This environment provides access to diabetes and cardiovascular management and education in lifestyle modification in a single encounter with a goal of enhancing patient compliance with scheduled visits and enhancing physician communication. Furthermore, education provided by the nonphysician staff, both at the initial visit and between visits, is expected to enhance compliance with physician recommendations. It is likely that these assumptions are true based on evidence of improved risk factors and greater percentages of patients reaching goals in the team-based approach. Furthermore, differences between the two groups are seen after as early as 1 to 2 years of treatment. Benefits may be even greater with longer term follow-up. It is also likely that a greater benefit would be seen if results were compared with percentage achievement of goal currently available in the literature as conventional care in this setting is somewhat superior to that reported in the literature. Finally, the possibility that patients attending the combined clinic may be more motivated than those in standard care may contribute to the differences between groups.

Outlook

Future directions should focus on demonstrating whether risk-factor reduction in this setting, does indeed translate into decreased cardiovascular events and mortality. If so, then a mechanism of implementing this strategy should be developed so that this approach can be translated across multiple care settings. In addition, comparing cardiovascular events and mortality between men and women will be particularly interesting, as this study suggests that the higher rate of events in women, as documented by the literature, may not be due to poorer achievement of goals. Finally, in order to be feasible in our society, careful cost analysis must be carried out to determine if such an approach is organizationally and financially realistic and cost effective. It is feasible that cost will be increased in the initial period of care due to medication expenses and professional costs, but it is likely that cost effectiveness will be achieved secondary to significant decreases in complications, hospitalizations and time lost from work in the years after multidisciplinary care is initiated. This multidisciplinary team based approach to

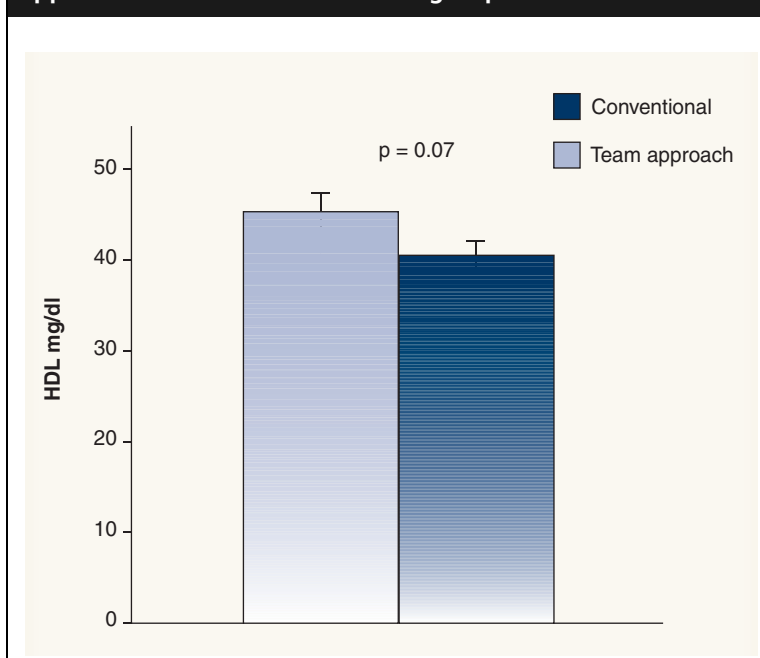
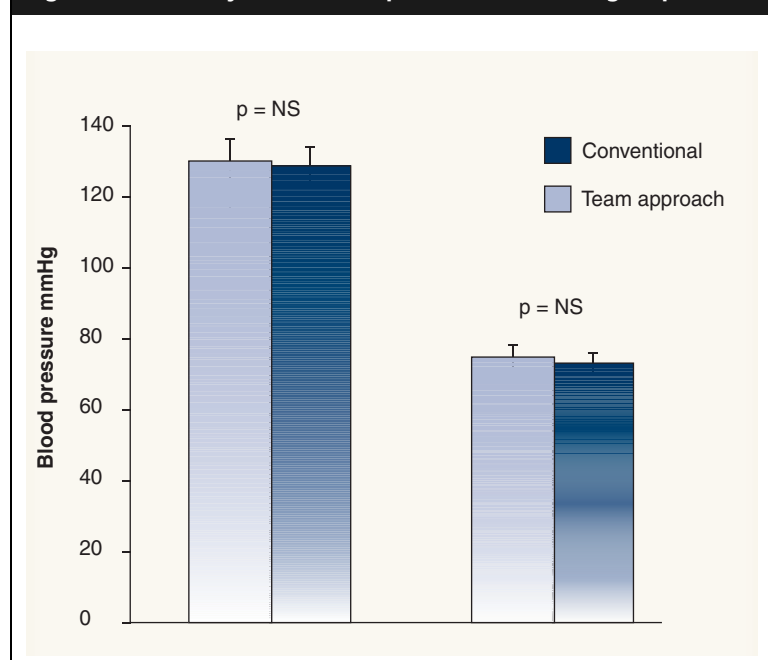
Figure 7. Trend towards improved HDL levels in the team-approach versus the conventional group.

Figure 8. Mean systolic blood pressure between groups.

management of cardiovascular disease in a high-risk population with DM provides a potentially effective solution for successful aggressive risk factor modification.

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Highlights

- Despite heightened awareness of the need for greater cardiovascular risk-factor modification, recent studies provide evidence that current cardiovascular risk-factor modification achieved in the diabetic population is far from optimal.
- There is evidence to suggest that lifestyle intervention and aggressive, targeted management of multiple risk factors decreases cardiovascular events and mortality in the diabetic population to a greater degree than studies targeting one risk factor alone.
- The largest hurdle to aggressive risk-factor modification is the development of a care organization that can effectively implement a focused intervention encompassing individualized patient education, lifestyle intervention, and aggressive, targeted risk factor modification.
- We present a model consisting of physicians and educators in which a cardiologist, endocrinologist, certified diabetes educator, dietitian, cardiovascular advanced practice nurses and an exercise physiologist collectively contribute to patient care, education and lifestyle modification resulting in greater targeted goal achievement than standard care.
- This multidisciplinary team-based approach to management of cardiovascular disease in a high-risk population with diabetes provides a potentially effective solution for successful aggressive risk-factor modification.

Bibliography

- Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III): *JAMA* 285(19), 2486–2497 (2001).
- Wingard DL, Barrett-Connor E. Heart disease and diabetes. In: *Diabetes in America* National Diabetes Data Group (Eds), Washington, DC, USA: National Institutes of Health, NIDDK NIH publication no. 95–1468, 429–448 (1995).
- Abbott RD, Donahue RP, Kannel WB, Wilson PW. The impact of diabetes on survival following myocardial infarction in men vs. women. The Framingham Study. *JAMA* 260(23), 3456–3460 (1998).
- Gu K, Cowie CC, Harris MI. Mortality in adults with and without diabetes in a national cohort of the US population, 1971–1993. *Diabetes Care* 21(7), 1138–1145 (1998).
- Engelgau MM, Geiss LS, Saaddine JB *et al.* The evolving diabetes burden in the United States. *Ann. Intern. Med.* 140(11), 945–950 (2004).
- Bonow RO, Gheorghiade M. The diabetes epidemic: a national and global crisis. *Am. J. Med.* 116(Suppl-10S) (2004).
- Kramer D, Raji A, Plutzky J. Prediabetes mellitus and its links to atherosclerosis. *Curr. Diabetes Rep.* 3(1), 11–18 (2003).
- George PB, Tobin KJ, Corpus RA, Devlin WH, O'Neill WW. Treatment of cardiac risk factors in diabetic patients: how well do we follow the guidelines? *Am. Heart J.* 142(5), 857–863 (2001).
- Knowler WC, Barrett-Connor E, Fowler SE *et al.* Reduction in the incidence of Type 2 diabetes with lifestyle intervention or metformin. *N. Engl. J. Med.* 346(6), 393–403 (2002).
- Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with Type 2 diabetes (UKPDS 33). UK Prospective Diabetes Study (UKPDS) Group. *Lancet* 352(9131), 837–853 (1998).
- Tight blood pressure control and risk of macrovascular and microvascular complications in Type 2 diabetes: UKPDS 38. UK Prospective Diabetes Study Group. *Br. Med. J.* 317(7160), 703–713 (1998).
- Malmberg K. Prospective randomised study of intensive insulin treatment on long-term survival after acute myocardial infarction in patients with diabetes mellitus. DIGAMI (Diabetes mellitus, Insulin Glucose Infusion in Acute Myocardial Infarction) Study Group. *Br. Med. J.* 314(7093), 1512–1515 (1997).
- Van Den BG, Wouters P, Weekers F *et al.* Intensive insulin therapy in the critically ill patients. *N. Engl. J. Med.* 345(19), 1359–1367 (2001).
- The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. The Diabetes Control and

- Complications Trial Research Group. *N. Engl. J. Med.* 329(14), 977–986 (1993).
 15. Riddle MC, Rosenstock J, Gerich J, Insulin G. The treat-to-target trial: randomized addition of glargine or human NPH insulin to oral therapy of Type 2 diabetic patients. *Diabetes Care* 26(11), 3080–3086 (2003).
 16. McFarlane SI, Jacober SJ, Winer N *et al.* Control of cardiovascular risk factors in patients with diabetes and hypertension at urban academic medical centers. *Diabetes Care* 25(4), 718–723 (2002).
 17. Saydah SH, Fradkin J, Cowie CC. Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes. *JAMA* 291(3), 335–342 (2004).
 18. Singer GM, Izhar M, Black HR. Guidelines for hypertension: are quality-assurance measures on target? *Hypertension* 43(2), 198–202 (2004).
 19. Pladevall M, Tunicki K, Lafata J. Trends in the management of dyslipidemia in patients with diabetes. P resented at the *64th Scientific Sessions of the American Diabetes Association*, 4–8 June FL, USA (2005) (Abstract).
 20. Cziracy M, Willey V, Bullano M. Assessment of combined lipid goal attainment in 8855 diabetic patients. Presented at the *64th Scientific Sessions of the American Diabetes Association*, 4–8 June FL, USA (2005) (Abstract).
 21. Taskinen MR, Kuusi T, Helve E, Nikkila EA, Yki-Jarvinen H. Insulin therapy induces anti-atherogenic changes of serum lipoproteins in noninsulin-dependent diabetes. *Arteriosclerosis* 8(2), 168–77 (1988).
 22. Coon P, Zulkowski K. Adherence to American Diabetes Association standards of care by rural healthcare providers. *Diabetes Care* 25(12), 2224–9 (2002).
 23. Putzer G, Roetzheim R, Ramirez AM, Sneed K, Brownlee HJ Jr., Campbell RJ. Compliance with recommendations for lipid management among patients with type 2 diabetes in an academic family practice. *J. Am. Board Fam. Prac.* 17(2), 101–107 (2004).
 24. Gaede P, Vedel P, Larsen N, Jensen GV, Parving HH, Pedersen O. Multifactorial intervention and cardiovascular disease in patients with Type 2 diabetes. *N. Engl. J. Med.* 348(5), 383–393 (2003).
 25. Hansson L, Zanchetti A, Carruthers SG *et al.* Effects of intensive blood-pressure lowering and low-dose aspirin in patients with hypertension: principal results of the Hypertension Optimal Treatment (HOT) randomised trial. HOT Study Group. *Lancet* 351(9118), 1755–1762 (1998).
 26. Sacks FM, Pfeffer MA, Moye LA *et al.* The effect of pravastatin on coronary events after myocardial infarction in patients with average cholesterol levels. Cholesterol and Recurrent Events Trial investigators. *N. Engl. J. Med.* 335(14), 1001–1009 (1996).
 27. Prevention of cardiovascular events and death with pravastatin in patients with coronary heart disease and a broad range of initial cholesterol levels. The Long-Term Intervention with Pravastatin in Ischaemic Disease (LIPID) Study Group. *N. Engl. J. Med.* 339(19), 1349–1357 (1998).
 28. Collins R, Armitage J, Parish S, Sleight P, Peto R, Heart Protection Study Collaborative Group. MRC/BHF Heart Protection Study of cholesterol-lowering with simvastatin in 5963 people with diabetes: a randomised placebo-controlled trial. *Lancet* 361(9374), 2005–2016 (2003).
- Website**
101. National Diabetes Education Program (NDEP)
www.ndep.nih.gov
(Accessed June 2005)
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